8th International Soil Science Congress on "Land Degradation and Challenges in Sustainable Soil Management"

May 15 - 17, 2012 Çeşme - İzmir / TURKEY

PROCEEDINGS



Volume-IV

Impact of Climate Change on Soils
Socio-Economic Aspects of Sustainable Land/Soil Management
Soil and Water Conservation
Soil Genesis and Classification

EDITORS
Dr. Huriye UYSAL
Dr. Yusuf KURUCU
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PROCEEDINGS BOOK

http://www.soilcongress.ege.edu.tr

This book of proocedings has been prepared from different articles sent to the congress secretary only by making some changes in the format. Scientific committee regret for any language and/or aim-scope

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PREFACE I



The 8th International Congress on Soil Science was held at the Altınyunus Hotel in Çeşme, Izmir, Turkey, from May 15th to 17th, 2012. The theme for this year was "Land Degradation and Challenges in Sustainable Soil Management". The congress was organized by Ege University's Department of Soil Science and Plant Nutrition, (Agricultural Faculty), and The Soil Science Society of Turkey (SSST). The congress also hosted the 6th International Conference on Land Degradation (ICLD).

The organization of International Soil Science Congresses is a long established custom for the SSST.
The 8 congresses held so far are listed below:

1998, Izmir:	1st International Congress on Soil Science
2000, Konya:	2nd International Congress on Soil Science
2002, Çanakkale:	3rd International Congress on Soil Science, organised by Onsekiz Mart University
2004, Erzurum:	4th International Congress on Soil Science, organised by Atatürk University
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2008, Aydın:	6th International Congress on Soil Science, organised by Adnan Menderes University
2010, Samsun:	7th International Congress on Soil Science, organised by Ondokuz Mayis University
2012, Izmir:	8th International Congress on Soil Science, organised by Ege University

For this 8th International Congress we received more than one thousand abstracts from 54 countries worldwide. After a rigorous evaluation process, 655 of these were chosen for presentation either as seminars or posters during the congress.

There were two plenary lecturers: Prof. Richard Dick from Ohio State University, spoke on soil microbiology and Prof. Dr. Sergei Shoba from the Faculty of Soil Science, Lomonosov Moscow State University, talked about the challenges of soil degradation in arid areas.

The papers have been organized into five volumes according to topics for the Congress Proceedings Book The on-line version of these volumes is accessible at: http://www.soilcongress.ege.edu.tr.

We would like to take this opportunity to express our thanks to all the authors for their efforts in the preparation of these excellent contributions.

Yusuf KURUCU, Ph.D in Soil Science
Chair, The 8th ISSC 2012



PREFACE II

Today the world community has recognized the importance of sustainable use of soil, which is one of the key life-supporting components on the earth. As suggested in UN Conference on Environment and Development (UNCED) in 1992, soil degradation caused by over exploitation of fragile resources and misuse of marginal areas, degrease of potential agricultural areas by sealing, uneven distribution of potentially cultivable areas, declining trends in per capita food production, lack of adaptation of improved technologies by subsistence farmers, non-availability of essential off-farm input to resource poor farmers, and problems such as soil-mining should be considered in soil resources management plans.

Action programs are needed to protect and improve soil health by developing thematic strategies toward protecting soils from numerous of threads such as erosion, decline of organic matter content and biodiversity, sealing, soil salinizaiton, alkalinizitaion, flooding, and many others. Function of soils in environment in relation to human activates should be understood well to manage the soils without declining their quality. Unique role of a specific soil type for environment and human activities should be considered in managing soils to secure soil health, water quality, and food and fiber production for future generations. The evidence that we all depend on the thin layer of earth should be articulated to the people with no knowledge of soil and its importance. In addition, high quality technical information should be available and ready for growers, decision makers, government agencies, and so on for an effective use of science and technology in soil management.

This congress was organized to discuss issues in “land degradation and challenges in soil management”. Interactions among soils, land degradation, and desertification were discussed and importance of soils for a better environmental quality and food security was stressed in the three-day congress. Poster and oral presentations covered a large spectrum of subject areas; including computer modeling, digital mapping, and new techniques and technologies used in data mining, decision making, and other related areas.

I trust that this proceeding will make a vigorous contribution to theoretical and practical soil science, and generate a prolific interest for appreciation of soil’s importance to public well-being. I thank Organizing Committee and all worked and appreciate them for this high quality work.

Sabit ERŞAHIN, Ph.D in Soil Physics
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President of The Eurasian Federation of Soil Science Societies

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VOLUME IV

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Plenary Lectures

Native Shrubs *Piliostigma reticulatum* and *Guiera senegalensis* as Companion Plants: Rhizosphere Hydrology and Microbiology in Relation to Crop Productivity in the Sahel

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The Sahel is experiencing landscape and soil degradation that reduces food and economic security of rural, underprivileged communities that depend on ecosystem services. The Parkland system of randomly distributed trees is an approach to address these challenges, but trees are slow growing and can compete with crops for water and nutrients. Conversely, two native shrubs, *Piliostigma reticulatum* and *Guiera senegalensis,* coexist in farmers' fields throughout the Sahel and until recently have largely been overlooked. It is well established that organic matter input to the soil is critical for improving soil quality and optimizing nutrient and water efficiencies, and ultimately crop productivity in the Sahel. Various non-indigenous vegetative systems have been proposed for the Sahel, but with limited adoption in cropped fields. Consequently, these two shrubs being indigenous and already found in farmers' fields to varying degrees, hold potential to meet these challenges. Unfortunately, the current management of spring coppicing and burning prior to cropping, is not utilizing this organic matter effectively. There has been very little research on how to ecologically or agronomically manage these shrubs. *Therefore, the global objective was to determine the unrecognized ecological function of these shrubs in agroecosystems of Senegal that are representative the Sahel*. To test these hypotheses, our team over the last 5 years, has conducted extensive field based investigations in the Peanut Basin of Senegal that included: ground surveys and remote sensing to determine the landscape levels of shrub C and biomass; hydrology and water relations between shrubs and crops; rhizosphere microbiology; residue decomposition; N and P cycling in relation to crops; and crop productivity. The project, funded by US National Science Foundation, graduated 4 PhD students and 3 post docs. The major findings in Senegal are that:

- shrubs are by far the largest source of organic matter on the landscape in cropped fields
- shrubs increase soil quality
- decomposition rates are rapid enough to allow non-thermal residue management
- shrub roots perform hydraulic lift by moving water from wet sub- to dry surface-soils that appears to drive microbial processes year around and assist crops through drought periods

- shrub roots recharge groundwater in the rainy season, reducing runoff and conserving water
- shrub rhizospheres promote microbial diversity and may harbour beneficial microbes
- intercropped shrubs do not compete with crops and actually stimulate yield by >50%
- repeated application of these low quality residues (in absence of live shrubs) begins increasing yields after 2 years.

Keywords: *Piliostigma reticulatum, Guiera senegalensis***,** soil remediation, Sahel, crop productivity

Soil Degradation Challenge in Arid Areas: The Role of Soil Databases and Soil Information Tools

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Abstract

Soil degradation is the biggest challenge to food security in the new millennium. Climatic change and increasing human pressure on ecosystems results in the extensive degradation of landscapes, especially in dry areas. Desertification is the major problem for agricultural development and for providing food for population in many regions of the world, including Eurasia. Both the south of Russia and neighboring suffer desertification, which consists of various complex processes, including the processes of soil degradation, such as salinization, compaction, organic matter loss etc.

In the context of soil conservation and protection we should develop scientific tools for effective prognosis of short-term and long-term soil degradation under scenarios of different land use and different paths of climatic changes. A reliable prediction is possible only on the basis of the most complete information on actual soil resources. The first component of soil information is the presence of soil databases, which allow spatial interpolation, data mining, and spatial and temporal modeling. The necessary feature of these databases should be a user-friendly format of data storage that allows multiple data management.

Our actual activities are aimed at the development of soil data storage system, the tools for effective soil data management, and the collection of legacy soil data. The main issues to be solved are poor compatibility of data in different regions, imprecise coordinates of soil pits in previous surveys, and low response from regional administrative bodies. However, with increasing desertification the attention to soil data should increase.

Keywords: land resources, sustainable development, risk evaluation, Russia, Central Asia.

Introduction

Despite of the impressive progress in technology, modern civilization is still completely based on agricultural production. The entire population of the Earth depends on the products obtained from soil either as crops or as forage. The development in agricultural technology is impressive, and now we can produce much more yields than few decades ago from the same area (Shoba, 2009). However, the population is growing rapidly, and we do not know, if the increase in productivity can compensate the increasing need in food and a loss of productive lands. The loss of productive arable lands is a widespread process that takes place all over the world due to various reasons, such as urbanization, soil erosion, desertification and many others. Some of these reasons are universal, and some of them are landscape-specific. One of the most vulnerable zones is the arid belt of Eurasia that is strongly affected by a complex of degradation processes associated with desertification.

Desertification is the major challenge for land management in many Eurasian countries. In the most severe cases we have to make difficult decisions on land use change and even change the whole strategy of the development of national economy. Soil degradation leads to food insecurity, poverty, and thus social instability. Even if a state has stable economy based on industrial production or mining industry, agriculture is a life-spring for millions of people who inhabit dry areas. For their sustainable living we should maintain a certain level of soil productivity, even taking into account progressing climatic changes.

For maintaining soil productivity and for successful planning of soil improvement and management we should have a complete set of data that characterize soil and water quality. In this short review we tried to show the state-of the art with soil resources information in Russia and neighboring Central Asian countries, and to outline the perspectives for future development.

Soil information in Russian drylands

Though Russia is traditionally considered to be a cold and humid country, its vast territory also possesses some areas with dry climates, where soils run the peril of drought (Fig. 1). These areas are localized mainly along the southern border of Russia, both in the European and Asian parts. The soils in these dry areas are affected by the degradation processes, which are common for most arid regions, such as salinization, alkalinization, wind erosion, and desertification (that is understood as a complex combined process). A comparison of the maps of drought probability and the distribution of the processes of soil degradation (Fig. 2) shows that there is a good agreement between dry soil regime and the distribution of the specific degradation processes mentioned above. Speaking more specifically, such process as salinization is widespread mostly in the southern part of European Russia, in Dagestan and Kalmyk Republics and in Volgograd region. In Asia most of saline soils are found in Novosibirsk, Omsk, and Altay regions. Alkaline soils are common in Kalmyk Republic and Volgograd region in European part of the country, and in Novosibirsk and Omsk regions in Siberia. Though desertification is not very common in Russia, being active only at 7% of the national territory, it strongly affects agricultural production. This negative process is especially dangerous in Kalmyk and Dagestan Republics, Astrakhan, Volgograd and Rostov regions (with lesser extent in Orenburg and Saratov regions) in European Russia, and in Altay and Omsk regions and Tuva, Khakassia, and Buryatia Republics in Siberia.

The processes of wind erosion are very active in dry areas. Totally 8.4% of the agricultural lands in Russia are affected by deflation; these are localized mainly in Stavropol and Krasnodar regions and in Kalmyk and Dagestan Republics (European part of Russia) and in Altay region and Khakassia Republic (Siberia).

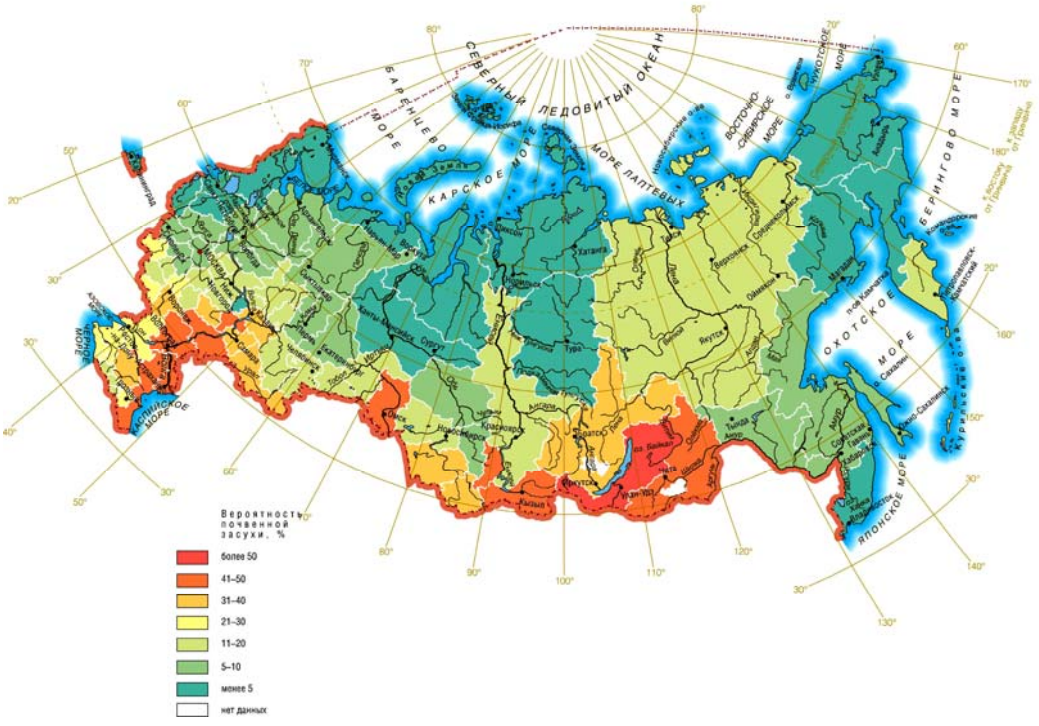


Fig.1. Schematic map of the probability of soil drought in Russian Federation. Red colour shows the probability of drought more than 50% (Shoba, 2011).

The other negative process usually associated with desertification is the loss of soil organic carbon. In the arid regions of Russia the balance of soil organic carbon is strongly negative that shows that the organic matter decomposes quickly in these soils (Fig. 3). Though arid soils usually have a positive balance of carbon from the point of view of global carbon cycling due to accumulation of carbonates, the loss of organic matter is a negative process resulting in the degradation of soil physical and chemical properties and in the decline of soil fertility.

In the context of soil conservation and protection we should develop scientific tools for effective prognosis of short-term and long-term soil degradation under scenarios of different land use and different paths of climatic changes. A reliable prediction is possible only on the basis of the most complete information on actual soil resources.

During the second part of the 20th century the soils of Russian drylands have been extensively studied, that allowed the development of soil and land evaluation maps of various scales, starting from the most detailed (1:10,000) to the most general (Shoba et al., 2010). These maps are valuable sources of information, but they have certain disadvantages. First, particular soil profiles seldom have exact coordinates. Second, some data are already outdated after several decades of anthropogenic transformation of soils. Third, the major part of this information existed only in paper form, and some important blocks of information are already lost.

Actually for successful soil data management, the first component of soil information is the presence of soil databases, which allow spatial interpolation, data mining, and spatial and temporal modeling (Panagos et al., 2012). Leaving apart an urgent need for updating soil data, the closest and the most reliable task is the development of soil database for Russia and possibly for neighboring countries. The necessary feature of this database should be a user-friendly format of data storage that allows multiple data management.

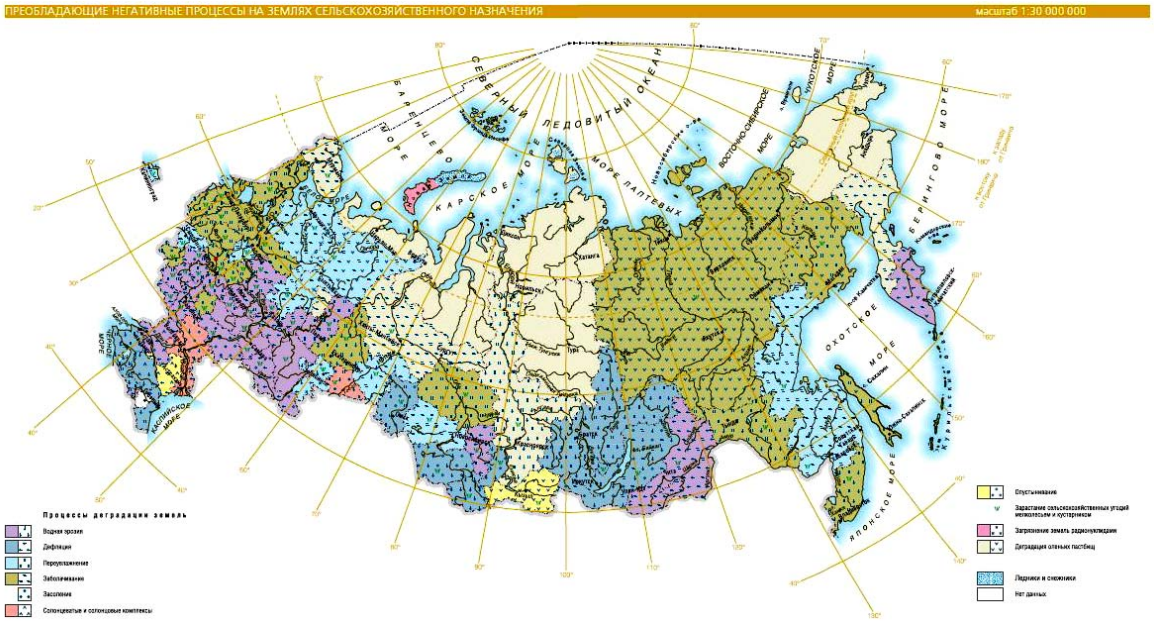


Fig.2. A schematic map of the processes of soil degradation in Russian Federation. Dark blue colour is for wind erosion, and yellow – for desertification (Shoba, 2011).

The development of such a soil geographical database started at the Faculty of Soil Science of Lomonosov Moscow State University several years ago (Shoba et al., 2008). The main blocks of the soil geographic database are the geographic database and the specialized attributive database (Rojkov et al., 2010). Relational Database Management (RDMS) System is used for data storage and processing. The Geographic Information Soil Database (GISD) forms the cartographic basis of the State Soil-Geographic Database of Russia. It consists of two digital coverages in MapInfo Professional. COVERAGE 1 is a digital map uniting the Soil Map of the RSFSR on a scale of 1: 2.5 M edited by Fridland (1988), and the digital map of the soil-ecological zoning of Russia. COVERAGE 2 is the digital map of the administrative division of Russia at a scale of 1:1 M. The soil profile (attributive) database of Russia is based on the concept of representative soil profiles (Kolesnikova et al., 2010). The database has a hierarchical structure ensuring soil description at several levels: SOIL–PIT–PROFILE–HORIZON–SAMPLE. The main object of the database is a specific soil profile with a set of soil horizons characterized by attributive data. The representative profiles should have an exact geographical location and be provided with a morphological description and a complete set of analytical data. The necessary conditions for the selection of representative profiles are: strict gridding of each soil profile, the most complete description of soil morphology, and the most extensive list of analytical soil characteristics (Shoba et al., 2011). The method of analysis, the units of measurement and the range of variation of each soil characteristic included in the database should be indispensably mentioned. For facilitating that, we developed uniform standards for soil information. The Program Soil-DB allows a provider of information to login in the site, to create and fill the soil description card, and to send it through Internet to the central server of the system (Anonimous, 2008). All necessary information on the properties and composition of soils is acquired by selecting representative soil profiles characterizing the main soil types in a generalized legend to the soil map on a scale of 1:2.5 M. Recently we started a joint project with neighboring countries for harmonizing the Russian, Ukrainian, and Belorussian soil databases.

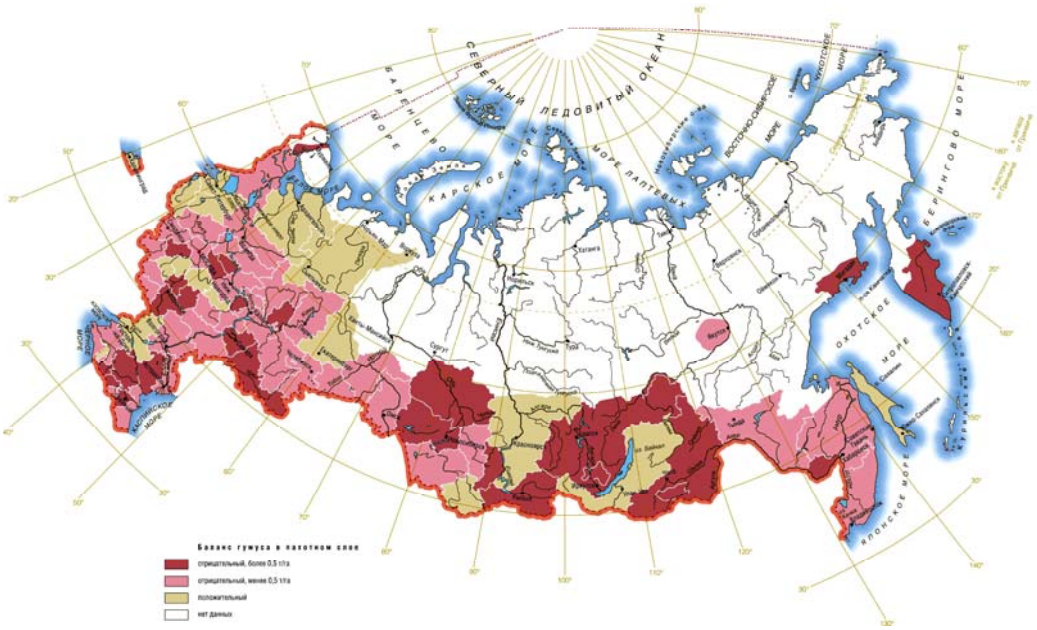


Fig.3. A schematic map of the balance of soil organic carbon in Russian Federation. Dark brown colour indicates strongly negative balance (Shoba, 2011).

Soil information in Central Asia

In the USSR the Central Asian region was always one of the most important centers of agriculture, because the climate allowed mellow-growing and especially extensive cotton production, which was impossible in other parts of the country. This epoch was both a time of great achievements in agriculture and a period of major negative impact on soils, especially related to secondary salinization. Several big state institutions and companies worked on the development of maps and explanatory notes on the land and water resources of Central Asia, with an emphasis on land improvement (irrigation, irrigation with drainage, chemical amelioration etc.). These data are important sources of information. Actually the Eurasian Center for Food Security of Lomonosov Moscow State University works on digitizing and publishing these materials on the web. Apart from this effort, we are discussing the possibility to include the information available on soil profiles of Central Asian countries in the joint Soil Database of Russia, Ukraine and Belorussia. We suggest using Soil DB tools for uploading the available soil information in Central Asia. The advantage of Russian Soil Database is that it can be easily converted to other soil database. Thus, the information would be integrated in the international data storage.

In Central Asia soil information obtained during the second part of the 20th century is of particular importance, because it can be used as a reference for soil monitoring, especially for irrigated areas suffering strong anthropogenic impact that have lead to soil salinization. The use of time series of remote sensing data may be also a good option for soil monitoring.

Perspectives of the use of soil databases

The perspectives for the future use and management of soil databases may be grouped in two main lines of research. Firstly, extensive soil information allows spatial modeling, and, secondly, it allows the prediction of the dynamics of soils on the basis of data mining, pedotransfer functions and dynamic models of the processes of soil degradation. These two lines are commonly interlinked, if we need to perform a spatial prediction of modeled variables.

The development of pedotransfer functions is of major importance for successful development of the guidelines for soil monitoring, land management planning and soil improvement. Usually the final user of soil information needs data in a format completely different from the primary soil data. The decision-makers do not care about pH values or electrical conductivity, they have to know, if the productivity of crops will be high enough to cover the investments to soil amelioration and management. This information may be produced only on the basis of pedotransfer functions, which, in their turn, can be obtained by data mining. For successful data mining we need thousands of soil profiler, otherwise any prediction and modeling would be baseless. Thus, both the development of information tools and filling the databases with reliable data are important components for information support of agriculture in dry areas.

Our task is to bring essential soil information to the decision-makers. Unfortunately, until now the response from regional administrative bodies is very low. However, now the situation changes slowly, because the governing bodies start to understand that soil degradation limits agricultural productivity, and, thus, the income of the population. Since increasing desertification leads to a drastic decrease in available soil resources and provides instability in agricultural production and food insecurity, the attention to soil data should increase.

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IMPACT OF CLIMATE CHANGE ON SOILS

ORAL PRESENTATIONS

Study of drought Tolerance indices of maize cultivars

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Abstract
In order to evaluate drought resistance of maize cultivars in Ardabil region through drought resistance indices, a factorial experiment based on randomized complete block design with three replications was carried out at the agricultural research station, Islamic Azad University, Ardabil branch, Ardabil, Iran in 2010. Factors included planting conditions with two irrigated levels (irrigated and non-irrigated) and also, eight maize cultivars: BC 678, BC 418, SC 700, BC 582, SC 301, BC 652, BC 566 and SC 704. Results showed that BC 566 cultivar had the lowest TOL index while SC 407 possessed the highest rates for TOL, GMP, and STI. Based on the SSI index, it was found that BC 566, SC 700, BC 418, and BC 652 cvs had the lowest rates (<1) and the others, showed the highest rates (p>1), respectively. Therefore, with regard to the indices, cluster analysis, analysis to the main components and calculated by-plot diagrams, SC 704, SC 301, and SC 700 were distinguished as the highest resistant cvs and suitable for planting in both irrigated and rain-fed conditions. Also, BC 566 cv. was distinguished as the most susceptible cv. among the others.
Key words: maize cultivar, yield, drought resistance indices and tolerance.

Introduction
Maize (*Zea mays* L.) is an important cereal crop of Iran. It is grown for fodder as well as for grain purpose in Iran. Approximately 320,000 hectares of field corn were grown with a production of 2560000 tons wth an average grain yield of 8000 Kg per hectare in Iran in 2010 (Nuraky et al., 2011). Corn (*Zea mays* L.) is one of the most important cereal crops grown principally during the summer season in Iran and the yield of corn in Iran is very low as compared to other corn producing countries (Seyed Sharifi and Pirzad, 2011). It is well established that the majority of the people in the developing countries depend mainly on cereal grains as their staple food due to limited income and the high prices of animal foods (Awad et al., 2011). Hudak and Patterson (1995) showed that irrigation during seed filling period, improves yield. Also, in another work, it was reported that three times irrigations during seed filling period, increased the yield (Eskine and Ashkar, 1993). Stress appearance during the reproductive stage, reduces seed weight (Katerji et al., 2000). Amount of the yield loss depends on the stress range and plant growth stage at which, stress occurred. In fact, plant susceptibility to stress varies from germination to the maturity (Schmidtke et al., 2004).
One of the main drought resistance factors in plants is ability of cells to tolerate a large amount of loosed water without serious un-repairable damages. As the cell losses water, vacuole usually crumples more than cell wall so, causes the silt in the protoplasm. It seems that such damage, results in the death of cells (Lessani and Mojtahedi, 2003). Yield loss of the plants under water deficit is one of the most important events for the plant breeders to improve yield but difference in the yield potential mainly relates to the adaptation factors than merely to the stress itself so, drought resistance indices are used to determine resistant genotypes (Mitra, 2001). Seasonal distribution rate of precipitation, temperature difference and soil conditions are of important factors affecting yield and yield components of sesame in the arid and semi-arid regions (Nath and Chakrabotary, 2001). Rosielle and Hamblin (1981) introduced tolerance against stress (TOL) as yield difference between stress (Ys) and non-stress (Yp). Based on their definitions, mean yield under stress and non-stress is called mean productivity (MP). An index named stress susceptibility index (SSI) was developed by Fischer and Maurer (1978). Also, stress tolerance index (STI) was introduced by Fernandez (1992) to determine genotypes having yields under both stress and normal conditions. Clarke et al. (1992) used SSI to determine resistance against drought. Guttieri et al. (2001), using SSI, suggested that the rates higher than 1, indicate more susceptibility to stress and rates lower than 1, indicate less susceptibility. Ramirez and Kelly (1998) reported that GM and SSI indices are mathematical derivatives of yield data and selection based on the combination of both indices, may be suitable criterion for drought resistance assessment. SSI and seed yield indices are used as the plant sustainability parameters and distinguishing resistance genotypes under drought conditions (Sinha and Bansal, 1991). Fredrick et al. (2001) found that drought stress

has no effect on the seed yield of the main stem of the determinate soybean however; this is a main part of the total yield. Also, they realized that the ratio of seed yield of the main stem to the total seed yield was low in the stress conditions than normal (irrigated). In this condition, harvest index of the main stems was low for the irrigated soybeans. They illustrated that the number of main stems and seeds per main stem was not affected by drought stress. In addition, correlation between seed yield of the main stem and weight of the individual seeds per main stem was insignificant. Desclams (2000) and Foroud (1993) reported that water deficit results in the decrease in the number of flowers, pods, seeds per pod, pod size and seed weight.
The aim of this research was determining the most suitable corn cultivars against drought stress, measuring the different drought resistance indices, and determining the most resistant and susceptible cultivars under drought conditions.

Materials and methods
In order to evaluate drought resistance of maize cultivars in Ardabil region through drought resistance indices, a factorial experiment based on randomized complete block design with three replications was carried out at the agricultural research station, Islamic Azad University, Ardabil branch, Ardabil, Iran in 2010. Ardabil region has cool winters and moderate springs and summers (38˚ 15' N, 48˚ 15' E) with an average annual precipitation of 400 mm and 1350 m height from sea level. Factors included two conditions of planting levels (irrigated and non-irrigated) and eight maize cultivars (BC 678, BC 418, SC 700, BC 582, SC 301, BC 652, BC 566 and SC 704). Experimental plots contained 5 cropping lines, each 5 meters, 75 cm apart, and 20 cm distances between the plants. Plots were separated 0.5 m from each other as boarder effect. Distance between blocks was determined 2 m. The field was under fallow last year. Soil preparation included deep plough, disc harrow and soil leveling and furrowing. To supply for required elements, 40 kg/ha zinc sulfate, 100 kg/ha super phosphate and 20 t/ha manure was soil incorporated based on soil test.
Seeds were disinfected pre plant with Benomyl fungicide at a ratio of 0.002. Two seeds were planted simultaneously for uniform emergence and then, were thinned to the final density.
Weeds and pests were controlled using herbicides and pesticides. First irrigation was performed after planting and the others, as needed by plant based on the region temperature and traditional experiences. 4 times irrigation were employed to complete plant stand under drought conditions.

Drought resistance indices:
After complete filling of the seeds, while the leaves and stems became yellowish, two side rows were removed and sampling was done from three middle rows by deleting 0.5m distance from both sides of which. The rest of the plants were harvested after ripening, seeds were air-dried and seed yield were measured.
SSI was calculated according to the Fischer and Maurer (1978):
$SSI= [1-(Ysi/Ypi)]/SI$ and $SI=1-(Ys/Yp)$
Where;
Ypi= yield of individual cultivars without stress, Ysi= yield of individual cultivars with stress, Ys= average yield of all cultivars with stress, Yp= average yield of all cultivars without stress.
Lower SSI rates refer to higher drought resistance. STI and TOL indices were calculated based on Fernandez (1992):
$STI= (Ypi)\ (Ysi) / (Yp)^2$ and $TOL= (Ypi-Ysi)$
Higher rates for the STI, indicates higher potential yield. Also, GMP and MP were calculated as follows:
$GMP= \sqrt{(Ysi)\ (Ypi)}$ and $MP= (Ysi+Ypi) / 2$
Statistical analysis:
Data were subject to analysis by SAS and MINITAB and graphs were drawn using Excel software.

Results and Discussion
Rates of seed yield under stress (Ysi) and normal (Ypi) conditions and also, drought resistance indices have been shown in Table 1. For classification of cvs., cluster analysis was performed based on the standardized means by Ward procedure and three classes of drought resistance indices

were determined for both conditions and cultivars (Fig 1). To separate criteria of each class, individual mean cluster and total mean was calculated for each parameter. First class included (3) SC 700, (5) SC 301, and (8) SC 704, the second consisted of (7) BC 566, and the third, contained (1) BC 678, (2) BC 418, (4) BC 582 and (6) BC 652 while based on Table 1, SC 700, SC 301 and SC 704 cvs. Possessed the highest yields under both conditions than others and BC 566 cv. gained the lowest yield. According to the TOL index, highest rates of this index indicates susceptibility to stress and selection is performed based on the lower rates. Regarding this fact, BC 566 is considered the most resistant (with lowest rate) and SC 704 is considered the most susceptible cv. (with the highest rate). For MP index, it was observed that SC 700 and BC 566 cvs. had the highest and lowest rates, respectively. By using MP and TOL indices, there is possibility to separate cultivars in normal and stress conditions (Rosielle and Hamblin, 1981). For GMP index, it was seen that SC 700 and BC 566 had the highest and lowest rates, respectively. The lower rates of stress susceptibility index (SSI) indicating the little differences in yield under stress conditions than normal and hence, more adaptability to stress conditions. Using this index, cvs. having high yields both in normal and stress conditions are distinguished (Fischer and Maurer, 1978). Based on SSI index, we found that BC 652, BC 418, SC 700 and BC 566 cvs. had the lowest rates (below one) and so, were considered as tolerant cvs., respectively. The remains possessed the numbers higher than one and were placed in susceptible group. Guttieri et al. (2001) using SSI index suggested that values higher than one indicate more susceptibility to drought stress. Ramirez and Kelly (1998) reported that GMP and SSI indices are the mathematic derivatives of yield and selection based on both of indices, can be a more suitable criterion for drought resistance evaluation. It was seen for STI index that SC 700 had the highest rate and BC 566 had the lowest value. Fernandez (1992) reported that more tolerant cvs. have the higher rates for STI index. By using this index, it is possible to select cvs. Which gain the highest yields in both normal and stress conditions. Samimi sadeh et al. (2006) found that under no-stress conditions, wheat seed yield, biomass and harvest index had significant correlation with STI index. Khayatnezhad et al. (2010 a,b) found significant correlation between STI index and wheat seed yield and yield components. Also, in both conditions, the greatest direct impact was related to seed yield and under normal conditions, biomass and length of awn had indirect impact on STI index. For stress conditions, biomass, plant height, length of awn and spike had indirect impact on STI index.

Table 1. Indices of drought tolerance cultivars studied.

Cultivars	Ypi	Ysi	SSI	TOL	STI	GMP	MP
BC 678	9342	6827.33	1.164	2514.67	0.611	7986.295	8084.665
BC 418	9650	8070	0.708	1580	0.746	8824.709	8860
SC 700	13390	10688	0.873	2702	1.372	11962.956	12039
BC 582	8704	5166	1.759	3538	0.431	6705.584	6935
SC 301	12488	9478	1.043	3010	1.135	10879.396	10983
BC 652	9584	8906	0.306	678	0.818	9238.782	9245
BC 566	5558	4330	0.956	1228	0.230	4905.725	4944
SC 704	12972	9346	1.209	3626	1.162	11010.736	11159

Yield rates under stress (Ysi) and optimum (Ypi) conditions, tolerance index (TOL), stress susceptibility index (SSI), mean productivity (MP), geometric mean productivity (GMP) and stress tolerance index (STI).

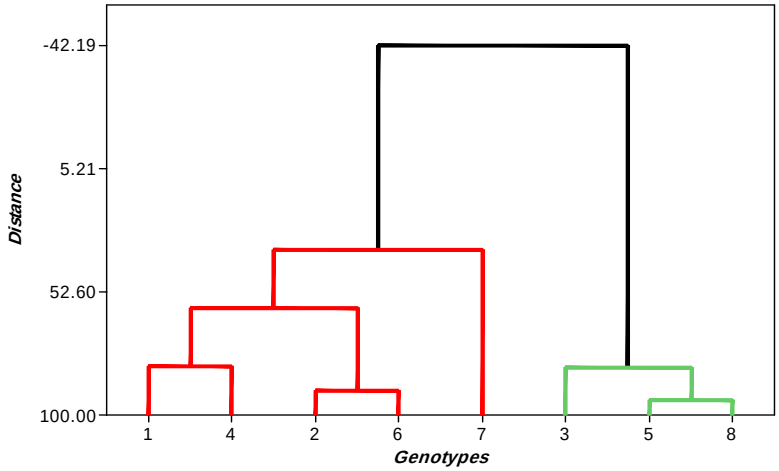


Fig 1. Dendrogram of maize cvs. Through Ward method based on the standardized mean of drought resistance and tolerance, calculated under both normal and stress conditions.

Table 2 indicates latent rootsand special vector of the studied cvs. Based on the two components. The first vector showed 72 percent differences and regarding the highest positive coefficient of the GMP, MP, YS, and STI indices to prepare this component, so selection based on the first component can choose cvs. with high yields. This component can be called as yield component. Differences between cvs in two clusters have been shown based on the two main first and second components (Fig 1). In this figure, the first component (yield component) had the highest impact on distinguishing of groups in terms of yield in both conditions. Also, this component had the highest role in separation of groups for STI, YS, GMP and MP indices so that, cvs in the right part of dendrogram were more tolerant and high yielding than those in the left one (Fig 2). The second component explains 27 percent total differences reminder and showed high correlation with TOL and SSI indices so, it can be said that the first component separates high and low yielding cvs. from each other. Also, the second component, distinguishes the tolerant and susceptible cvs. In general, first and second main component explains 99 percent total differences.

Based on the first two components, by-plot diagram was divided into 4 parts (Fig 2). Hybrids in part A had the highest yield under both conditions. Also, hybrids in part D had the lowest yield under both conditions so, SC 700, SC 301, and SC 704 cvs. were considered as the most tolerant cvs. and placed in part A, and BC 566 was considered as the most susceptible one and placed in part D. Results of by-plot diagram confirms the results of cluster analysis. Indices which had the highest correlation with yield under both conditions and were placed in the angle of yield in both conditions were also introduced as the superior indices including MP, GMP and STI. Moghaddam et al. (2002) found that MP is more suitable for selection of tolerant hybrids against drought stress than SSI and TOL indices. This is in accordance with our findings.

Table 2- Principle components Analysis

Indices	PC1	PC2
GMP	0.443	-0.034
MP	0.443	-0.013
TOL	0.174	0.667
SSI	-0.089	0.711
STI	0.441	-0.025
Yp	0.436	0.121
Ys	0.430	-0.177
Eigenvalue	5.081	1.89
Variance%	0.727	0.271
Calamities Variance%	0.727	0.997

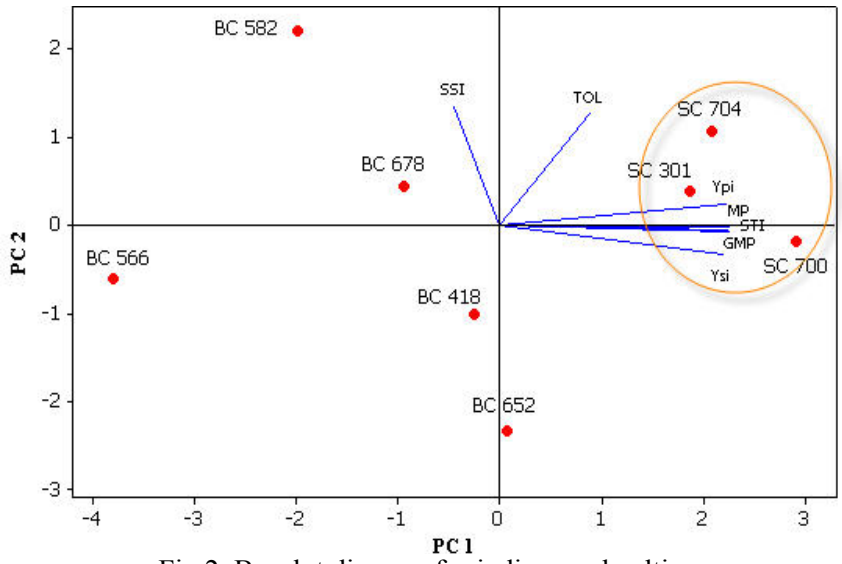


Fig 2. By-plot diagram for indices and cultivars.

Conclusions

Generally, it was found that BC 566 and SC 704 cvs. Possessed the highest and lowest rates for TOL, GMP, MP and STI indices, respectively. Also, it was seen that BC 652, BC 418, SC 700 and BC 566 cvs. had the lowest rates and lower than one, in terms of SSI index and hence, considered as tolerant cvs. and the others, as susceptible. So, with regard to the results of calculated indices and also cluster results, analysis to main component and resulted by-plot diagram, SC 700, SC 301 and SC 704cvs. are considered as the most tolerant and suitable for planting in both conditions. Based on these results, BC 566 was distinguished as the most susceptible cv.

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Main Forms of Energy Involved In Soil Formation and Environmental Processes

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Abstract
Four different forms of energy are involved in soil formation: gravity, orogenic energy, solar energy and anthropogenic energy. The specific influence of these forces is important for understanding soil development under different physio-geographic conditions and environmental processes.
Keywords: soil formation, gravity, orogenic energy, solar energy, anthropogenic energy, environmental processes.

Introduction

Soils are providing goods and services of paramount importance for sustaining human societies and the environment (Blum 2005; Frossard et al. 2006; Costanza et al. 1997).
In view of the world wide losses of soil, e.g. through sealing, erosion and further impacts, information about the time scale of soil formation becomes increasingly important (European Commission 2006). Until today, we have measurements and assessments regarding soil losses, e.g. through erosion, but no solid data about the pace of soil formation. Therefore, the question arises: How much soil is formed with time, under different climatic, geological, topographical, hydrological and biotic conditions, under the influence of human activities, including different forms of land use and climate change and how to classify these soils. At the moment, national and international research groups on critical zone processes are targeting this issue (Chorover et al. 2007).

Materials and Methods

For answering this question, a first approach could be to identify the basic forms of energy involved in soil forming processes. With such an approach, it would also be possible to develop a comprehensive concept, which would allow to describe processes of soil formation as well as methods to measure them, e.g. weathering of rock parent material and the development of the regolith zone, as well as the further development from regolith to soil. This concept could also allow to define measurable indicators for the different characteristics of rock, regolith and soil and to improve soil classification.

Results and Discussion

Soil formation is driven by four main forms of energy: gravity, orogenic energy, solar energy and anthropogenic energy.
Gravity influences all movements of solid, liquid and gaseous materials. It is an inherent form of energy and influences the vector and the velocity of fluxes within soils (e.g. movement of solutes) as well as at their surface (e.g. soil erosion by water). – Therefore, gravity is also the main factor of morphogenesis.
Orogenic energy is the second form of energy and is herited from the rock parent material, which was formed through orogenesis, an endogenic process which created very diverse types of rocks and minerals under high temperature and pressure. This endogenic energy, which can also be called orogenic energy, is still contained in rocks and in the rock forming minerals. This energy is normally not renewed for a long time, except in cases such as volcanic activities and others. – Through exogenic forces, derived from solar energy, e.g. through processes of weathering and transport (e.g. erosion), this orogenic energy pool is constantly lowered. Primary minerals, such as micas and feldspars contain more energy, derived from orogenesis as their weathering products, e.g. clay minerals and oxides. Moreover, the resistance of different minerals against weathering or the buffer capacity of soils against acidification can also be explained by orogenic

energy. Orogenic energy is manifest in the texture and structure of rocks and the crystallography of minerals and their resistance to exogenic forces, which is mainly explained by the form and density of the mineral package in the rocks or the element package in the crystal structure of minerals. – Orogenic energy is also manifest in the chemical composition of minerals, which plays an important role, e.g. through the content of alkaline and earth alkaline cations in relation to silica, aluminium and metals such as iron, manganese, copper, zinc and others. In detail, this becomes evident in the thermodynamics and kinetics of weathering processes:

Thermodynamically, 4 characteristics of minerals are important for weathering processes:

- the type of mineral structure, e.g. phyllosilicates, chain silicates etc.;
- substitution of Si by Al in the mineral lattice (Al-ion is about 50% larger than Si);
- type of metal cations connecting the Si-tetraeder in the silicate structure, e.g. Ca, Mg, Fe^{2+} in biotite or Al in muscovite;
- amount of oxidizable Fe^{2+} and Mn^{2+} in the crystal structure,
  allowing to define the following weathering sequence:
  Olivine < Anorthite < Pyroxene < Amphibole < Biotite < Albite < Muscovite < Orthoklase < Quartz .

Kinetically, 4 main factors are important for the weathering of minerals:

- the surface of minerals in the rock texture: fine-grained, e.g. basalt or coarse-grained, e.g. granite;
- the amount of protons in the soil solution, e.g. expressed by the pH or other specific indicators;
- the velocity of percolation (leaching) creating disequilibria in the weathering environment.
- the type of elements in the minerals and their mobility under aerobic conditions:
  Cl > S > Na > Ca >Mg > K > Si > Fe > Al

Solar energy is the third form of energy, deriving directly from solar radiation or from diffuse radiation through reflection. Solar radiation is the basis of photosynthesis producing biomass, which again is the basis of physical, chemical and biological weathering, producing protons in the form of H_2CO_3 and organic acids through the biological decomposition of litter at the soil surface and of roots within the soil or the delivering of photosynthates to root-mycorrhiza, which acts at the weathering front by exsudates and other organics delivering protons. Therefore it can be concluded that the intensity of photosynthesis is directly correlated with the intensity of weathering processes. This means that clear differences exist between the influence of forests, grass covers and land surfaces without vegetation, on weathering processes.

In the past, soils developed under different climatic conditions (paleoclimates) and types of vegetation, especially in the tropics and sub-tropics, which makes it difficult to use current climatic data, such as temperature and/or precipitation to classify soils wich have developed over a long period of time.

Anthropogenic energy is the fourth form of energy, deriving from anthropogenic activities. It is a mixture of different energy forms, including human labour, and is mainly based on fossil energy and non-renewable resources, such as oil, coal, rocks and minerals. - Since the end of the 18th century, anthropogenic influences on terrestrial and aquatic ecosystems have been exceeding natural impacts (Crutzen, 2002; Blum and Eswaran 2004) and are therefore important for understanding soil formation and for classifying soils in general.

Conclusions

For making soil formation and environmental processes understandable, the energy concept is a useful tool. Anthropogenic influences on soil formation should be given more attention in the future.

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IMPACT OF CLIMATE CHANGE ON SOILS

POSTER PRESENTATIONS

Soil Temperature and Moisture Monitoring and Recommendations on the Optimum Sowing Period for the Main Crops in the Transylvanian Plain

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Abstract
The Transylvanian Plain (TP) is a geographical region located in north-central Romania and is bordered by large rivers to the north and south, the Someş and the Mureş, respectively. The TP is 395,616 ha and ranges from 231-662 m in elevation, with some of the highest elevations occurring in the NW region. Contrary to the name, the TP consists of rolling hills with patches of forests located on the tops of hills. Soil temperatures of the TP were evaluated using a set of 20 data logging stations positioned throughout the plain. Soil temperatures were monitored at the surface and at depths of 10, 30, and 50 cm. Soil moisture was monitored at 10 cm. The presence of the Carpathian mountains ring and the arrangement, almost concentric, of the relief from Transylvanian Depression, determines the development of a zonal sequence of soil types, a horizontal zonality as a direct influence of lithology and indirect of the relief, by changing climate and vegetation. Diversity of the pedogenetical factors - highly fragmented relief, forest and herbaceous vegetation grafted on a lithological background predominantly acid in the north – west and predominantly basic in south – est, parent rock composition and especially their combination in the contact zones, have conditioned in this hilly area of TP a tessellated soil cover. During soil pedogenesis, soil properties and features developed in response to differential lithology and macro/microrelief. Evaluated soils were found to largely be a complex mix of Cernisols, Luvisols and Antrisols. Soil temperatures of the TP are mesic, with small differences between the northern and southern extents. However, differences in seasonal warming and cooling trends across the plain were noted. These have important implications for planting recommendations. Recorded data allow us to say that towards the optimal sowing period known from the literature, during 2010, for all cultures were recorded minimum temperatures for germination with approx. 5-10 days earlier. The optimum sowing period was recorded 15 days earlier at soybeans, with 10-12 days earlier at corn and beans, 2-3 days earlier at potato, sunflower and sugar beet.
Keywords: soil temperature, sowing recommendations, Transylvanian Plain.

Introduction

Transylvanian Plain (TP) with an area of approx. 395,616 ha, includes areas of three counties (Cluj - CJ, Mures - MS, Bistrita-Nasaud - BN) and is characterized by hilly climate floor with oceanic influences. Zoning cultures and establishing the optimum sowing periods was made after the observations arising from practice and after the results obtained in the agricultural experimental research stations. Climate changes in recent years and climate monitoring from TP offers the possibility to check the calendar for the optimum sowing period.

TP has a predominantly agricultural character, and in the past, because of the large areas of agricultural land, with fertile soil, produced large quantities of grain, for economic and social needs of the country. Cereal and steppe character (or anthropogenic steppe) of the area, led to widespread of the popular term "plain", as over 30 villages, located in mid-southern region, wears, along with their name, the addition "plain". Contrary to its name, the TP is characterized by extensive rolling hills and is bounded by two main rivers, the Someş to the north and west, and the Mureş to the south and east. Elevation of the TP ranges from 231 to 662 m. Original geologic deposits in the area are Miocene, with contemporary hills largely derived from Pliocene and Quaternary materials (Balteanu, D., 1997).

Over time, the rugged terrain, deforestation, erosive slopes, and irrational agrotechnical practices for crop production have combined to degrade large areas of agricultural land, reducing its productivity. Within the TP, tens of thousands of hectares of land show signs of denudation or reduced productivity (Ministry of Agriculture and Rural Development, 2011). Furthermore, most of the land is non-irrigated, owing to a lack of available groundwater and limited access to surface waters in the central TP (Man, T., Pop, R., 2000). Another feature of the TP is that, although it is lower than the surrounding region, no major river valleys, no major roads, do not converge to its center, but it surrounds it on the periphery. So it is a poor area in water resources, avoid by the

heavy traffic, and so it partly explains its rural character and layout of cities around the edges (Rusu, T. et al., 2009).
The last research upon the evolution of the climate inside the Carpathian basin, pointed out an increase of the air temperature in the last one hundred years with about 0.7°C. This fact is also shown by the fact that, six of the warmest years of the 20th century were registered in 1990's. Contrary to its name, the TP is not a geographically flat plain, but rather a collection of rolling hills approximately 300 to 450 m above sea level in the south and 550 to 600 m above sea level in the north. Climate of the TP is highly dynamic, ranging from hot summers with high temperatures of >25°C to very cold winters with lows ~-5°C (Climate charts, 2007). The southern TP generally has a xeric moisture regime with steppe vegetation while moisture increases somewhat in the northern TP as an udic moisture regime.
Under these conditions, the research project: monitoring the temperature and water regime of soils in the TP, is the first paper, on large-scale, on soil monitoring (temperature, humidity, precipitation) of the TP which is a first for the Romanian science. The data logging stations determines air temperature (at a height of 1 m) and precipitation (in 10 locations) as well as temperature (10, 30, 50 cm) and soil moisture (10 cm, by reflectometry), data being transmitted to a data collector of data storage capacity of about one year (depending on the frequency set for collection). The immediate objectives of the research are related to soil resource assessment, determining the thermal regime of soils and determining the relationship between the thermal regime of soils and optimum sowing period.

Materials and Methods

Twenty datalogging stations have been deployed across the TP on divergent soil types, slopes, and aspects. The location of each site was recorded using Garmin eTrex Vista (Olathe, KS, USA) handheld GPS units. Ten datalogging stations were installed in March of 2008, with an additional ten stations installed in March of 2009. HOBO Smart Temp (S-TMB-M002) temperature sensors and EC-5 (S-SMC-M005) moisture sensors were connected to HOBO Micro Stations (H21-002) at each site (On-set Computer Corp., Bourne, MA, USA). Additionally, at 10 of the 20 sites, tipping bucket rain gauges (RG3-M) were deployed (On-set Computer Corp., Bourne, MA, USA, figure 1; Weindorf, D.C. et al, 2011).
At sites with a tipping bucket rain gauge, the following data were recorded: soil temperature at 10, 30, and 50 cm; soil moisture at 10 cm; surface air temperature; and precipitation. At sites without a tipping bucket rain gauge, the following data were recorded: soil temperature at 10 and 50 cm; soil moisture at 10 cm; and surface air temperature. Data is downloaded from the Micro Stations every two months via laptop computer using HOBOware Pro Software Version 2.3.0 (On-set Computer Corp., Bourne, MA, USA). Table 1 shows the station configuration (Rusu, T. et al, 2011).

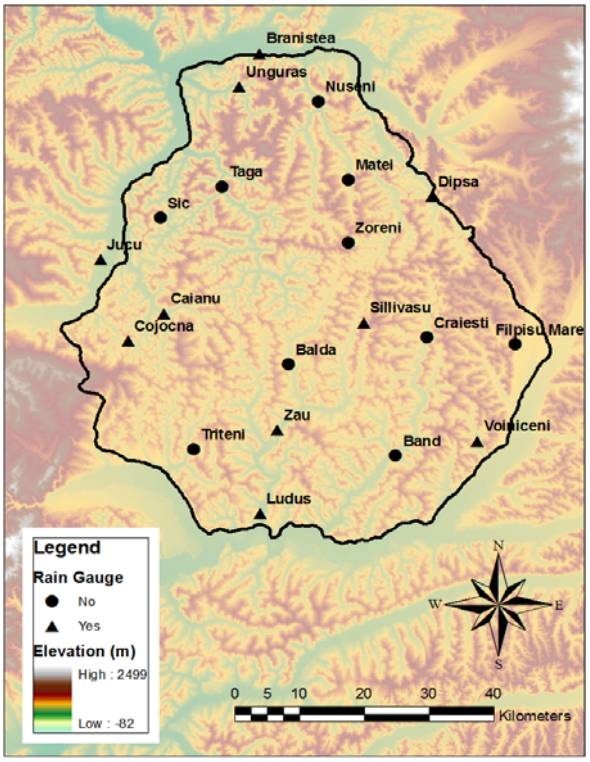


Figure 1. Location, elevation, and configuration of soil temperature and moisture monitoring stations within the Transylvanian Plain

Table 1. Station configuration in the Transylvanian Plain

Station number	Station name	Latitude	Elevation, m	Rain gauge
1	Balda (MS)	46.717002	360	No
2	Triteni (CJ)	46.59116	342	No
3	Ludus (MS)	46.497812	293	Yes
4	Band (MS)	46.584881	318	No
5	Jucu (CJ)	46.868676	325	Yes
6	Craiesti (MS)	46.758798	375	No
7	Sillivasu de Campie (BN)	46.781705	463	Yes
8	Dipsa (BN)	46.966299	356	Yes
9	Taga (CJ)	46.975769	316	No
10	Caianu (CJ)	46.790873	469	Yes
11	Cojocna (CJ)	46.748059	604	Yes
12	Unguras (CJ)	47.120853	318	Yes
13	Branistea (BN)	47.17046	291	Yes
14	Voiniceni (MS)	46.60518	377	Yes
15	Zau de Campie (MS)	46.61924	350	Yes
16	Sic (CJ)	46.92737	397	No
17	Nuseni (BN)	47.09947	324	No
18	Matei (BN)	46.984869	352	No
19	Zoreni (BN)	46.893457	487	No
20	Filpisu Mare (MS)	46.746178	410	No

MS = Mures county; CJ = Cluj county; BN = Bistrita-Nasaud county

Results and Discussion

TP belongs geographically in the Transylvanian Depression. This represents the largest negative morphological inter-Carpathian area, formed during the alpine folding, with general appearance of hills and plateaus, divided tectonic in geomorphological succession of areas, arranged almost concentric, from exterior to interior, with large variations of structure and relief from one area to another. The relief prints considerable differences throughout the hilly area of TP. Here are the biggest contrasts of the stationary factors due to the very fragmented relief and the varied lithologic sublayer. In general, any relief change entail fundamental changes in all local factors, forming interdependencies in topoclimat, in soil characteristics and vegetation physiognomy. The relief creates exhibition contrasts, temperature inversions, patches of vegetation unequal haunted by the wind and subjected to different rainfalls etc. Also, the relief is the one that determines differences in soil characteristics, namely: deeper soils in the mild portions of the slope, thin and eroded soils in highly inclined portions, more advanced or less, with higher or lower trophicity etc. Micro relief also creates differences and discontinuities on the distribution of soils and phytocoenoses even on slopes relatively small.

Like other components of the geographical landscape in the TP, soils, are only apparent uniformly distributed. On closer analysis, it appears that they are some of the most complex elements, through the variety and distribution on the two distinct sectors of the region: Somesan Plain and Muresan Plain. What was considered in 1967 as a „pedo-geographical limit in Transylvanian Plain" (Mac, I. et al, 1990), namely the gradual tansition from the forest soils from the Somesan Plain to chernozem which is specific for the Muresan Plain, turns out to be not only a „limit with significance in agricultural land evaluation", but also an ecological threshold. The differential action of air masses on the two sectors, the „shadow" of rainfall which is the south - west) and the energy of the relief which is greater in the northern sector, required the development of different vegetation and fauna, with repercussions on the development of the edaphic support.

Soils of the TP were digitized (table 2; Weindorf, D.C. et al, 2011) and converted into the contemporary taxonomic system used in Romania, SRTS - 2003 (Florea and Munteanu, 2003).

Table 2. Total area and extent of soil classes for soils of the Transylvanian Plain, Romania derived from digitization of 1:200,000 scale soil maps

Class	Area (ha)	% of TP
Antrisoluri	58921	14.9%
Cambisoluri	35679	9.0%
Cernisoluri	200543	50.7%
Hidrisoluri	6816	1.7%
Luvisoluri	86410	21.8%
Pelisoluri	6737	1.7%
Protisoluri	154	0.0%
Salsodisoluri	356	0.1%
Total:	395616	100.0%

Cernisoluri occupies the southern sector of the plain on the obverse and the interfluvial cuesta peaks and are characterized by high fertility (fertile to middle fertile), generally negligible surface erosion, locally affected by landslides, medium porous and with heavy texture.
Luvisoluri occupies the northern region and the south - eastern sector, potentially fertile soils, cold, with heavy texture, exposed to erosion due to clay content.
Protisoluri soils with different fertility (aluviosoluri – fertile, but displayed to flood, rogosolurile – used successfully in a period for vineyards, erodosolurile – with properties losses, resulting from poor agrotechnics or overgrazing).
Hidrisolurile meadow soils affected by stabilized landslides, late soils with excess moisture on the surface and in depth, potentially fertile, with adverse physical and biological properties, clay-loam and silty-clay texture.
Pedogeographical, regional differences are clearly expressed in the studied areas, in the northern sector – Somesan Plain and the southern region – Muresan Plain. The predominance of forest in the north was a definite reality, and the correlation with the presence of forest soils was easily accomplished.
The pedogeographical areas characteristic for the Plain are:
1. The northern area with forest soils. Here we have soils from Lusivsol and Cambiosol classes, in overwhelming extent. Typical Preluvisols dominates the north - western sector to the marginal border area of the inferior Fizeş and Bandău. Follows a series of typical and stagnant Luvisols, alternating with Preluvosols, in the central - northern area. In the upper basin of Bandău eroded Luvisols and Erodisols are correlated with heavily deforested areas, on both cuesta overheads and on the obverse. In the eastern and southern area, stagnic Luvisols occur in alternation with typical and eroded Eutricambisols, while the origin of the valley developed on the left side of the consequent rivers – have as edaphic support the clinogleic Phaeozems. Erodisols from the upper basin of Fizeş supports a grassy associations in advanced stage of decay. Southern boundary of this area with forest soils, we draw it on a line on a clear hint of Phaeozems argic.
2. Central area of argic Phaeozems alternating with forest soils. The superior basins of River of Plain, Sesul and Comlod are predominating mollic and typical Preluvisols, typical and eroded Eutricambisols, clinogleic Phaeozems.
3. South – west area, of Chermozems. The rain shadow of Trascău, weather conditions have allowed the development of Cernisoils, that, independent of diverse land use over time, are a presence and a geo-ecological reality. To the west line of River of Plain Valley cambic Chernozem (typical, vertic and eroded) are dominant, alternating with Erodisoils, Vertisoils and Phaeozems.
4. The area of forest soils in south – eastern border. In this case, the Mures valley was not a pedological barrier, forest soils in this sector are developing in synchrony with the surrounding plain areas. Typical and stagnant Luvisols, typical Preluvisols have a considerable way, aside Eutricambisols from the eastern side and Phaeozems (Pseudorendzine).
Calculation of soil temperature regime according to the Soil Survey Staff (2010) consists of averaging soil temperatures at 50 cm between summer (June, July, and August) and winter (December, January, and February). The Soil Survey Staff (2010) defines mesic soil temperature as

a "mean annual soil temperature that is >8°C, but <15°C where the difference between mean summer and mean winter soil temperatures is more than 6°C at 50 cm or at a densic, lithic, or paralithic contact, whichever is shallower." Data from the monitoring sites clearly indicated that all sites have a mean annual soil temperature of ~10°C at 50 cm with more than 6°C variation between summer and winter. Thus, the soil temperature regime of the TP was determined to be mesic.
Recorded data allow us to say that towards the optimal sowing period known from the literature, during 2010, for all cultures were recorded minimum temperatures for germination with approx. 5-10 days earlier (table 3). The optimum sowing period was recorded 15 days earlier at soybeans, with 10-12 days earlier at corn and beans, 2-3 days earlier at potato, sunflower and sugar beet.
Table 3. The optimum sowing periods recorded in Transylvanian Plain

No	Crop	Area (ha)			MTG ^{0}C	OSP	OSP, 2010		
		CJ	MS	BN			Caian, CJ	Ludus, MS	Braniste, BN
1.	Corn	42063	60822	28316	8-10	10-30.IV	07.IV.	26.III.	02.IV.
2.	Potato	9984	5978	11727	>5	20.III-20.IV	23.III.	20.III.	18.III.
3.	Sun flower	2727	2972	1388	6-8	25.III-15.IV	25.III.	22.III.	22.III.
4.	Sugar beet	1721	3038	103	5-6	20.III-15.IV	23.III.	20.III.	18.III.
5.	Soybean	725	1075	39	7-8	10-20.IV	27.III.	24.III.	25.III.
6.	Bean	456	34	20	8-10	15-30.IV	07.IV	26.III.	02.IV.

MTG - minimum temperatures for germination (^{0}C).
OSP - optimum sowing period (Gus, P. et al., 2004).
OSP, 2010 – the date when the optimum germination temperature was registered (2010).

Conclusions
Soil temperatures of the Transylvanian Plain, Romania were evaluated via 20 datalogging stations in 2008 and 2010. Data from the loggers indicated that the soil temperature regime of the TP is mesic. More than 50% of the soils on the TP were Cernisoluri, followed by Luvisoluri (21.8%) and Antrisoluri (14.9%).
The presence of the Carpathian mountains ring and the arrangement, almost concentric, of the relief from Transylvanian Depression, determines the development of a zonal sequence of soil types, a horizontal zonality as a direct influence of lithology and indirect of the relief, by changing climate and vegetation. Diversity of the pedogenetical factors - highly fragmented relief, forest and herbaceous vegetation grafted on a lithological background predominantly acid in the north – west and predominantly basic in south – est, parent rock composition and especially their combination in the contact zones, have conditioned in this hilly area of TP a tessellated soil cover. During soil formation, soil properties and features have changed under the direction and intensity of pedogenesis, on the basic lithologic fund according to the micro and macrorelief forms. The result is a complex and specific soil cover, represented by Cernisols, Luvisols, Hidrisols and Antrisols.
Zoning cultures and establishing the optimum sowing periods was made after the observations arising from practice and after the results obtained in the agricultural experimental research stations. Recorded data allow us to say that towards the optimal sowing period known from the literature, during 2010, for all cultures were recorded minimum temperatures for germination with approx. 5-10 days earlier. The optimum sowing period was recorded 15 days earlier at soybeans, with 10-12 days earlier at corn and beans, 2-3 days earlier at potato, sunflower and sugar beet.

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Dust Storm Monitoring and its Relation with Global Warming and Climate Change

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Abstract

Dust storms have a large of impacts upon the environment and human health by transport material over many thousands of kilometers. In recent years, identification of source areas for dust storms has been an important research area. This paper illustrates the global sources, spatiotemporal distribution and trend of dust storms (as Aerosol Optic Depth) (AOD) around the world. Also, precipitation rate, carbon monoxide levels and vegetation cover (as Normalized Difference Vegetation Index) (NDVI) were investigated during the past decade. Consequently, vegetation data, carbon monoxide concentration and precipitation rate were obtained from MODIS-Terra, MOPITT-Terra and TRMM satellite, respectively, from NASA[1] database. The Aerosol Optical Depth (AOD) index was used for haze evaluation. These data were considered as monthly average of April, May and June months of 2001, 2002, 2008 and 2010. NDVI index was obtained 0.9 for tropics and less than 0.2 for Sahara desert, China, Saudi Arabia, Iraq and major parts of Iran. The results obtained by overlapping NDVI with AOD and precipitation maps, show that regions with NDVI index lower than 0.2 are prone to wind erosion and dust production. Long-term investigation of satellite imageries in global scale revealed close correlation between release of greenhouse gases, vegetation extent, precipitation rate, haze frequency and concentration and climate change.

Keywords: Haze, Climate Change, Greenhouse Gases, NDVI Index, Carbon Monoxide

Introduction

Excessive application of fossil fuels and use of maximum lands potential has made increase temperature of the earth and consequently destroy farming lands. In this case, water and carbon cycle has been disturbed and hydrologic and hydro-climatologic processes lose their natural state. These states can be resulted occurrence of droughts, decrease in productions, aerosols and dust storms appearance. Main reason to recent attitudes concerning aerosol or dust relates to global effect on the earth. Dust activity and appearance depends to three factors:1) Human activities and involvement in field of natural sources, climate natural changeability (El Nino, southern Pacific Ocean or northern Atlantic Ocean) and climate unnatural changeability (global warming) (8) dust has ability to effect on weather temperature by absorbing and disseminating light energy. Also its particle can prevent of clouds formation and effect on carbon dioxide and atmospheric sulfur. (14)

One of direct consequence of dust is effect in human health and immunity. Research showed that, separation of dust from droughty lakes base (like Aral) makes transferring slight particles of soil, slats and chemical compositions to atmosphere and respiratory disturbances in human. Researchers explain existence of asthma disease in children who live near the Aral sea due to negative effects of dust (1) Transferring dust may effect on region features of destination in very long distances. For example, Africa north desert dust has significant effect on evaluation of Canary Islands soils (10). Also transferring elements such as iron, phosphor and nitrate to oceans may control sea phytoplankton's population (5) all these suggest that we shall take a worldwide approach to study dust and evaluate it in enormous scale. This study was performed with goal of recognizing dust origin regions and surveys it in worldwide scale and also study effect of factors such as the earth warming, rainfall and vegetation on dust changes.

Method and Materials

Required data including dust concentrations and vegetation index (NDVI) obtained from MODIS sensor Terra satellite. Carbon monoxide level measured from MOPITT of Terra satellite and

[1] National Aeronautics and Space Act

precipitation rate was obtained by TRMM satellite from National Aeronautics and Space Administration (NASA). This information has been considered as monthly average in the months of April, May and June in 2001, 2002, 2008 and 2010.

Results and Discussion

Aerosol optical depth (AOD) distribution and also its local-temporal changes procedure has been showed especially in Iran. AOD parameter is a quantitative criteria regarding level of strip ray of solar radiation which passes among aerosol particles inside the atmosphere. This parameter has no dimension and it can't be measured directly, but it is measured by observations from atmospheric spectral fissure. Regions with light yellow cover which have denseness less than 0.1 rates indicate soft and limpid sky and maximum visibility. Whilst, near and equal to 1 rates, indicate servant position of dust in atmosphere (brown inclined to red) contiguous areas to Africa desert, China desert, Seistan region in Asia southwest and Tolar delta in Sudan are main origins of dust. Researches results show that dust global rate is between 1000 to 3000 million/Tons in year that of which 500 to 1000 million/Tons belongs to Africa desert and amount of 800 million/tons belongs to china annually (17). Some researchers reported amounts between 100 to 460 million/tons annually for china deserts (7). Despite of small area relatively, Africa north desert forms about 6 to 18 percent of dust global dissemination. Recently researchers use MODIS measurer images to recognize origin of dust in china and understood that that sandy lands in east of Mongolia plateau is important factor in transferring dust to north of Pacific Ocean (17). Also it is specified that origin of dust comes from Beijing which located on west of china by tracking some rare elements (16) (figure 1).

Amount of AOD in Iran during 2010 epically in west and southwest was increased compare to 2008 (figure 1) undoubtedly this issue indicates dust particles denseness increase in west atmosphere of the country which often is influenced of Iraq, Syria and Arabia. One of the reasons which researchers consider to global dust effect is its transfer with too long distances. For example, dust transfer of drought lands of Iraq, Syria, Arabia and part of Africa desert to Iran. Transferring dust through Eyre lake in south of Australia to east of Australia (13), transferring Asia dust through Pacific Ocean to north of America (3), transferring dust through Africa desert through pacific ocean to north of America (9) and transferring large amount of dust of Africa desert to south of Gina Gulf in west of Africa (12) are samples of necessity of global approach to survey and study of dust phenomenon.

In figure (2), global distribution of total rainfall has been showed as monthly average (millimeter). Districts with dark blue color are high rainfall areas and districts with low rainfall have been indicated with white color. Iran has xeric and half-xeric climate due to location of north moderate area and average of annually rainfall is 250 millimeter. By comparing rainfall average of April, May and June during 2001 and 2010 it would be observed that total amount of rainfall has not significant change. Even this amount of rainfall that is three times more that worldwide average has been distributed as nonuniform (figure 2). This subject intensifies probability of drought in case of non-management of country water. On base of performed researches aside from soil state, dust storm origin is in areas which has xeric climate and average of annually rainfall is less than 100 millimeter (4).

In figure (3) distribution of carbon monoxide monthly denseness (based on part in billion in volume unit) on April, May and June during 2002 and 2010 and in elevation of 3.6 kilometers has been showed. Carbon monoxide has been produced as one of six important gaseous pollutants in world and due to overuse of fossil fuels and it has made formation of greenhouse gasses in atmosphere and warming temperature of the earth. As we can see, carbon monoxide denseness in April is more than May and June. Also in global and Iran scales, its amount shows increase from 2003 to 2010 as monthly average (Figure 3). Major origin of carbon monoxide formation located on northern hemisphere and in USA, Russia, China and parts of Europe. Whereas also other parts were affected of carbon monoxide circulation, it is necessary to take a global approach to stop it (Figure 3). Main sources of greenhouse gasses including power houses (as the most important centered source), transporting and complexes of oil and gas production that its per capita in industrial countries is much more than developing countries

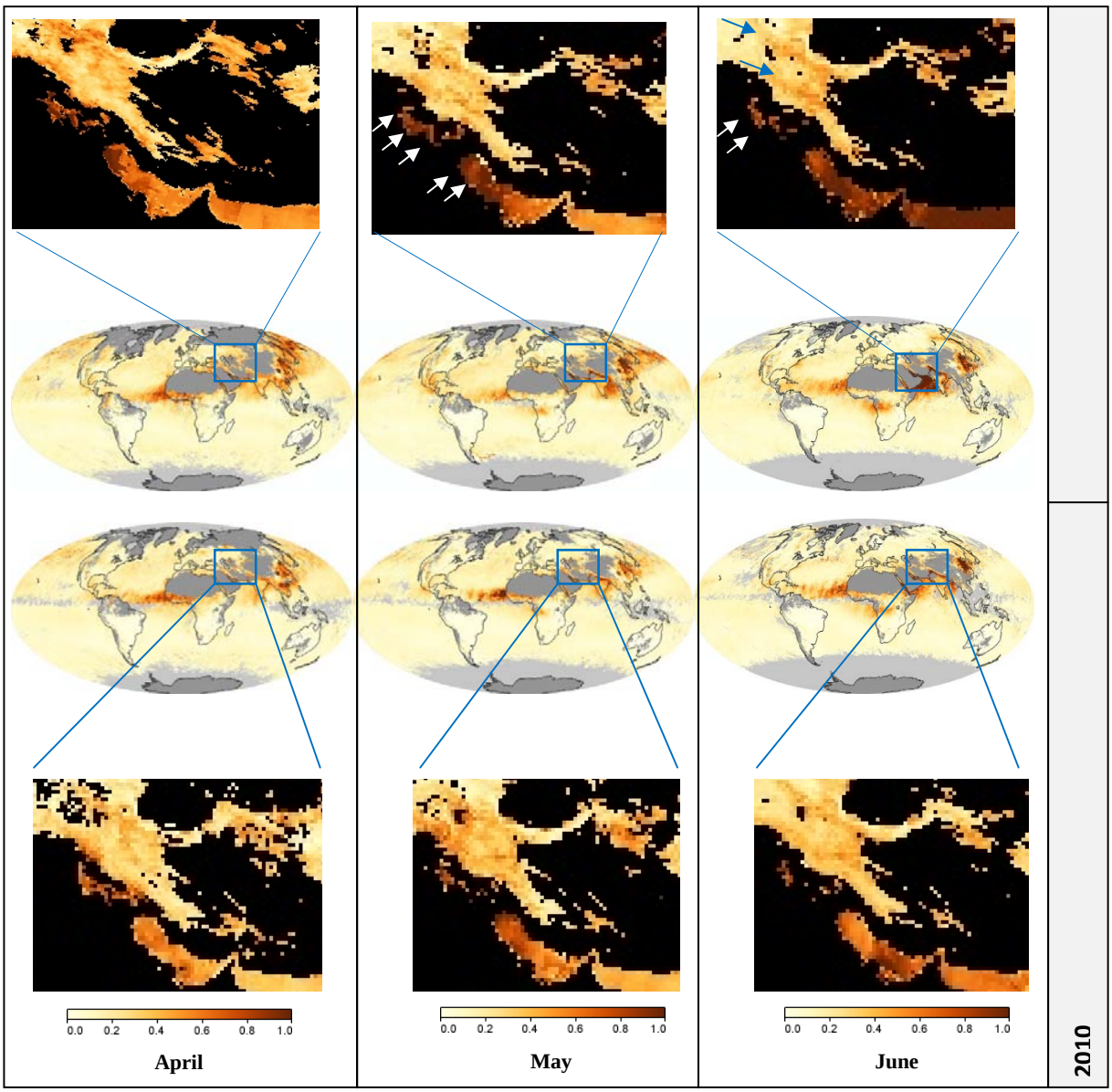


Figure1. Variability trend of AOD in the world and in Iran (2008 -2010) in April, May and June (gray points include no data)

Study by the united nations of 168 countries of world in the field of greenhouse gasses production shows that China and then America are first rank in greenhouse gasses production. Russia, India, Japan, Germany, Canada, England, South America and Iran are next ranks. According to this report, main oil producer countries in Middle East such as Iran, Arabia, Iraq and Emirates has a high growth in field of polluting environment and greenhouse gasses production. It seems that burn of gasses with oil and overuse of private cars is one of factors of greenhouse gasses increase in Iran. Therefore, in addition that Iran is one of the main ten countries of greenhouse gasses production, it has rapid direction in annually production increase of greenhouse gasses compare with world. Greenhouse gasses production in Iran was 175 million Ton at 1990 and it would be increased to about 520 million

Ton in next few years, this amount has been increased about 300 percent less than 20 years. According to published statistics by the united nations and Energy Global Institute, amount of greenhouse gasses production was increased from annually 20 milliard Tons to annually 30 milliard tons. This amount indicates increase average of 33 percent during 9 years. Whilst in similar time, amount of growth of greenhouse gasses shows 100 percent increase.

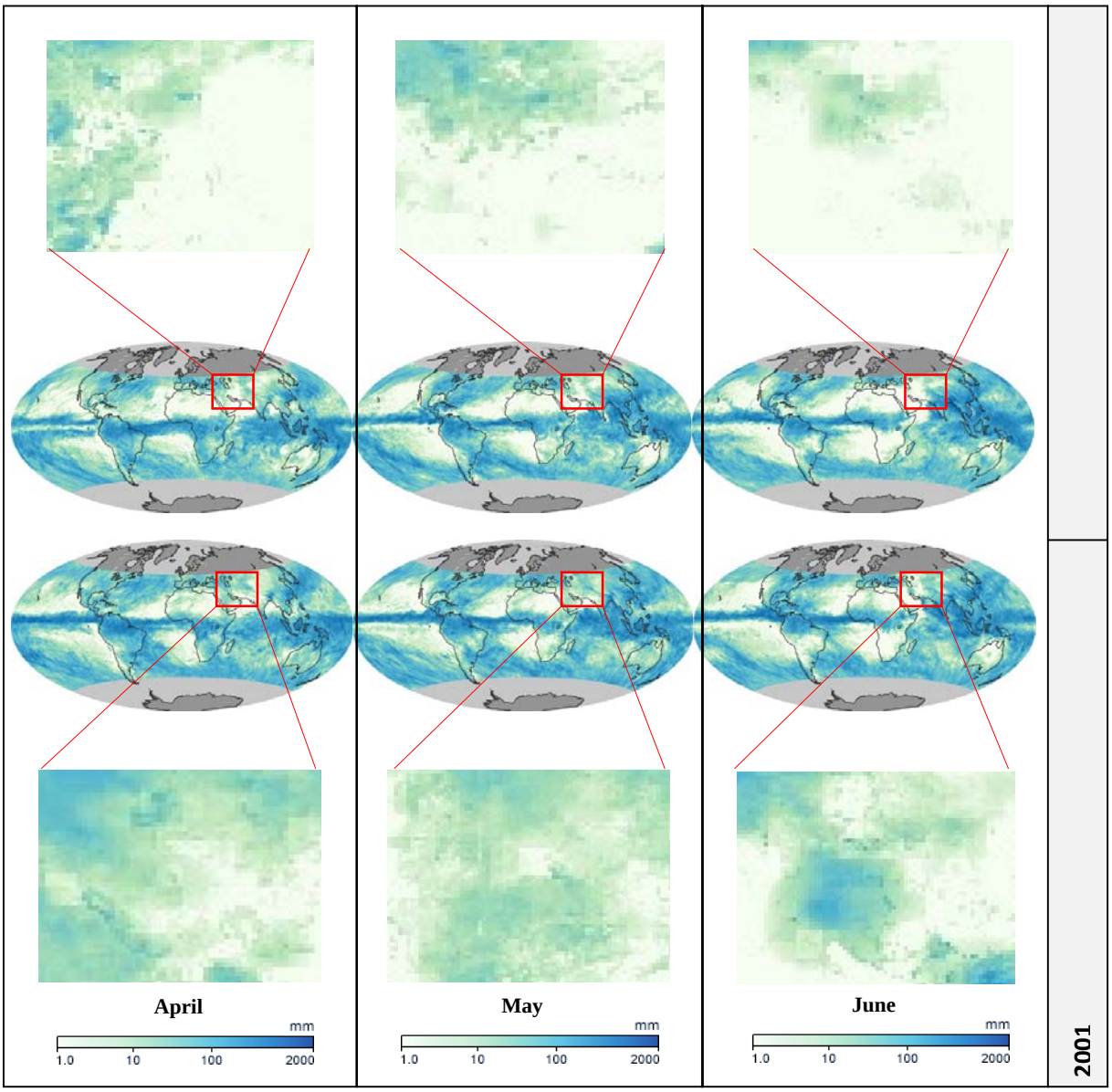


Figure 2. Variability trend of total rainfall in the world and in ran (2001 – 2010) in April, May and June (gray points include no data)

This global warming affected on amount of rainfall and its distribution and it increased amount of soil, lakes, rivers evaporation and also plant transpiration. Whereas all procedures which involved with matter and energy transfer may affect by each other, then global warming may change climate and resulted consequences such as drought and dust appearance. Climate natural changeability is unavoidable, but global warming may cause main changes in dust dissemination. According to IPCC

idea (6) under many of scenarios, drought lands due to having high rate of evaporation and transpiration has rainfall shortage and moisture. Aside from wind energy, appearance of such a position would make increase of dust activities probability. Performed researches in south of Africa shows that fixed sands are moving in Kalahari Desert during century 21. In such a position, dust storm activity would increase in this area.

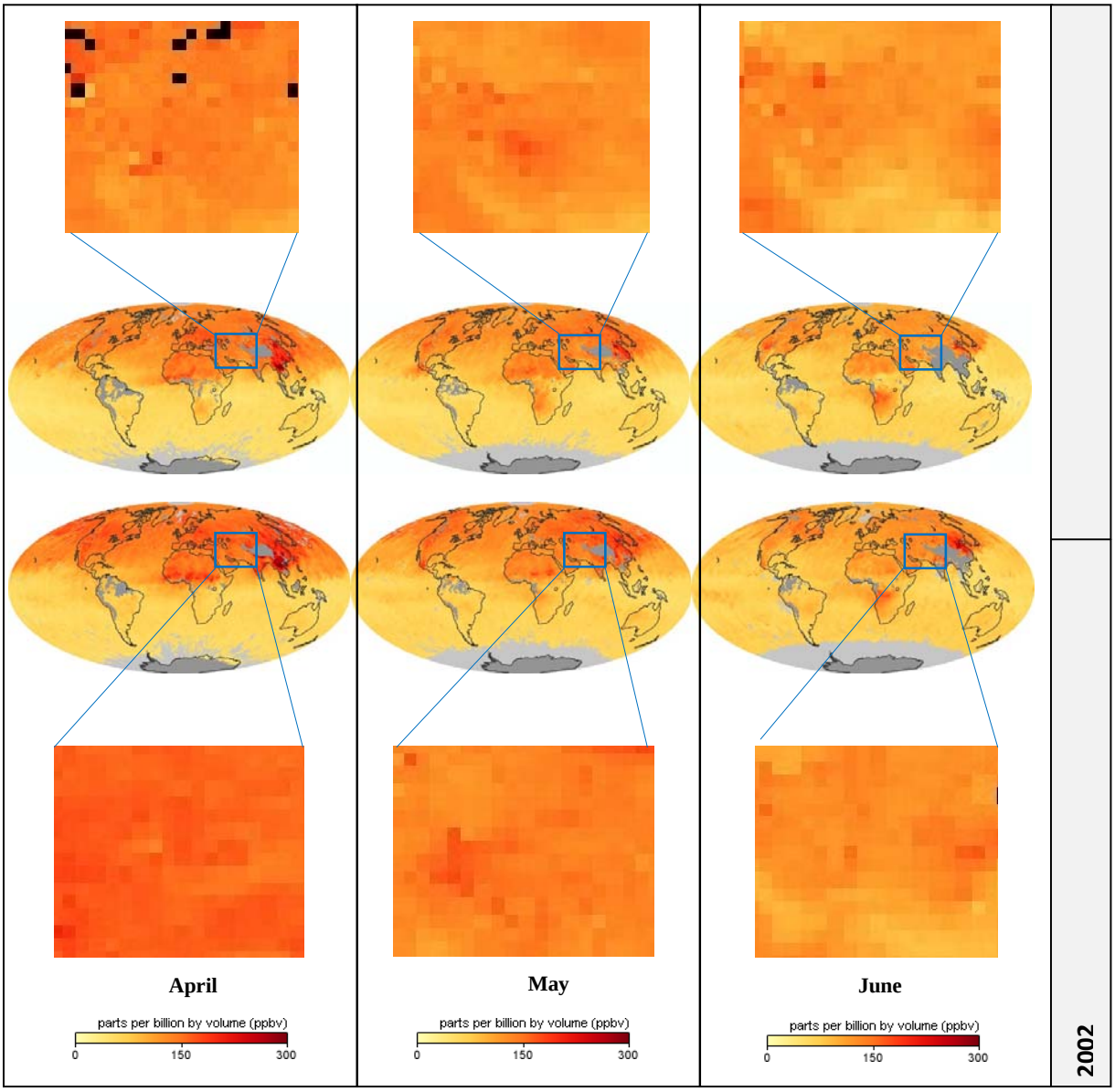


Figure3. Variability trend of carbon monoxide level in the world and Iran (2008-2010) in April, May and June (gray points include no data)

Vegetation patterned satellite observations in global scale, mainly are used to study changes in plant growth and development due to human activities and climate and environmental changes. Photosynthesis has an important role in carbon dioxide of atmosphere and save it on plant tissue. Hence, vegetation map producing is considered as key part of carbon circulation studies and carbon sequestration. In figure 4, vegetation changes are presented within frame of NDVI index in April, May

and June during 2002 and 2010. Areas with accumulated vegetation are dark green color and areas with low accumulation or lack of vegetation are seen in bright color. Equatorial and contiguous areas have accumulated vegetation due to sufficient rainfall and sun light and NDVI is about 0.9. In great desert of Africa, China, Arabia, Iraq and mainly Iran, vegetation accumulation is too low and has no vegetation in some areas (figure 4). In these areas NDVI index is less than 0.2 and/or close to zero. On the basis of overlap plant index map (figure 4) with AOD maps (figure1) and rainfall (figure 2), we can see that areas such as great desert of Africa, China desert, Arabia and Iraq are regarded as ready areas to be effected by windy erosion and dust production. Amount of NDVI index decreased in 2010 compare with 2002 to some extent in Iran (figure 4) Part of the decrease was happened due to overuse by Human such as destroying vegetation to use wood, animal farm forage and harvest successive production, making wetland dry and underground waters due to water overuse.

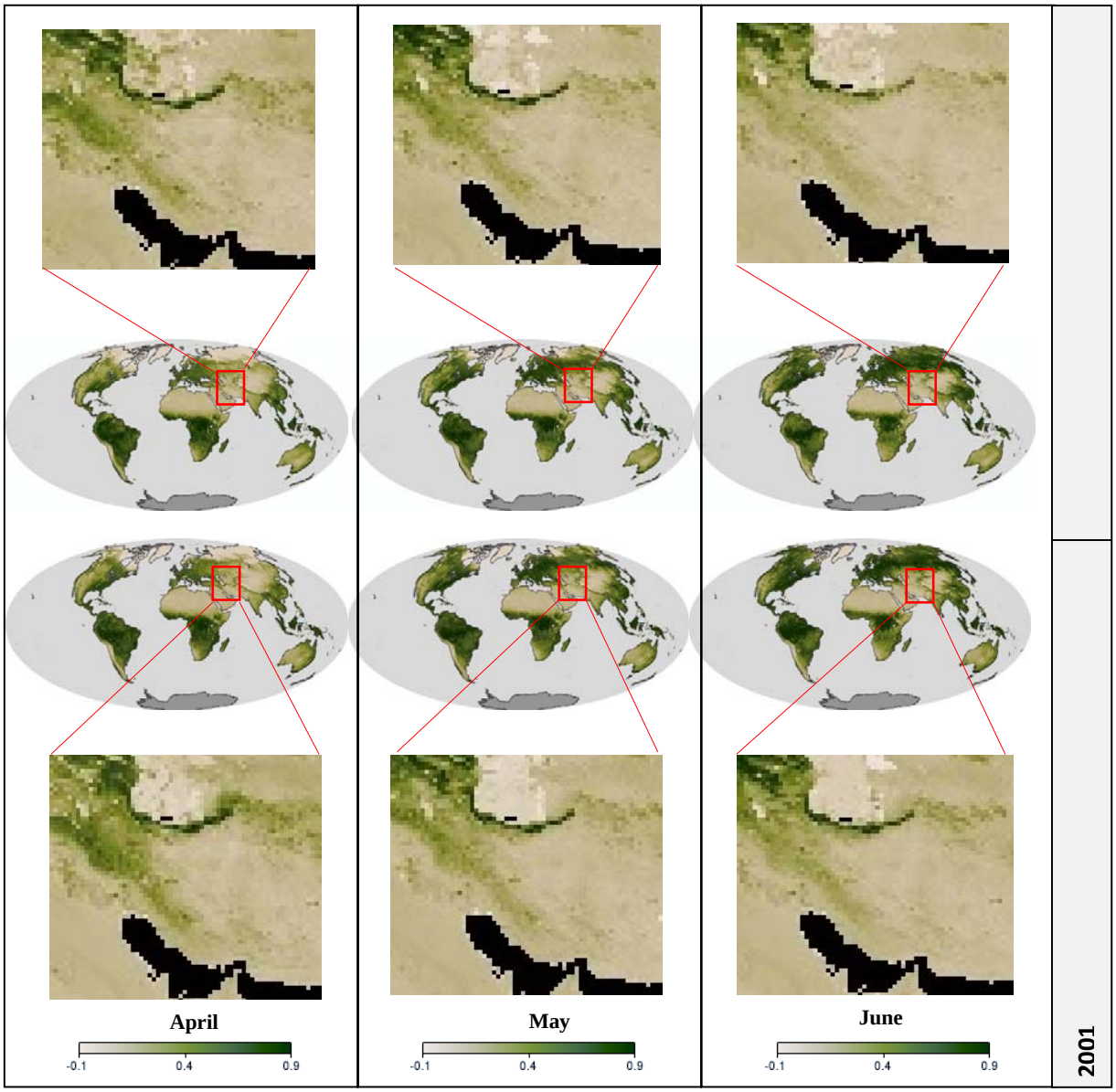


Figure4. Variability trend of Normalized Difference Vegetation Index (NDVI) in the world and in Iran (2001 – 2010) in April, May and June (gray points include no data)

Conclusion

Long term study of data through satellite images in global scale shows there is close relationship between amount of greenhouse gasses production, vegetation wide, rainfall amount, plentitude and dust denseness and climate change. Whereas three are main bases of dust production in world and also due to long distances that pass dust, it must take a global approach. Such an event is affected by other factors undoubtedly that they act in global scale. These factors are the very global warming due to greenhouse gasses overproduction that itself effected on amount of the earth moisture and vegetation and makes change in climate conditions in long term. The important consequence of climate change is dust appearance that it is happening in some locations of world such as China, Africa, Iran and Iraq.

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Greenhouse gas budgets after 46 years of continuous application of various tillage practices

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Abstract
Accumulation of the greenhouse gases (GHG) carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) in the atmosphere alters the earth's atmospheric energy balance and is thought to contribute to the accelerated "greenhouse effect". Agriculture is thought to be a major contributor to the concentration of GHG in the atmosphere, but there is a paucity of field-based data regarding the long-term impacts of soil tillage on GHG fluxes. Therefore, the overall goal of our study is to create a GHG inventory under various conservation tillage practices at one site in the United States. The results will provide guidance as to the best tillage practices that can achieve optimum GHG mitigation potential. The experiments were conducted at Wooster OH, USA in soil under a corn-soybean rotation for 46 years. At this site there are two tillage treatments: no-till (NT) and conventional moldboard plow tillage (MP). An adjacent forested control soil area was also sampled. The experimental design was a randomized block design. GHG fluxes associated with soil from each tillage treatment or forested area were measured using a static chamber technique. Based upon research results obtained to date, the greatest overall greenhouse warming potential occurred under MP and the least under NT. Thus conversion tillage, especially NT, offers the best potential for mitigating atmospheric greenhouse gases by agricultural practices.
Keywords: Greenhouse Gases, No-Till, Conventional Moldboard Plow.

Introduction

Greenhouse gases (GHG) carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) in the atmosphere causes a global "greenhouse effect" and leads to accelerated global warming. Methane and N_2O have global warming potentials 310 and 21 times that of CO_2, respectively (IPCC, 2001). Land use change and agricultural activities (e.g. fertilization, livestock, rice production) contribute an estimated 25%, 60-65% and 90% of the total anthropogenic CO_2, N_2O and CH_4 emissions, respectively. Natural forest soils are considered sinks for CH_4 (Watson et al., 1992; Duxbury, 1994; Smith, 1997; IPCC, 2001).
No-tillage farming is a method of producing crops without tillage other than the small amount of soil disturbance that occurs at time of planting (Figure 1). No-tillage is used to produce approximately 25% of the corn and 65% of soybean in Ohio. Ohio has the longest continuously maintained no-till plots in the world (48 years). As no-tillage is continuously applied to soil it can remove CO_2 from the atmosphere and sequester it in soil as humus. The soil properties also become more like that of a forest soil. The impact of no-tillage on the other greenhouse gases, N_2O and CH_4, is less well understood. Likewise, several studies (Goodroad et al., 1984; Lin and Doran, 1984; Robertson et al., 2000; Baggs et al, 2003) have reported higher rate of N_2O emission under NT while in other studies lower rates of N_2O emission under NT were found (Jacinthe and Dick, 1997; Kesavalou et al., 1998).
The greater the numbers of year's crops are grown using continuous no-tillage, the more efficient the soils become in reducing their ability to produce greenhouse gases. The purpose of this study is to create a greenhouse gas inventory for soils with different number of years of continuous no-tillage crop production.

Material and Methods

Chronosequence experimental sites:
Six locations, those include Mount Gilead (10 years no-till), Mount Gilead (17 years no-till), Bucyrus (14 years no-till), Centerburg (37 years no-till), Wooster and South Charleston (48 years no-till). We report results from the Wooster site only.

Tillage applications:
No-tillage (NT) and moldboard plow tillage (PT) (**Figure 1**). No-tillage uses a systems approach where crops are grown with minimal soil disturbance and the soil is kept covered with crop residue to conserve soil and water. Plow tillage uses a tillage tool to mix the soil with surface trash and stubbles and thereby promote more rapid decomposition.

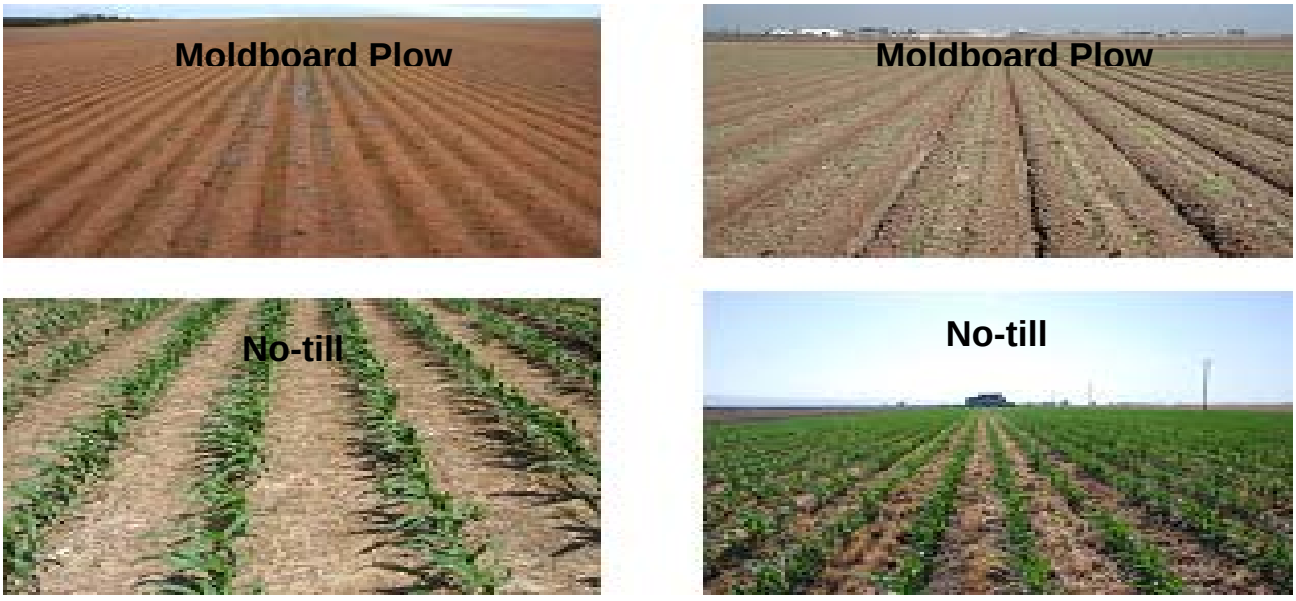


Figure 1. No-till (bottom) uses a systems approach to crop production where crops are grown with minimal soil disturbance and the soil is kept covered with crop residue to conserve soil and water. **Moldboard plow** (top) uses a system to dig the soil and invert it for quick decaying of surface trash and stubbles. This leaves the soil open to erosion and leads to loss of valuable organic matter (i.e. humus).

Cropping system:
Continuous corn (NT and PT) and adjacent forested area (reference site).
Gas sampling technique:
Static chamber technique using chambers made of polyvinyl rings of 20cm height by 30cm diameter (Figure 2). Gas samples (10ml) were taken biweekly during the year.
Measurement of gas samples:
Automated gas chromatograph (Varian CP 3800) interfaced with a Combi Pal auto sampler.
Soil temperatures and moisture:
Each plot was instrumented with four static chambers, as well as soil temperature and moisture probes.
Experimental design: Randomized block design with minimum of three replicates.



Figure 2. Installing the chambers (A), closing the lids to begin gas flux measurement (B), taking a gas sample (C), and storing air sample in a vial until analysis by gas chromatography (D).

Results

√ The highest CO_2 fluxes from the soil to atmosphere were observed in forest soils and the lowest CO_2 fluxes in no-till soils.

√ The highest CH_4 fluxes from atmosphere to the soil were observed in NT soils and the lowest forest fluxes from the adjacent forest.

√ The highest N_2O fluxes from the soil to the atmosphere were observed from PT soil and the lowest fluxes in no-till soils.

√ When CO_2, CH_4 and N_2O fluxes from Wooster (Ohio) soils to the atmosphere in 2009 were compared with 2010 data (Figure 3), we conclude the following:

►CO_2 fluxes were the lowest from NT, and the highest from forest in 2009-2010.

►CH_4 fluxes were the lowest from forest and the highest from PT soil in 2009-2010

►N_2O fluxes were the lowest from NT soils, the highest from PT soils in 2009-2010

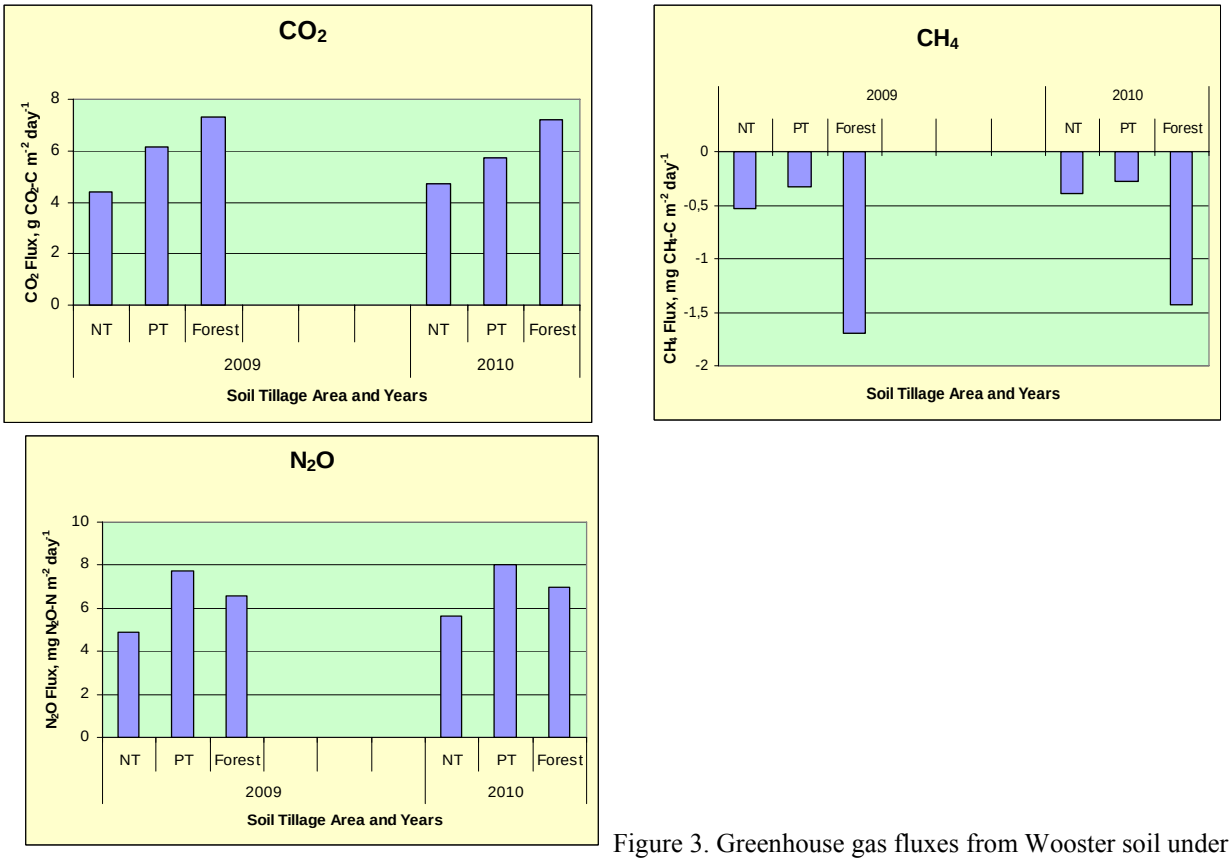


Figure 3. Greenhouse gas fluxes from Wooster soil under continuous corn no-tillage (NT), moldboard plow tillage (PT) and forest in 2009 and 2010.

Discussion

√ Carbon dioxide (CO_2) is the dominant green house gas in the Wooster soil.

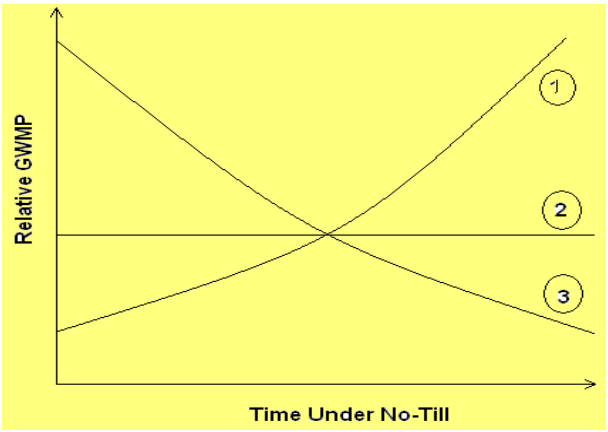
√ Methane (CH_4) was removed by the soil and nitrous oxide (N2O) was emitted from the soil under

all three management systems.
√ Methane (CH_4) removal was least under forest, intermediate under NT, and least under PT.
√ Overall; the greatest greenhouse warming potential occurred under forest and the least under NT. This observation based on measurements made for months of July through September (2009) and May through September (2010).

Table 1. Greenhouse warming potential. The CH_4 and N_2O results (Figure 3) were multiplied by 310 and 21, respectively, to calculate the total combined CO_2 equivalence for each management system

Year	Greenhouse Gases (mg m^{-2} day^{-1})	Management System (CO_2 equivalents)		
		NT	PT	Forest
2009	**CO_2**	4420	6160	7320
	CH_4	-160	-100	-525
	N_2O	110	160	135
Combined Gases		**4365**	**6220**	**6930**
2010	**CO_2**	4715	5700	7220
	CH_4	-120	-90	-480
	N_2O	115	170	130
Combined Gases		**4710**	**5780**	**6870**
Combined Gases Mean (2009-2010)		**4540**	**6000**	**6900**

Conversion from moldboard plow to reduced tillage, especially the most extreme form of reduced tillage called no-till, offers the best potential for mitigating atmospheric GHG by agricultural practices. Although data collection is not yet complete, we propose the relative global warming mitigation potential with long term maintenance of no-till will result in lower N_2O emission and increasing CH4 uptake with time as illustrated by Scenario 1 (Figure 4) (Robertson et al., 2000; Six et al., 2004; Johnson et al., 2005),



***Scenario 1*:** Lower N_2O emission and increased CH_4 uptake with time. This scenario illustrates a positive GWMP of no-till.

Scenario 2: Soil C sequestration offset by higher N_2O and CH_4 fluxes. No net GWMP of no-till.

***Scenario 3*:** Increased N_2O and CH_4 emission with no-till. Under this scenario, no-till practices have a negative impact on the GWMP of agro-ecosystems.

Figure 4. Possible scenarios of relative global warming miti-gation potential (GMWP) with long-term maintenance ofno-till.

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The roll of potassium and micronutrients application to enrich of forage maize under drought stress situation

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Abstract
To study the effect of drought stress, potassium and, soil and foliar application of micronutrient on yield and yield components of hybrid grain–maize S.C.704, this study was carried out in split-split-plot experiment based on RCBD with three replications in 2010 in Urmia (Iran). The factors include: drought stress as a main factor with two levels (normal and cutting irrigation), potassium as a sub-plot with two levels (non-application and 200kg/ha application) and micronutrients as sub-sub-plot with three levels (non-application, soil and foliar application). Fresh forage, biomass, concentration of Fe and Mn in grain, leaf and stalk were studied. Results showed that; foliar application of micronutrients increased the whole characteristics except biomass that increased with soil application of micronutrients. Foliar application of micronutrients with potassium in drought stress situation, significantly increased concentration of Fe and Mn stalk. Foliar application of micronutrients and drought stress without potassium increased concentration of Fe in grain. In normal irrigation form: Foliar application of micronutrients without using potassium increased concentration of Mn in leaf, but soil application of micronutrients with using potassium increased biomass. It can be concluded that in drought stress, using potassium with micronutrients leads to improvement of growth index, therefore under this conditions using this nutrients is recommended in Urmia.
Keywords: drought stress, forage maize**,** micronutrients, potassium

Introduction
Corn (Zea mays L.) is a very important forage plant that its shoot part was used for silage or fresh forage. The feeding and forage characteristics of corn are better than the other forage plants and the amount of its protein is an important factor to be considered when it compared with other (Curran and Posch, 2000). One of the important factors of abiotic stresses is water deficit that it decreased the agriculture products and the amount of yield in arid and semi arid areas (Taize and Zaiger, 2002). Therefore the roll of the nutrients appears well-enough when the plant is provided with other essential nutrients and also micronutrients has secondary effects on plants, that cause increased resistance of plants to some pests, diseases and stresses. Zn and B increased grain yield and the consumption of these rich grains, removed deficiency of these nutrients in human body and animal (Marschner, 1995). The study of the results of potassium application represented that, Fe and Cu deficiency decreased in plants (Dalipathy, 1998). The soil Fe_{av} has an effective influence on the produced chlorophyll and the deficiency in the amount of the Fe leads to some certain problems. Fe is also necessary in some enzyme activity such as Catalase, Oxidase and Hydrogenise (Marschner, 1995). Jafari and Imani (2004) considered the effect of drought stress and the results showed that drought stress significantly decreased corn yield. Hugh and et al., (2003) represented that drought stress situation decreased biomass as compare with not using it. Rahimi and Mazaheri (2008) considered Fe and Cu chemical combination on morphological reaction and corn yield, and they approved that foliar application of Fe and Cu had a significant effect on several generation stages of plant, flowering time and 1000 grain weigh.
Therefore the purpose of this study is the effect of potassium and micronutrients on yield and yield components of forage maize 704 on drought stress situation.

Materials and Metods
In order to study the effect of application of drought stress, potassium and micronutrients elements application on yield and yield components of forage maize (KSC704), a field experiment was carried out in the Sarribaghloregeon of Urmia, Iran in 2010, the climate of reign is arid and semiarid, Annual minimum and maximum degrees was -17°C and +35°C.

Table1. Physicochemical characteristics of soil:

ppm						Texture	%								
Fe	Mn	Cu	Zn	$K_{ava.}$	P_{ava}		Sand	Silt	Clay	T.N.V	S.P	O.C	T.N	pH	EC (ds/m)
4.5	3.7	2.9	1.7	434	28.4	Loam	17	26	57	16.1	54	1.19	0.12	8.04	0.68

The experimental design was split-split plot based on RCBD with three replications. The factors were: (A) drought stress as main factor with two levels: a_1: complete irrigation, a_2: water deficit in two stages: before tasseling in vegetative stage- in grain filling stage. (B) Potassium application as sub-plot factor with two levels: b_1: non potassium application, b_2: soil application of potassium. (C) Micronutrients (Fe + Mn + Zn) as sub-sub plot factor with three levels: c_1: non application c_2: soil application, c_3: foliar application. Here are fertilizer which were used in this experimental design: Nitrogen from of Urea as a base fertilizer used at the rate of 100Kg/ha in two stages: in vegetative stage (V5 to V6), in tasseling stage. Potassium Sulfate was used as a source of K at the rate of 200Kg/ha with soil application and used at the sowing time. Iron Sulfate, Manganese Sulfate and Zinc Sulfate were used as a sources of Iron, Mn and Zn at the rates of 100, 100 and 60kg/ha respectively for soil application and at the rate of 5Kg/ha was used as a source of foliar application. Soil application of micronutrients was used at the sowing time and foliar application of them was used at two stages; before tasseling in vegetative stage and at the grain filling stage after corn appearance. In this study we don't need any phosphorus fertilizer. The characteristic was measured are:

1. Fresh forage: was measured by cutting two middle rows of bushels from every patch and use the weight of whole fresh bushels (Kg/ha).
2. Biomass: was measured by dried whole bushels in 70^0Cin oven for 72h (Kg/ha).
3. Fe, Mn and Zn (grain, leaf, and stalk): Micronutrients was measured by standard dry digestic and extracting by normal HCL flame atomic absorption machine was used for reading the data (mg/kg) (Ali Ehyaie1996).

Results and Discussions

1. Fresh Forage (Fresh weight): The effect of drought stress on fresh forage was significant (table2). Fresh forage decrease 13% with drought stress (Table 3). Hagh and et al., (2003) showed that fresh forage decrease with drought stress significantly.

2. Biomass (Dry weight): interaction of each three factors on biomass was significant (Table2). Drought stress decreases the growth period and photosynthesis materials so transformation and assembling of these materials was increased (Nesmith and Ritch, 1992). Using potassium with normal irrigation increased biomass up to 11% (table4). Interaction of each three experimental factors, including soil application of micronutrients and potassium with drought stress, decreased biomass up to12 % (Table 5). Using iron fertilizer increased biomass. When the fertilizer was used the nutrients of them go to many vegetative and productive points of plants and increase biomass of shoots. Ghahfarokhy et al., (2004) reported that biomass decreased significantly with drought stress.

3. Grain Iron concentration: Interaction of each three factors on maize iron was significant (Table 2). Using of potassium with drought stress increases the concentration of Fe in grain (Table 4). In comparison of each three experimental factors, foliar application of micronutrients with potassium and drought stress increased this factor up to 20 % as compare with similar situation without potassium using (Table 5). Marshner (1995) were concluded that the use of iron and zinc increased the grain yield by increasing the total carbohydrate, 1000 grain weight and number of grain.

4. Leaf Iron concentration: Interaction of potassium×micronutrients and drought stress×micronutrients on leaf iron concentration was significant (table2). If foliar application of micronutrients using with normal irrigation, leaf iron will increase up to 20%. So, with normal irrigation, application of micronutrients should be in foliar form and leaf iron increased. If foliar application of micronutrients using without potassium, iron absorption by leaf was increased (Table 4).

Table2. Result of analysis variance on studied characteristics in corn Mean square

S.OV	d.f	Fresh forage	biomass	Grain Fe	Leaf Fe	Stalk Fe	Grain Mn	Leaf Mn	Stalk Mn
				Square	Mean				
Replication	2	282235291.361	1794766.361	128.072	55.422	374.135	0.151	85.881	12.951
Irrigation	1	1197321472.111*	8580993.778ns	94208.071**	20.400ns	721.818ns	0.490ns	364.810*	26.010**
Error 1	2	22350260.028	855670.861	222.542	6.630	182.655	1.051	7.323	0.256
potassium	1	77833565.444ns	205119684.000**	55.254*	196.467ns	15.210ns	8.8001*	126.938**	76.854*
Irrigation*potassium	1	6320196.000ns	72431447.111**	535.151**	125.067ns	376.360ns	0.018ns	77.440*	22.721ns
Error 2	4	14315968.139	953323.556	2.704	48.718	426.864	0.832	4.374	6.289
micronutrients	2	3247202.164ns	39986626.861**	5130.418**	23704.648**	7074.175**	19.840**	24574.512**	3567.303**
Irrigation* micronutrients	2	1308417.194ns	29785179.861**	3353.352**	716.925**	1130.245*	1.403ns	1104.691**	111.093**
Potassium*micronutrients	2	5282605.528ns	10866638.250**	1760.519**	264.221**	15.091ns	9.031*	381.744**	44.658**
Irrigation*potassium* micronutrients	2	9867891.083ns	2587313.028*	1605.299**	15.521ns	1466.411*	1.034ns	72.932**	84.511**
Error 3	16	39733164.458	876566.417	5.298	20.551	251.169	1.498	9.410	3.928
%C.V	-	7.69	6.63	2.38	3.31	19.67	10.89	3.12	4.93

5. Stalk Iron concentration: Interaction of each three factors on stalk iron was significant (Table 2). Foliar application of micronutrients increased the stalk iron concentration (Table 3). Foliar application of micronutrients with drought stress increased this index up to 23%. If foliar application of micronutrients, using without potassium, stalk absorbed iron much than other micronutrients (Table 4). In comparison with three experimental factors, foliar application of micronutrients with potassium using and drought stress increased stalk iron concentration up to 19% (Table 5).

6. Grain Manganese concentration: Interaction of potassium, micronutrients and potassium×micronutrients on grain manganese concentration was significant (Table 2).Using of potassium decreased this factor up to 9%. Foliar application of micronutrients increased this factor up to 16% (Table 3). If foliar application of micronutrients using without potassium, grain manganese increased up to 21% in comparison with using of foliar application of micronutrients with potassium. But if potassium was used, grain manganese absorption does not related to the way of micronutrients application (Table 4).

7. Leaf Manganese concentration: Interaction of each three factors on leaf manganese was significant (Table 2). Using of potassium decreased leaf manganese up to 4%. Foliar application of micronutrients was increased leaf manganese up to 24% (Table 3). Leaf manganese concentration was decreased with foliar application of micronutrients and using potassium up to 11% as compare with foliar application of micronutrients without potassium application. So this is well-enough when foliar application of micronutrients was used, potassium not recommended (Table 4). Interaction of each three factors showed that in foliar application of micronutrients with using potassium and drought stress, leaf manganese concentration decreased up to 6% as compare with foliar application of micronutrients in drought stress without using potassium. But it has better results, if in normal irrigation and non-potassium using, application of micronutrients was used as foliar form (Table 4).

Table3. Mean comparisons of main interactions on studied characteristics in corn

factors	Fresh forage (Kg/ha)	Biomass (Kg/ha)	Grain Fe (mg/Kg)	Leaf Fe (mg/Kg)	Stalk Fe (mg/Kg)	Grain Mn (mg/Kg)	Leaf Mn (mg/Kg)	Stalk Mn (mg/Kg)
irrigation								
T1	87784	-	45.5	-	-	-	101.5	41.0
T2	76250	-	147.7	-	-	-	95.1	39.3
potassium								
K1	-	11731	95.3	-	-	11.7	100.2	-
K2	-	16505	97.8	-	-	10.7	96.4	-
micronutrients								
M1	-	12779c	77.5c	94.9c	53.9b	10.3b	49.8c	22.9c
M2	-	16197a	93.7b	132.6b	86.3a	10.7b	105.6b	40.1b
M3	-	13377b	118.5a	183.4a	101.4a	12.7a	139.4a	57.4a

Table 4. Mean comparisons of two factors interactions on studied characteristics in corn

factors	Biomass (Kg/ha)	Grain Fe (mg/Kg)	Leaf Fe (mg/Kg)	Stalk Fe (mg/Kg)	Grain Mn (mg/Kg)	Leaf Mn (mg/Kg)	Stalk Mn (mg/Kg)
Irrigation*potassium							
T1 * K1	9825c	48.1c	-	-	-	104.8a	-
T1 * K2	17435a	42.8d	-	-	-	98.1b	-
T2 * K1	13637b	142.6b	-	-	-	95.5bc	-
T2 * K2	15575ab	152.8a	-	-	-	94.7c	-
Irrigation*micronutrients							
T1 * M1	13356c	40.3e	94.9e	51.1c	-	46.6e	22.8d
T1 * M2	16455a	47.1d	126.1d	90.7b	-	104.2c	44.4b
T1 * M3	11079e	48.9d	192.3a	89.5b	-	153.7a	55.8a
T2 * M1	12203d	114.6c	94.9e	56.8c	-	53.1d	23.1d
T2 * M2	15940b	140.3b	139.2c	82.1b	-	107.1c	35.9c
T2 * M3	15675b	188.2a	174.6b	116.3a	-	125.2b	59.1a
Potassium*micronutrients							
K1 * M1	9637e	70.4d	92.6d	-	10.7b	46.4e	22.4d
K1 * M2	14879c	84.4c	125.5c	-	10.3b	106.9c	39.9c
K1 * M3	10677d	131.2a	185.8a	-	14.1a	147.2a	53.7b
K2 * M1	15923b	84.6c	97.1d	-	9.8b	53.3d	23.4d
K2 * M2	17516a	103b	139.7b	-	11.1b	104.3c	40.3c
K2 * M3	16073b	105.8b	181.1a	-	11.3b	131.7b	61.1a

8. Stalk Manganese concentration: Interaction of each three factors on stalk manganese concentration was significant (Table 2). Foliar application of micronutrient with potassium using increased concentration of manganese in stalk up to 10% (Table 4). Interaction of each three experimental factors on this index approved that, in foliar application of micronutrients with potassium using and drought stress increased stalk manganese concentration up to 8%as compare with foliar application of micronutrients in drought stress and without using potassium (Table 5).

Table5. Mean comparisons of three factors interactions studied characteristics in corn

factors	Biomass (Kg/ha)	Grain Fe (mg/Kg)	Stalk Fe (mg/Kg)	Leaf Mn (mg/Kg)	Stalk Mn (mg/Kg)
Irrigation*potassium* micronutrients					
T1 * K1 * M1	8431g	39.1g	50.6e	42.3g	22f
T1 * K1 *M2	14241de	52.1f	75.2cde	106.7e	48.1c
T1 * K1 * M3	6803h	43.1f	94.6abcd	165.5a	51.1c
T1 * K2 * M1	18281ab	41.6g	51.4e	50.8f	23.7f
T1 * K2 * M2	18669a	42.1g	106.2ab	101.8e	40.8d
T1 * K2 * M3	15355cd	44.8g	78.4bcde	141.8b	60.5ab
T2 * K1 * M1	10843f	101.7e	57.3e	50.5f	22.9f
T2 * K1 * M2	1557cd	116.8d	97.3abc	107.1e	31.8e
T2 * K1 * M3	14553de	209.5a	112.1a	129c	56.4b
T2 * K2 * M1	13564e	127.6c	56.2e	55.7f	23.1f
T2 * K2 * M2	16363c	163.9b	66.7de	106.9	39.9d
T2 * K2 * M3	16797bc	166.9b	120.5a	121.5d	61.6a

In all tables factors was shown in this shape:
T1: normal irrigation, *T2*: drought stress, *K1*: without potassium using, *K2*: potassium using, *M1*: without micronutrients application, *M2*: soil application of micronutrients, *M3*: foliar application of micronutrients

Conclusion
Drought stress has alkaline effect on soil, and decreased absorption of micronutrients, therefore, soil application of micronutrients could not well-enough effect on uptake of them by plants. So, foliar application of micronutrients; obtain a direct path to uptake of nutrients by grain, leaf or stalk, and absorption surface of these nutrients increased, So concentration of micronutrients increased in shoot. Mohseni and et al., (2005) showed that quantity and way of micronutrients using had good effected on yield, quality and nutrient absorption on two varieties of corn and foliar application of micronutrients increased the quality and quantity of yield as compare with normal treatment.

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Effects of Silicon, Salinity and Waterlogging on the Extractable Zn, Cu, K and Na in a Sandy Loam Soil

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Abstract: The influences of silicon, salinity and soil moisture on changes of extractable Zn, Cu, K and Na concentrations were studied on a sandy loam calcareous soil in a laboratory experiment. The experiment was arranged as factorial based on completely randomized design with three replications. Treatments consisted of two levels of silicon (8 and 200 mg per kg of soil), three salinity levels (0.46 dS m^{-1}, 8 dS m^{-1} as NaCl and 8 dS m^{-1} as four-salts combination), two soil moisture regimes (-20 kPa and waterlogged) and four incubation times (0, 7, 30 and 45 days). Salt combination included NaCl, Na_2SO_4, $CaCl_2$ and $MgSO_4$ at a molar ratio of 4:2:2:1. Determination of 0.5 N acetic acid extractable Zn, Cu, K and Na was carried out after 0, 7, 30 and 45 days of incubation at 25°C. Waterlogging caused a significant decrease in Zn and Cu and a marked increase in K concentrations, but no change was observed in Na content. Soil salinity of 8 dS m^{-1} decreased extractable Zn and Cu, showing no significant difference between mixed-salts and single-salt treatments. In contrast, salinity enhanced acetic acid extractable K and Na levels. Increase in K concentration was statistically higher in mixed-salts treatments, whereas higher Na content was observed in NaCl treated soils. Silicon addition did not affect soil extractable Cu, K and Na, but decreased Zn concentration. It was concluded that Zn and Cu fertilizers should be applied in sufficient amounts to waterlogged and/or saline soils to prevent their deficiencies in plants. Furthermore, K over-fertilization must be avoided in waterlogged soils, because high concentrations of potassium were found under such conditions. Decreasing effect of silicon fertilization on soil extractable Zn should also be considered for accurate fertilizer recommendations.
Keywords: Incubation, NaCl, Salts composition, Soil moisture regime

Introduction

Although Si has not been listed among the generally essential elements of higher plants, it has been demonstrated to be beneficial for the growth of plants, particularly gramineous plants to alleviate both biotic and abiotic stresses in plants (Epstein, 1994; Liang et al., 1994). The concentration of silicic acid in soil solutions typically varies between 0.01 and 1.99 mmol L^{-1}, much more than the concentration of some macronutrients such as phosphorus (Epstein, 1999; Karathanasis, 2002). Therefore, it could be very important to know if availability of nutrients such as Zn, Cu and K are affected by soil silicon content. Nascimento et al. (2008) reported that silicon altered the Zn distribution in soil fractions, decreasing the most bio-available pools and increasing the allocation of this metal into more stable fractions such as organic matter and crystalline oxides. Silicon may also lead to the formation of $ZnSiO_3$, being almost insoluble (IRRI, 1970; Lindsay, 1992).

The most common salt in saline soils is NaCl; meanwhile others are $CaCl_2$, Na_2SO_4 and $MgCl_2$. Most soils considered to contain a combination of different salts in their solution (Grattan and Grieve, 1999). In saline and sodic soils, the solubility of micronutrients (e.g. Cu, Fe, Mn, Mo and Zn) is particularly low, and plants grown in these soils often experience deficiencies of these elements (Page et al., 1990). Soil microorganisms are involved in enhancement of soil Zn and Cu availability through reactions involving end products of their metabolism. For example, *Thiobacillus ferrooxidans* is capable of bringing about the oxidation of cuprous to cupric ions (Marandi et al., 2005). Microbes could also increase the solubility of these elements by the production of organic acids, declining pH, and releasing adsorbed Zn and Cu through increasing solubility of Fe and Mn oxides (Lovley and Goodwin, 1987; Nevin and Lovley, 2002;). Rietz et al. (2001) found a negative exponential relationship between increasing EC of the soil solution and microbial biomass and activity. The reason for the reduced size and activity of the microbial community with increasing salinity is likely to be osmotic stress which is caused by large concentrations of salts in soil solution (Galinski, 1995; Oren, 1999). Osmoregulation becomes a problem and the hypertonic environment tends to dehydrate the microorganisms. Specific ion toxicities (e.g. those of Na^+ and Cl^-) may also tend to inhibit microbial growth in saline soils (Zahran, 1997). Detrimental effects of soil salinity on microbial activity may cause important

decrease in zinc and copper availability, as well as subtracting soil organic matter decomposition, resulting in significant decrease in soil extractable Zn and Cu content.

Saline soils contain considerable quantities of cations such as Na^+, K^+, Ca^{2+} and Mg^{2+}. These cations undergo simultaneous exchange reactions with each other on the soil surfaces, and the study of their effects on K distribution between the solution and the solid phases are extremely important for plant nutrition (Feigenbaum et al., 1990). With increasing concentrations of competing cations, larger fractions of K from the soil or from fertilizer sources are found in the solution phase (Feigenbaum and Meiri, 1988; Polubesova and Nir, 1999; Bohn et al., 2001).

Availability of Zn and Cu usually decreases in waterlogged conditions (Ponnamperuma, 1977; De Datta, 1981; Swarup, 1982; Weil and Holah, 1989; Deka Medhi et al., 1996; Sadana and Nayyar, 2000; Towfighi and Najafi, 2002; Speelmans et al., 2007). Zinc deficiency of wetland rice has received more attention than any other micronutrient problem in recent years. Since its recognition as a field problem of rice by Nene (1966), zinc deficiency has been reported in Pakistan, India, the Philippines, Japan, the United States, Colombia, Chad, and Nigeria (Ponnamperuma, 1977). Once a soil is submerged, the concentration of water-soluble zinc decreases and reaches values as low as 0.03 mg L^{-1} despite desorption from Fe^{3+} and Mn^{4+} oxide hydrates. The concentration of zinc also decreases in calcareous and sodic soils in spite of the decrease in pH brought about by the accumulation of CO_2. Solubility criteria suggest that ZnS may be present in submerged soils (IRRI, 1972). Waterlogging leads to increase of soluble P by bringing soil pH into the neutral range (Kim et al., 1991; Chen ming et al., 1994; Najafi & Towfighi, 2007), resulting in decrease of zinc availability (Akhgar & Towfighi, 2002; Towfighi & Najafi, 2002). In soils containing free $CaCO_3$ or $MgCO_3$, zinc may be strongly adsorbed on them (Yoshida & Tanaka, 1969; Katyal & Ponnamperuma, 1975). Mikkelsen et al. (1978) reported that waterlogging causes an increase in the concentration of HCO_3^- and CO_3^{2-} in the soil solution. Other insoluble zinc compounds that may be present in waterlogged soils are $ZnSiO_3$ and $ZnNH_4PO_4$ (IRRI, 1970; Lindsay, 1992).

Patrick and Reddy (1978) suggested that the chemistry of copper in waterlogged soils is similar to zinc. In reduced environments copper may be present as Cu, CuS, or Cu_2S, and adsorbed on soil minerals (Krauskopf, 1972). Saha and Mandal (1998) reported that waterlogging may lead to the conversion of active fractions such as soluble and exchangeable copper into the inactive forms, resulting in decrease of Cu availability. Copper occurs predominantly in the +2 oxidation state in soils as a divalent cation, though Cu^{2+} may be reduced to Cu^+, especially if soft bases such as halides and S^{2-} are present to stabilize the Cu^+ ion. Copper tends to form insoluble sulfide in anaerobic conditions (p*K*s = 36.1). It therefore tends to have low mobility in submerged soils (Kirk, 2004). Copper is also probably present as insoluble complexes with organic matter (Ponnamperuma, 1977), because the decomposition of organic matter in waterlogged soils is much slower than non-waterlogged soils (Thenabadu, 1968). So, the conversion of organically bound Cu to soluble and available forms decreases in waterlogged conditions.

Reductive conditions caused by soil waterlogging results in a fraction of K^+ ions being displaced from the exchange complex into the soil solution (Islam & Islam, 1973). The release of relatively large amounts of Fe^{2+} and Mn^{2+} ions and the production of NH_4^+ ions probably are responsible for this displacement (Ponnamperuma, 1972; Ponnamperuma, 1978; Tian-ren, 1981; Bahmaniar et al., 1993; Regmi et al., 2002; Ibrahim et al., 2011). De Datta and Mikkelson (1985) showed that waterlogging quickens the release of K^+ from minerals. Phillips and Greenway (1998) observed that K^+ concentration in soil solution increased rapidly with time under submerged conditions and reached maximum at 24 days after submergence. Narteh and Sahrawat (1999) also found that electrochemical properties of the soils and their solutions tended to stabilize with time in a narrow range after waterlogging.

According to the above mentioned literature, various factors such as salt composition and salinity levels, time lapse, soil moisture regime and fertilization may cause significant changes in the availability of nutrients. However, there is little if any information about interactive effects of salinity and soil moisture regime, as well as silicon fertilization on soil extractable Zn, Cu, K and Na. The main purpose of this study was to evaluate the effects of these factors on nutrients availability. Thus, present research was carried out to determine the main and interactive effects of silicon levels, salt composition and salinity levels, and soil moisture regime on 0.5 N acetic acid extractable Zn, Cu, K and Na in soil.

Materials and Methods

This experiment was accomplished with two silicon levels (8 and 200 mg kg soil^{-1}) as silicic acid, three salinity levels (0.46 dS m^{-1}, 8 dS m^{-1} as NaCl, 8 dS m^{-1} as four-salts combination), two soil moisture regimes (-20 kPa and waterlogged) and four incubation times (0, 7, 30 and 45 days), replicated three times as factorial complete randomized design. Salt combination consisted of NaCl, Na_2SO_4, $CaCl_2$ and $MgSO_4$ at a molar ratio of 4:2:2:1. This is approximately the same salt composition found in saline-sodic soils of Tabriz Plain in northwest of Iran. Silicon levels were selected according to the results of Mauad et al. (2003), Tahir et al. (2006), Ahmad et al. (2007), and Ghanbari Malidareh et al. (2009). Selection of salinity levels also was done according to the findings of Goudarzi and Beecher (1991), Zeng and Shannon (2000), Pakniyat (2008), Sepaskhah and Yousofi-Falakdehi (2009).

A non-saline soil (EC= 0.46 dS m^{-1}) low in available silicon (8 mg Si kg^{-1} extracted by 0.5 N acetic acid) (Heckman & Wolf, 2009) was selected for this experiment. Soil texture (Bouyoucos, 1962), organic carbon (Nelson & Sommers, 1996), soil pH and EC, calcium carbonate equivalent (Allison & Moodie, 1965), 0.5 N acetic acid extractable silicon (Wang et al., 2004; Heckman & Wolf, 2009), available phosphorus (Olsen et al., 1954), available potassium (Haby et al., 1990), DTPA extractable iron, manganese, zinc and copper (Lindsay & Norvell, 1978), saturation percentage by weighting a saturated soil sample before and after oven drying, and soil moisture content at -20 kPa were determined (Table 1).

Table1. Main physical and chemical properties of the soil

Texture	Sandy loam
pH (paste)	7.2
pH (1:2.5 soil:water)	7.7
Organic carbon (%)	0.52
Calcium carbonate equivalent (%)	33.6
Sodium (meq L^{-1})	0.49
Available phosphorus (mg kg^{-1})	11.7
Available potassium (mg kg^{-1})	113
Available zinc (mg kg^{-1})	0.83
Available iron (mg kg^{-1})	9.48
Available manganese (mg kg^{-1})	7.24
Available copper (mg kg^{-1})	1.84
Acetic acid extractable silicon (mg kg^{-1})	8
Electrical conductivity of saturation extract (dS m^{-1})	0.46
Saturation percentage (w/w, %)	36
Moisture content at -20 kPa (w/w, %)	24

Each sample contained 10 g soil in a 50 mL centrifuge tube. Silicon and salts were added as solutions. The soil was waterlogged with water height of 2.5 cm above the soil surface with distilled water, in waterlogged treatments. Soil moisture content in non-waterlogged treatments was preserved at 24% (dry weight basis), corresponding to -20 kPa. At the end of each incubation period, the 0.5 N acetic acid extractable Zn, Cu, K and Na were determined. The extraction was performed on moist soil (-20 kPa and waterlogged) samples. For adjustment of extractant concentration, acetic acid was applied in concentrations of 1.34 and 0.55 N in waterlogged and non-waterlogged treatments, respectively.

After extraction with acetic acid, determination of zinc and copper was carried out by atomic absorption spectrometer (Model SpectrAA-220, Varian Company of Australia). Moreover, potassium and sodium concentrations were measured by flame photometer (Model Jenway PFP7, Company Rhys Scientific, UK). Statistical analysis including normality test, analysis of variance and means comparison were performed using MSTATC software. Comparison of means was carried out by LSD test at $p<0.05$.

Results and discussions

Extractable zinc

According to the analysis of variance table, 0.5 N acetic acid extractable Zn was affected by all four factors of the experiment. Bilateral and trilateral interactions among soil moisture regime,

silicon and time were also statistically significant. Other interactive effects caused no significant changes in soil extractable Zn (Table 2).

Table 2. Analysis of variance for extractable Zn, Cu, K and Na

Variation source	df	Mean squares			
		Zn	Cu	K	Na
Moisture regime	1	1.869 **	1.962 **	6045 **	5065 ns
Silicon	1	0.279 **	0.001 ns	4.34 ns	201 ns
Moisture regime × Silicon	1	0.033 **	0.000 ns	2 ns	67 ns
Salinity	2	0.128 **	0.535 **	7394 **	53150118 **
Moisture regime × Salinity	2	0.001 ns	0.065 **	170 **	917 ns
Silicon × Salinity	2	0.001 ns	0.000 ns	16.8 ns	742 ns
Moisture regime × Silicon × Salinity	2	0.001 ns	0.005 *	9.8 ns	11 ns
Time	3	0.048 **	0.075 **	192**	2239 ns
Moisture regime × Time	3	0.039 **	0.048 **	30 *	7 ns
Silicon × Time	3	0.003 **	0.003 ns	0.637 ns	2064 ns
Moisture regime × Silicon × Time	3	0.008 **	0.005 *	0.303 ns	2.5 ns
Salinity × Time	6	0.001 ns	0.001 ns	2.5 ns	1379 ns
Moisture regime × Salinity × Time	6	0.000 ns	0.000 ns	4 ns	23.6 ns
Silicon × Salinity × Time	6	0.001 ns	0.000 ns	2.5 ns	2459 ns
Moisture regime × Silicon × Salinity × Time	6	0.000 ns	0.001 ns	3.2 ns	22 ns
Error	96	0.001	0.002	10.236	2493

ns ,* and **: Non-significant, significant at 5% and 1% probability level, respectively.

In both moisture regimes, application of 200 mg Si kg^{-1} in the form of silicic acid resulted in significant decrease in soil extractable Zn (Figure 1). Decreasing effect of silicon fertilization on soil extractable zinc has also been reported by others (Liang et al., 2007; Cunha and Nascimento, 2008; Nascimento et al., 2008). Monosilicic acid reacts with Zn and forms slightly soluble silicates such as $ZnSiO_3$ and Zn_2SiO_4 (Tiller, 1968; Tiller and Pickering, 1974; Liang et al., 2007). Figure (1) also reveals that waterlogging caused a significant decline in soil extractable Zn during the incubation period. Regression equations presentd in the figure legend may be useful to predict extractable Zn concentration with a high precision at different times. Reduction of soil extractable Zn after waterlogging has been observed by other researchers (Deka Medhi et al., 1996; Chatterjee & Khan, 1997; Sadana & Nayyar, 2000; Kashem & Singh, 2001; Towfighi & Najafi, 2002; Speelmans et al., 2007). Waterlogging leads to increase of soluble P by bringing soil pH into the neutral range (Kim et al., 1991;Chen Ming et al., 1994; Akhgar & Towfighi, 2002; Najafi & Towfighi, 2007), resulting in formation of $Zn_3(PO_4)_2$ and $ZnNH_4PO_4$ compounds and hence, decrease in zinc availability (IRRI, 1978; Saha et al., 1992). Furthermore, some insoluble zinc compounds such as ZnS, $ZnCO_3$, $Zn(OH)_2$ and $ZnSiO_3$ may be formed in waterlogged soils (IRRI, 1970; IRRI, 1972; Lindsay, 1992; Liang et al., 2007).

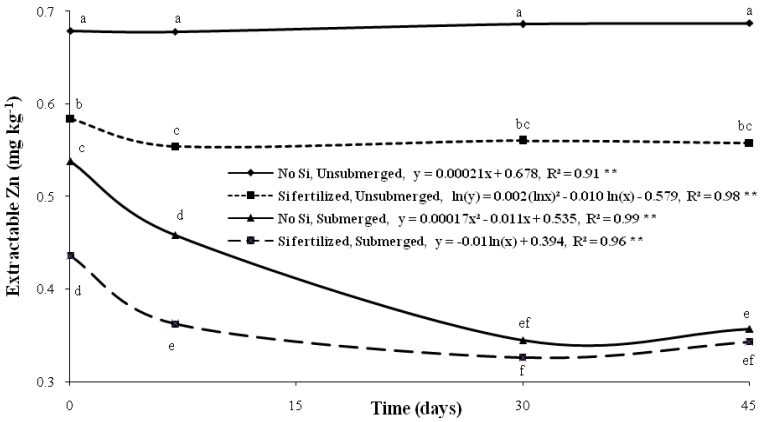


Fig. 1. Effects of soil moisture regime, Si and incubation time on acetic acid extractable Zn

Soil salinity of 8 dS m^{-1} resulted in diminishing soil extractable Zn in both soil moisture regimes (Figure 2). Increasing salinity levels increases soil Eh, making Fe oxides less soluble (Mahrous et al., 1983; Lu et al., 2004), therefore zinc is adsorbed onto these oxides. This could be a reason why salinity decreases soil extractable Zn. Moreover, a negative relationship between soil electrical conductivity and microbial biomass and activity has been reported (Rietz et al., 2001; Egamberdieva et al., 2010; Saviozzi et al., 2011). Thus, organic matter mineralization, as well as Fe bio-reduction diminishes with salinity, resulting in decrease of soil extractable zinc content.

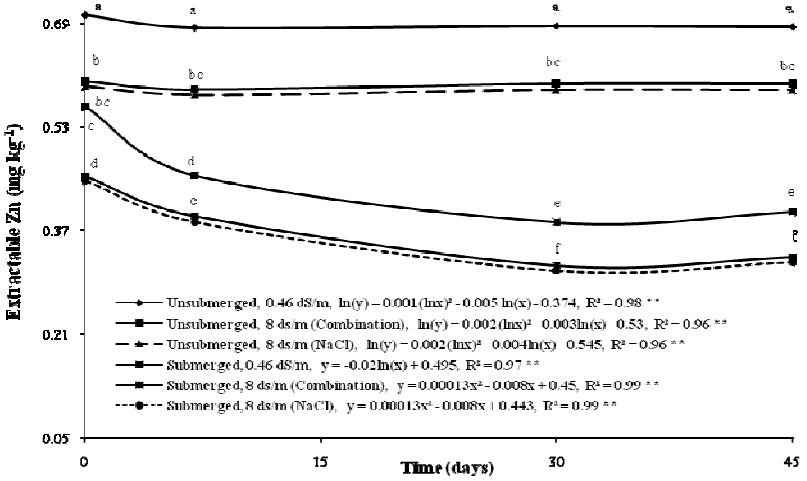


Fig. 2. Effects of soil moisture regime, salinity and incubation time on acetic acid extractable Zn

Extractable copper

Silicon fertilization showed no marked effect on extractable copper concentration. Also, some interactive effects including moisture regime×silicon, silicon×salinity, silicon×time, salinity×time, moisture regime×salinity×time, silicon×salinity×time and moisture regime×silicon×salinity×time were not significant. Other main and interactive effects were statistically significant (Table 2).

Acetic acid extractable Cu significantly decreased in waterlogged treatments after 7 days of incubation. This trend continued less intensely until 30 days, although Cu content was the same on the 30th and 45th days. The soil extractable Cu was not affected by incubation time in non-waterlogged and non-saline treatments (Figure 3). Influence of waterlogging on decreasing soil extractable Cu has been reported by other investigators (Ponnamperuma, 1977; De Datta, 1981; Dutta et al., 1989; Weil & Holah, 1989; Saha et al., 1992; Towfighi & Najafi, 2002; Speelmans et al., 2007). Decreasing extractable copper content in waterlogged soils could be due to the formation of insoluble copper compounds such as CuS and Cu_2S as a result of reducing Cu^{2+} to Cu^{+}, as well as the presence of S^{2-} in such conditions (Krauskopf, 1972; Kirk, 2004). Also, much slower decomposition of organic matter in reduced conditions (Thenabadu, 1968) may lead to keeping copper complexed with organic matter (Ponnamperuma, 1977), resulting in decrease of soluble and available forms of Cu in waterlogged soils.

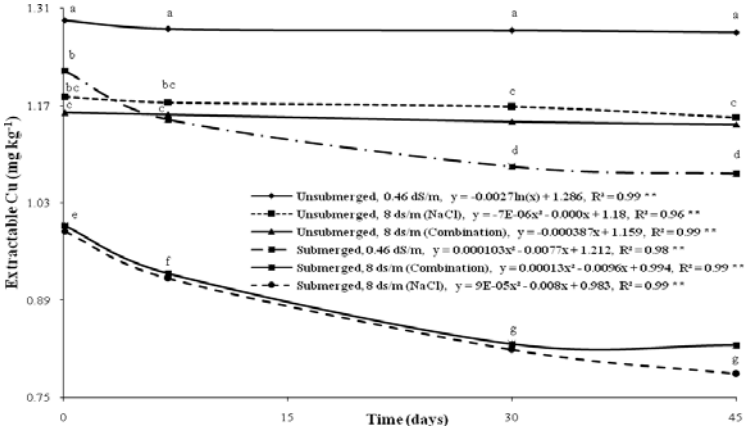


Fig. 3. Effects of salinity, moisture regime and incubation time on acetic acid extractable Cu

Soil salinity, regardless of salt composition, decreased the acetic acid extractable copper concentration during incubation period in both moisture regimes (Figure 3). Salinity inhibits organic matter mineralization (Oren, 1999) due to its mitigative effect on microbial biomass and/or activity through osmotic stress (Galinski, 1995; Zahran, 1997; Egamberdieva et al., 2010). Moreover, increased soil Eh in saline conditions makes Fe oxides less soluble (Mahrous et al., 1983; Lu et al., 2004) and therefore copper is adsorbed onto these oxides. These mechanisms may be responsible for decreasing extractable Cu content in saline soils. Equations illustrated in the figure (3) legend may be useful for estimating extractable Cu concentration with high precision at different treatments during incubation period.

Extractable potassium

All experimental factors, except for silicon application, had significant effects on 0.5 N acetic acid extractable K content. Moreover, significant changes in soil extractable K were only found in bilateral interactions of soil moisture regime with salinity and time (Table 2).

Figure (4) shows that extractable K markedly enhanced with waterlogging during incubation, showing statistically similar values in the incubation periods of 7, 30 and 45 days in all treatments. These results are in accordance with those observed by others (Islam & Islam, 1973; De Datta & Mikkelson, 1985; Phillips & Greenway, 1998; Regmi et al., 2002; Ibrahim et al., 2011). The release of relatively large amounts of Fe^{2+} and Mn^{2+} ions and the production of NH_4^+ ions in reduced conditions could make a fraction of K^+ ions being displaced from the exchange complex into the soil solution (Islam & Islam, 1973; Ponnamperuma, 1978; Tian-ren, 1981; Bahmaniar et al., 1993; Ibrahim et al., 2011), resulting in enhancement of extractable potassium concentration in waterlogged conditions. Equations presentd in figure (4) legend could be used to estimate extractable K concentrations with a high level of precision at different times.

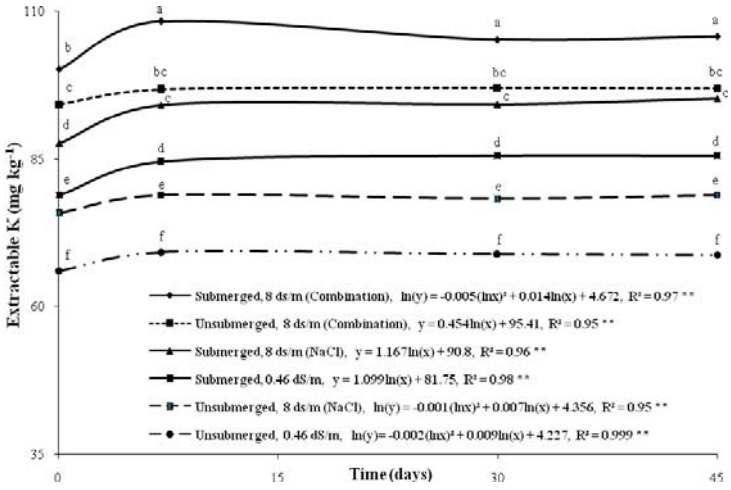


Fig. 4. Effects of soil moisture regime, salinity and incubation time on acetic acid extractable K

Soil salinity resulted in a marked increase in extractable potassium concentration in both moisture regimes. The increase was statistically more vigorous in mixed-salts treatments than single-salt ones (Figure 4). Increasing available K in saline soils has been reported by other researchers (Feigenbaum & Levy, 1977; Feigenbaum, 1986; Feigenbaum & Meiri, 1988; Feigenbaum et al., 1990; Jalali & Merrikhpour, 2008). Increase in concentration of competing cations in saline soil leads to release of larger amounts of K^+ from exchange sites into the soil solution. Higher extractable K levels in treatments with a combination of salts is likely due to the presence of divalent cations such as Ca^{2+} and Mg^{2+}. High affinity of these ions for adsorption onto soil particles is probably responsible for releasing more adsorbed potassium into soil solution (Feigenbaum & Meiri, 1988; Polubesova & Nir, 1999; Bohn et al., 2001; Jalali, 2011).

Extractable sodium

Soil salinity showed marked effect on 0.5 N acetic acid extractable Na, where other main and interactive effects were not significant (Table 2). Salinity caused significant increase in extractable

sodium concentration, showing severe enhancement in NaCl treatments (Figure 5). The considerable solubility of NaCl could be an acceptable reason for increasing extractable Na concentration in soil after NaCl application. Lower sodium content in mixed- salts treated soils may also be explained by lower proportion of Na in these treatments. Estimation of extractable Na concentrations at different times can be

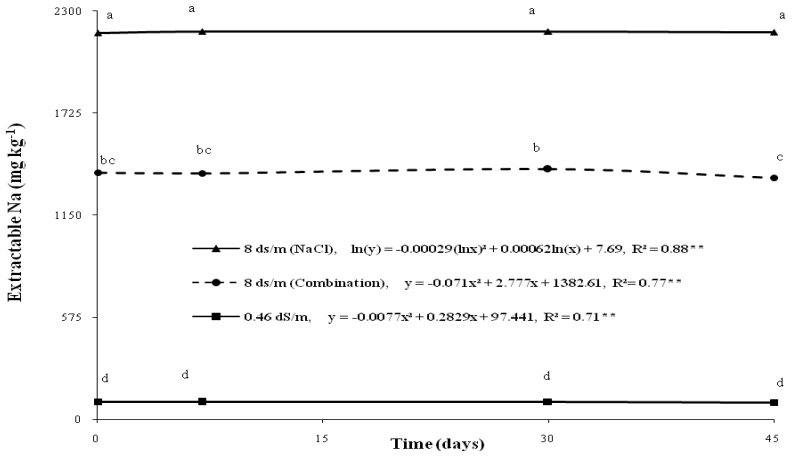


Fig. 5. Effect of salinity and incubation time on acetic acid extractable Na

carried out using equations shown in the legend of figure (5). Lu et al. (2004) reported that concentration of water soluble Na in soil greatly increased with addition of NaCl, whereas no significant changes in Na content were found during the 12-week waterlogging period. Increase in soil sodium concentration due to NaCl application has also been reported by others (Mahrous et al., 1983; Al-Busaidi & Cookson, 2003).

Conclusions

Sufficient amounts of zinc and copper fertilizers must be applied in waterlogged and/or saline soils, because of the significant decrease of available Zn and Cu under such conditions. On the other hand, waterlogging, as well as soil salinity, makes potassium more extractable. Thus, over-fertilization in waterlogged conditions should be avoided, in order to prevent spending extra costs. Other significant point is decreasing effect of silicon on the extractability of zinc. This is the reason why application of more amounts of Zn fertilizers should be regarded in silicon fertilized soils.

Acknowledgement

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Impact of Climate Change on Agricultural Soils

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Abstract
As known, soils and climate are closely linked and covered the world's surface. So, they are always prone to all external factor(s). One of them is "*Climate change*". Some important impacts of the *climate change* on agricultural soils can be mentioned as follows: i) *on soil water* (drought, location, crop, temperature, soil water content reducing, etc.) ii) *on soil temperature* (vegetation, organic matter, moisture, conductivity, etc.) iii) *on soil workability* (management of arable crops, tillage machinery, accessibility of land, the soil water content, etc.) iv) *on soil structure* (combination or arrangement of the particles, organic or inorganic components of the soil matrix, etc.) v) *on soil degradation* (salinity, waterlogging, transporting agents such as water, wind, acidification, erosion etc.) vi) *on soil organic matter* (availability of soil water, decomposition and decaying of the remains, etc.) vii) *on soil nutrient status* (availability of the soil water use, plant growth, ecological factors, soil profile depth, etc.) viii) *on soil ecology* (soil microbial and faunal populations, nutrient cycling, topography, climatology, etc.) ix) *on mineral transformation and clay surface processes* (weathering, temperature, water percolation, etc.) x) *others* (land management and use, interactions between soil and climate, soil carbon deposition and sequestration, etc.)
Without losing time, all necessary precautions should be taken and always consider them. Otherwise, it will be very late for the agricultural sector and its vital components.
Keywords: Carbon sequestration, Climate change, Agricultural Soils, Soil properties, Waterlogging

Introduction

Soils and climates are closely linked each other and last one covered the world's surface. But, it always opens to the external factor(s). One of them is, perhaps the most vital and important, "*Climate change*". There are increasing concerns regarding food security and an increasing demand for food to be grown locally, both issues partially driven by climate change themselves.
This point is clear that climate change could potentially increase the area of the agricultural lands (Anonymous 2011b). In addition, the agricultural soils are also the main resources source and responsible from the main greenhouse gases (GHGs) such as CO_2, CH_4, N_20, etc.(Figure 1) by different processing types such as fertilizing, tillage, land management practices, etc. The potential impacts of climate change on soil (sensu lato) are not only causes on the soils but also and at the same time it appears on many component(s) or factor(s) (such as biodiversity, production pattern, quality and quantity, irrigation, flood, flowering time, harvest, etc.). But it is contradiction that increasing the (agricultural) production will result in increasing the GHGs levels, and finally this formation will resolve a positive feedback to the climate change. The process of global warming and the concomitant change in the water regimen are likely to affect all soil traits, besides, the quantitative evaluation of the predicted climate change on soil conditions is difficult, not only because of the uncertainties in the forecasts but also because of the complex, interactive influences of the agricultural soilsand water relations, vegetation, and land use (Rosenzweig and Hillel 2000). The physiological effects of the GHGs on plants which are inseparable parts of the agricultural soils, are directly stimulates to the soils, but these type impacts are not topic of this paper.

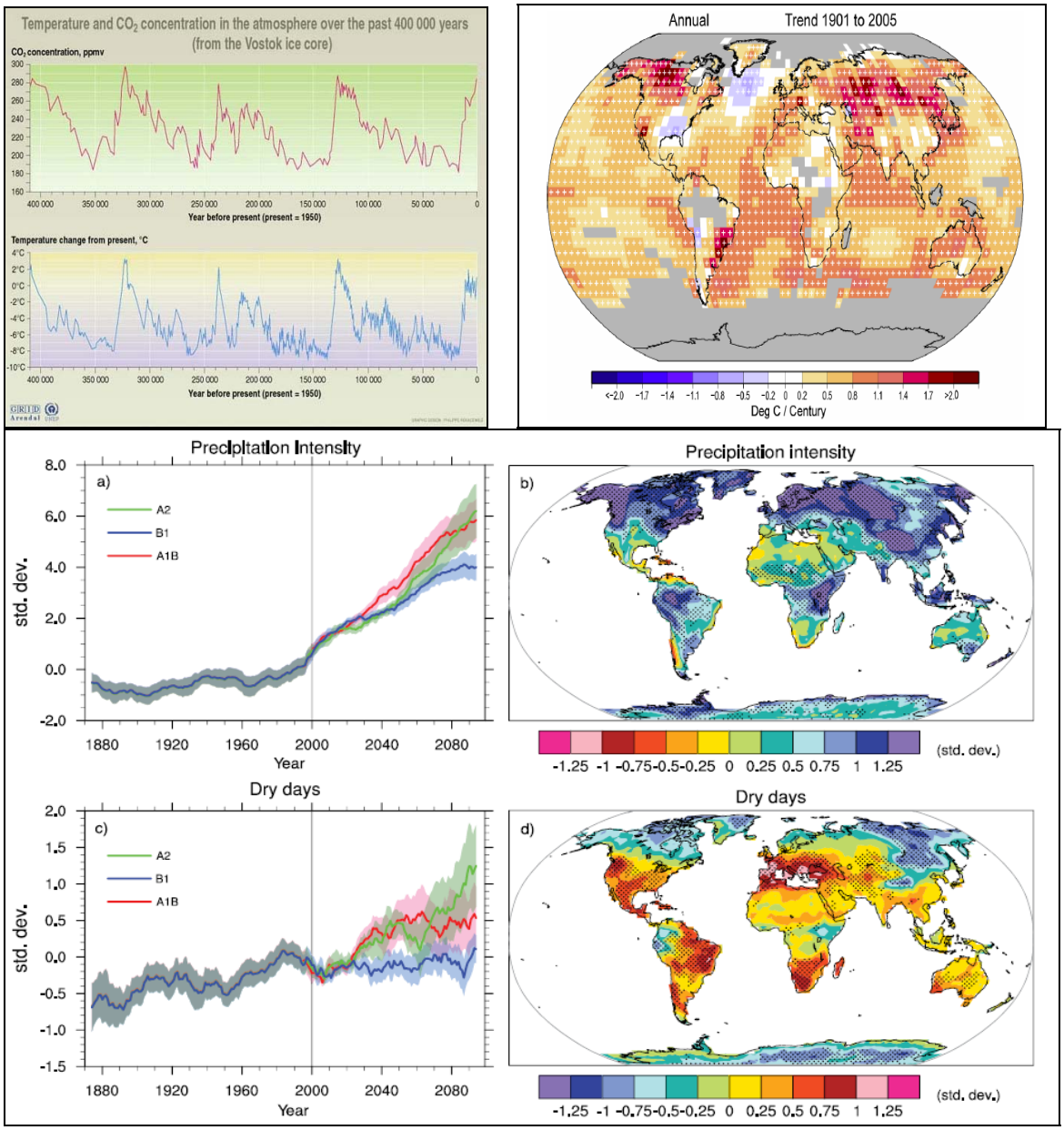


Figure 1. Climate change symptoms with some climatic parameters and satellite images (Modified from Anonymous 2008).

Material and Methods

As mentioned before, all the soils covers of the world's surface 29%. And, humans make their production activities with the combination of soil processes, climate, ecology agricultural managements and their interactions on the agricultural soils. The general consensus is that changes in temperature and precipitation will result in changes in land and water regimes that will subsequently affect agricultural productivity (Kurukulasuriya and Rosenthal 2003). Many factor(s) shape the natural resources, and main resources from them is the agricultural soils. It is very important and indispensable for all organic or inorganic objects. Without its existence, first of all could not be any agricultural activity, agricultual production, etc. Generally climate change effects on many sectors (Figure 2).

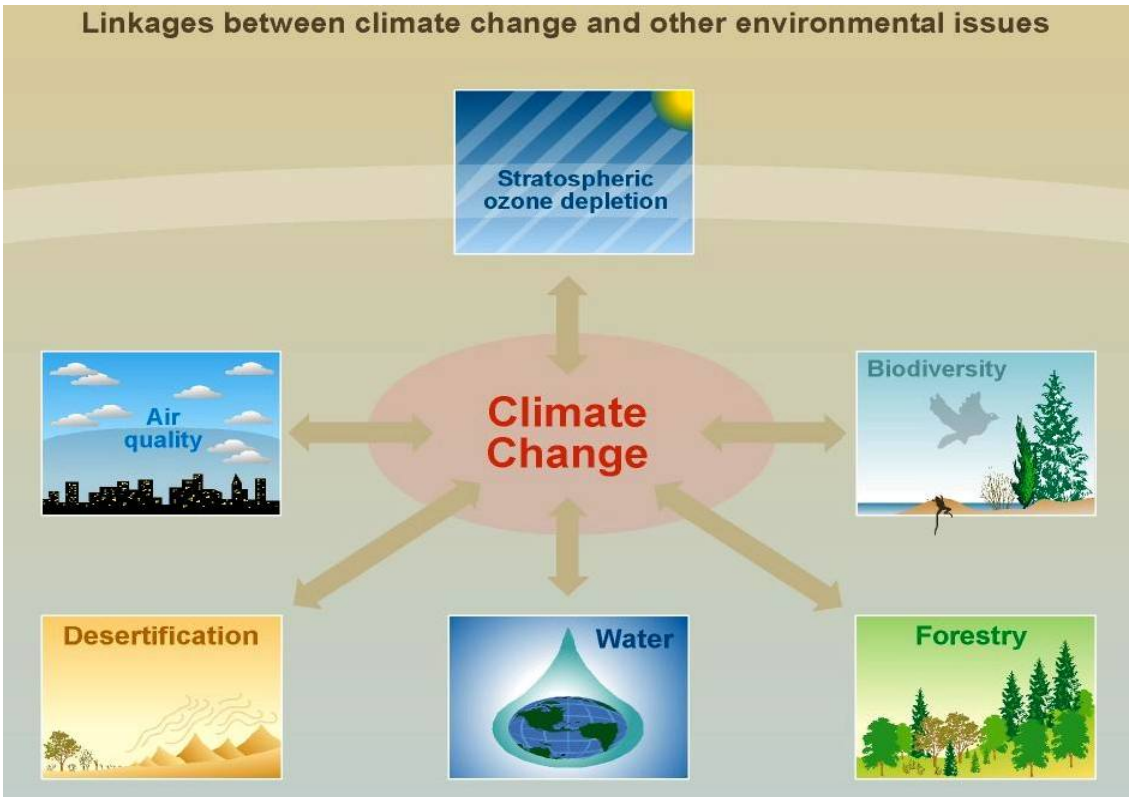
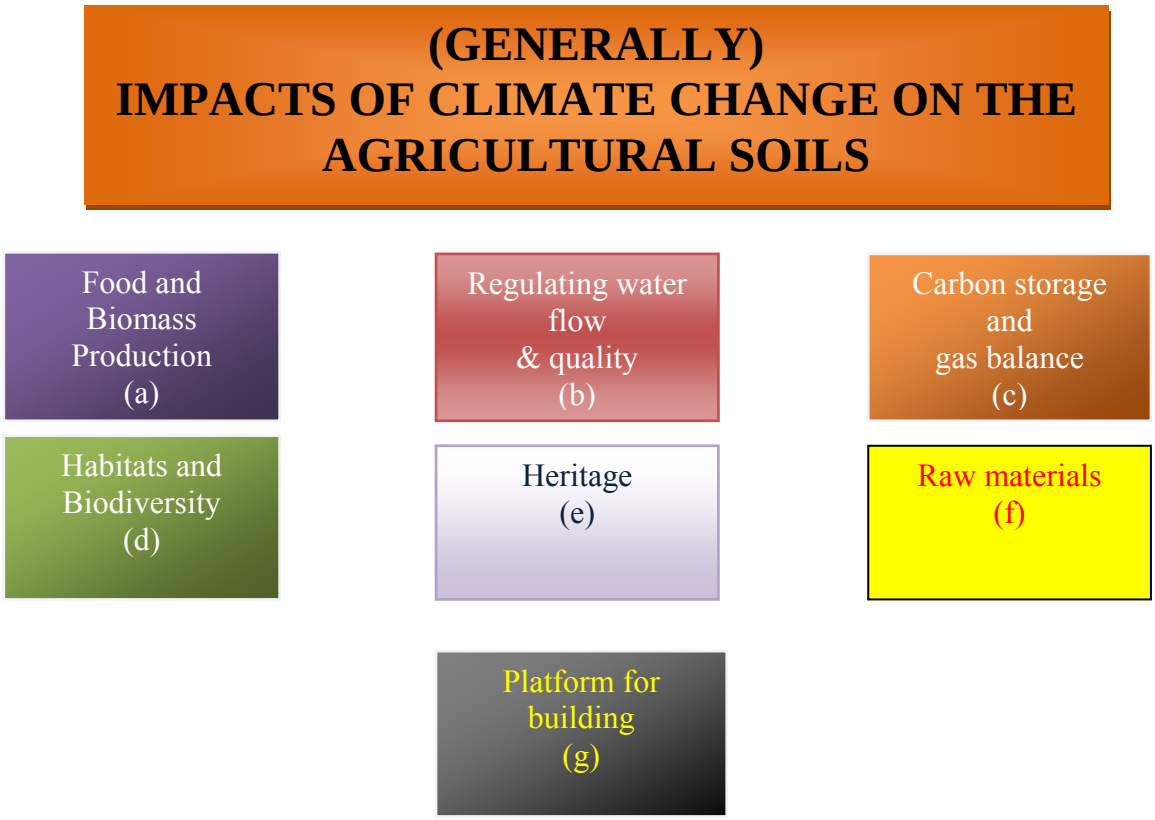


Figure 2. Climate change effected sectors (Kappelle et al., 1999; Anonymous 2011a)

Similarly, all generally effected factors were illustrated as the impacts of climate change on the agricultural soils at the Table 1 and specifically at the Table 2 (Rounsevell et al. 1999; Rosenzweig and Hillel 2000; Olesen and Marco 2002; Rattan 2006; IPCC 2007; Komatsuzaki and Ohta 2007; Brouder and Volenec 2008; Damatte et al. 2010; Delucchi 2010; Schaufler et al. 2010; Anonim 2011a; Anonymous 2011b):

Table 1. The agricultural soils sensitivity to climate change or potential impacts on the agricultural soils' functions examples (generally) (Modified from Rounsevel and Bullock 1999)



(a) Crop and grass yields may decreases due to drought; cropping flexibility may increase; increased storminess/drought/fire risk could impact on forest expansion.
(b) Soils's ability to store and retain water and buffer pollutants may be reduced. Possible increase in compaction and erosion risk, reducing soil fertility, decreasing crop yields and increasing risk of pollutants entering watercourses. Increased risk of flooding.
(c) Soil carbon stock may decline; increased potential for the GHGs emissions.
(d) Some valued soils which underpin important habitats are at risk from increasing temperatures and/or soil level rise. Risk of invasion by non-native species above and below ground.
(e) Increased risk of soil erosion leading to exposure of artefacts.
(f) Not affected, potential minimal impact on peat provision.
(g) Increased risk of foundation subsidence; increased risk of flooding.

Table 2. The agricultural soils sensitivity to climate change or potential impacts on theagricultural soils (specifically or direct and indirect) (Modified from Rounsevel et al. 1999)



(a) Drought, location, plant-crop, temperature, soil water content reducing, etc.
(b) Vegetation, organic matter, moisture, conductivity, etc.
(c) Management of arable crops, tillage machinery, accessibility of land, soil water content, etc.
(d) Combination or arrangement of the particles, organic/inorganic components of the soil matrix, etc.
(e) Salinity, waterlogging, transporting agents such as water, wind erosion, acidification, etc.
(f) Availability of the soil water, decomposition and decaying of the remains, etc.
(g) Availability of the soil water use, plant growth, ecological factors, soil profile depth, etc.
(h) Soil microbial and faunal populations, nutrient cycling, topography, climatography, etc.
(ı) Weathering, temperature, water percolation, etc.
(j) Land Management and use, interactions between soil and climate, soil carbon deposition and sequestion, etc.

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SOCIO-ECONOMIC ASPECTS OF SUSTAINABLE LANDSOIL MANAGEMENT

ORAL PRESENTATIONS

Soil Resources and Anthropic Threats to the Mediterranean Ecosystems

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Abstract

The Mediterranean regions - in addition to a huge cultural, historical, technological and scientific heritage - have environmental, natural, agricultural and forestry resources of inestimable value.
Waters, soil, vegetation, and wildlife, under the present climatic conditions, could provide, if rationally managed, security and prosperity to the future generations.
But very numerous and serious signs of environmental degradation, due to human impacts that compromise the values at stake, are everywhere evident.
Here are some of the resources examined, with particular emphasis on the soil, together with the threat of impairment and progressive environmental and economic risks of a future total collapse.

SOCIO-ECONOMIC ASPECTS OF SUSTAINABLE LANDSOIL MANAGEMENT

POSTER PRESENTATIONS

Evaluation of Watershed Management Measures in Hezargereh Basin of Fars Province by WOCAT program

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Abstract
Investment on soil and water conservation measures require detailed study and planning based on documented experiences and evaluation impacts and benefits of measures. Introducing success of measures needs evaluation of soil and water conservation projects by a standard and uniqe method by all experts in different regions of the country. This study introduces the results of applying WOCAT programme for the evaluation of bio-mechanical alternatives which have been done in Hezargereh region in the Izadkhast basin, southwest of Fars Province. This programme provides a complete data set about physical characteristics of the watershed, applied measures, human environment, maintenance and problems. This study evaluated the effect of biological operations, including; seeding, Drill seeding, seeding operations of management practices to reduce erosion and sedimentation in Hezargereh basin. Assessment of soil and water conservation technologies in Hezargereh with WOCAT programme indicated the success of ecological, economical and social aspects. Increased vegetation and grazing management in the watershed management caused to increase quality and quantity of water, soil moisture, biomass, infiltration, improvement of surface runoff, reduction of soil loss. Terms of direct economic impact of these measures can be mentioned; increase of fodder production income, the value of the collected seeds, job creation and increase in infiltration.
Keywords: drill Seeding, seeding operation, Hezargereh, WOCAT, Technology.

Introduction
Today, soil and water conservation (SWC) has become a global concern. The UN secretary general, Kofi Annan, has stated that 1/3 of the world's land is degraded. "Drought and desertification threaten the livelihood of over 1 billion people in more than 110 countries around the world" (UNCDD, 2005). At the international level, 92% of soil degradation is caused, directly or indirectly by agriculture: 28% by agricultural practices, 35% by overgrazing and 29% by deforestation to open new agricultural lands (Simons, 1996). Land degradation is simply defined, within the 'FAO-LADA Approach' as a decline in ecosystem goods and services from the land. Land degradation negatively affects the state and the management of the natural resources– water, soil, plants and animals - and hence reduces agricultural production. Assessments in this basin show the Severity of land degradation and the urgency of improving natural resource use through sustainable land management (SLM). Sustainable Land Management (SLM) in the context of WOCAT is defined as the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions. (WOCAT Questionnaire,2010,2008). Sustainable land management is simply about people looking after the land – for the present and for the future. The main objective of SLM is thus to integrate people's coexistence with nature over the long-term, so that the provisioning, regulating, cultural and supporting services of ecosystems are ensured(Hanspeter Liniger et all., 2011). Sustainable Land Management has been defined by TerrAfrica as: 'the adoption of land use systems that, through appropriate management practices, enables land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources.
In IRAN, as much as 125 million hectare of the total land area is already degraded by soil erosion and nutrient depletion(Dehghan,1985), causing farmers to suffer financial losses due to the reduced productivity of cultivated soils .The main reason for this is the enormous population growth and therefore human needs for livelihood, which increased in recent years. On the other hand ,Annually, billions Toman of governmental budgets and facilities are consuming for executing of watershed projects in Iran and Fars province. While their assessment for determining the obtained

goals are not distinguished. So far evaluation of implemented of watershed projects in Fars province, and WOCAT program was used standardization assessment for possible comparison.
Concerted efforts to standardize documentation and evaluation of SWC technologies and approaches are needed and fully justified. Since 1992 the world overview of conservation approaches and technologies (WOCAT) programme is filling in this gap by using a standardized methodology to document and evaluate case studies of SWC world-wide and assess their spatial extent.WOCAT mission is to provide tools that allow SWC specialists to share their valuable knowledge in soil and water management, that assist them in their research for appropriate SWC technologies and approaches, and that support them in making decisions in the field and the planning level. WOCAT's **tools** include three comprehensive questionnaires and a database system which cover all relevant aspects of SWC technologies and approaches, including area coverage(liniger et all.,2007).The objectives of this study were to:

- Using WOCAT program in evaluation of soil and water conversation measures in order to assessment of strengths and weaknesses points in terms of this basin.
- Rigorous impact assessment, involving the evaluation of strengths and how to sustain them, as well as evaluation of weaknesses and how to overcome them.
- Recognition of effective factors on sediment and erosion in this basin.

Material and methods

Study area

The study area (152/75km2) was located in the Fars province at between 51° 50 43 and 52° 1 31 E longitude, 31° 14 32 and 31° 25 9N latitude, on the 62 km western side of Abadeh. The topography is characterized by ridge and hill slope. Elevations in this area range from 2368/54 to 3262/79 m(A mean elevation is 2557 above mean sea level), with a Semiarid-type climate according to Demorton classification. Average annual rainfall is 394/4 mm, nearly 67% of which falls between December and march. Mean monthly rainfall is generally below 20 mm, except during December and April. The catchment area is 22/62 sq.km, that is limited to Qara Tepe in the northern highlands, Loryon in the east, Morvarid in the south and Gharedagh in the west. The average annual temperature in this region is, 10/7 Cº, average maximum is17/4 Cº, the mean minimum temperature is 3/4 º C. According to Amberotermic diagram the humid period is started in mid-October and is finished in the early of May That means that about 173 days of year is wet period and 192 days is dry one.

WOCAT methodology

WOCAT has developed a set of standardized tools to document, monitor and evaluate soil and water conservation SWC (know-how world-wide), and to disseminate it around the globe in order to facilitate exchange of experience and better decision making and planning. WOCAT has the mission of providing tools that allow SWC specialists to share their valuable knowledge in soil and water management, assist them in their search for appropriate SWC technologies and approaches, and support them in making decisions in the field and at the planning level. WOCAT has developed three comprehensive questionnaires and a database system to document all relevant aspects of SWC Technologies, Approaches, including area coverage, and The methodology for mapping soil degradation and conservation. A set of three comprehensive questionnaires and corresponding databases has been developed to document all relevant aspects of SWC technologies and approaches, and the mapping of their area coverage. The collection of information on SWC technologies and approaches focuses on case studies that describe the technology and its human and natural environment, where it is used, and which approach was used for its implementation. The questionnaire and database on the SWC map aims at providing a spatial overview of soil degradation and conservation. It can be applied at different scales, from local to national and international level(Van Lynden et all., 2002).
In this project we only used the technologies Questionnaire of WOCAT. The questionnaire on SWC technologies addresses the specifications of the technology (purpose, classification, design, and costs) and the natural and human environment where it is used. It also includes an analysis of the benefits, advantages and disadvantages, economic impacts, acceptance, and adoption of the technology (Hanspeter Liniger and Gudrun Schwilch, 2002).

Measurements

A: Erosion and deposition measurement

Due to lack of any station for hydrometric and erosion measurement, an experimental model, modified PSIAC, was used .At first specific sediment yield and total sediment was estimated after watershed measures in each work unit using this method. Soil erosion was calculated using sediment delivery ratio (SDR) in each work unit.Weighted average of so called parameters was calculated in this sub-basin and using the results, efficiency of watershed measures was compared (Ttable1).

Table1: Amount of erosion and sediment in different facies

Number of facies	Area (km^2)	Sediment Yield degree	specific sediment $m^3/Km^2/Y$	Specific sediment yield ton/ha/Y	SDR%	Specific erosion	Total erosion	Erosion severity
3	11/8613	49/45	222/12	3/33	49/33	450/2737	5340/83	low
4	3/8630	48/4	214/04	3/21	57/89	369/7357	1428/29	low
6	4/9367	53/25	254	3/81	55/85	1117/192	2245/16	low
7	35/7503	70/75	471/12	7/07	42/17	847/2945	399395/59	Medium-high
8	29/2905	63/7	367/98	5/52	43/43	954/0345	248178/68	medium
9	10/9949	71	475/3	7/13	49/82	473/2677	10489/15	Medium-high
10	8/3740	52/25	245/2	3/68	51/81	699/6733	3963/14	low
11	19/7722	59/9	321/22	4/82	45/91	757/7281	13834/80	medium
12	22/0679	51/9	342/19	5/13	45/16	575/0687	16721/74	low
13	5/8458	59/25	313/93	4/71	54/59	783/14	3361/74	low
Total area	152/7567	61/05	362/36	5/44	46/27		122141/85	medium

Result and discution

1-The effectiveness of measures on vegetation cover

Seed sowing was done in 23 blocks with an area about 2717/01 ha with species of Medicago sculata and polymorpha in this basin. Sangisorba minor was observed rarely under other plants. Seed planting in pits was done in the block number 11 with an area about 8629/56 ha with Medicago codi, Onobrychis sativa and Prangus ferulacea and Ferula gummosa. Sepecies such as Prangus ferulacea and Ferula gummosa were established more than others. Seed planting was done in 36 blocks with an area 703/17 ha and was cultivated with one type of medicago. Species such as Stipa barbara, Bromus tomentollus, Hordeum bulbosum were abundant in the area. Hordeum bulbosum was established with Bromus tomentollus and had good results. Range exclosure was done in an area about 63.5 ha. This project improved range condition toward positive trend and accelerated succession that resulted increasing delicious species and decreasing invadors.

2- Ecological effects

- Reduction of soil erosion and sedimentation

This study indicated that with increasing canopy cover from 21% to 27% to 31% to 41% after implementation, the rate of sediment has been decreased from 5/44 ton/ha/year to 4/10 ton/ha/year.

- Increase of soil organic matter

Relationship between plant cover percentage and Carbone percentage of the soil, shows increase of organic matter due to increasing of vegetation cover after implementing project of exclosure. The units 3, 6 and 7 which had been undergone range management, have similar brush cover and

vegetation type but their vegetation cover were different. In other words effects of exclosure measure is not similar on every footslope, and with increasing of average slope in footslope, the percentage of organic matter and vegatation cover were decreased(Figure1).



figure1: grassland condition after the soil and water conservation

- impact on groundwater

evaluating the effects of these measures on underground water resources indicated that amount of discharge of aquifer has increased from 17.6 liters per second before the measures to 33.4 liters per second after implimantation. This increase, indicates the positive effects of plant cover measures on underground water resources.

- impact of management and vegetative measure on the control of surface runoff

The results indicated that due to significant increases in vegetative cover and density per unit area after implementation, the sign of rills and intensity of runoff decreased.

- Impact on grassland condition

Results demostarated that forage yield has increased from 65 kg/ha to 270 kg/ha. There has been 205 kg increase in each hectare and 2602 tons increases of forage production in the basin . Canopy cover increased in some tips from 26% before implimantation to 41 to 61% after implimantation.

3- Impact on income and employment

Assessment the effects of SWC measure on social welfare of stackholders showed that levels of life quality for stackholders are increased and there have been improvements in their social conditions, social welfare and also cultural and social development. Incomes from following factors have caused improvement in life quality and economic situation of beneficiaries. These incomes consist of:

- Increase in forage production

Increase in forage production in the basin:

205kg ×12693 / 127ha = 2602091 / 035

each kilogram of forage value is 1200 Rials then income obtained from forage production in one year is:

1200 Rials × 2602091/ 035kg/ha = 3122509242 Rials

- Income from sediment decrease
- Income due to increase of land price resulting from increase in productivity of agricultural lands
- Income from seed Collection in pasture

Amount of collected seed was 1550 kilograms and 6000 Rials per kilogram for seed value, the income was 930,000,00 Rials.

- Income from employment

45 labourer had been employed for 1 month per year from 2002 to late 2007.

In order to protection of rangeland**,** two labourer had been employed for 6 years.

4- Popular participation

Land users usually are more willing to adopt practices that provide rapid and sustained pay-back in terms of food or income. Participation and cooperation of people in implimantion measues was very good in Korsali and Shourcheshme and landusers in Shiriincheshmeh were very low.

5-evaluating the effects of plant cover measures on agriculture

Results from this assessment indicate that implementation vegetative measures have helped to amplification and also improvement s qualities and quantities in agricultural products.

6-evaluating effects of water and soil protection measures on livestock

Implementation vegetative measures and management measures in this region had been caused increasing forage production and therefore each livestock has gained 10 to 15 kilograms weight after exclosure s season.

7-evaluating these measures on drinking water

rise of canopy cover, plant litter, had positive effect on infiltration and water purification.

In summary we can say that using various watershed management technologies in this area had been successful and we should study all factors of this project in order to reach a successful pattern to perform on other watershed areas of Iran.

Conclusion

Results of questionnaire of WOCAT indicated that, management measures such as exclosure and vegetative measures including seed sowing and seed planting were implemented in the basin. Type of land use after and before soil and water conservation measures was grazing land. Seed planting had been implemented in 2717/01 hectare and seed sowing in 703/17 ha and seeding a few seeds into a hole in 8629/56 ha. Range exclosure was done in an area about 68.5 ha. The stage of intervention due to severe water erosion in this area was rehabilitation. So in this basin longer-term and more costly investments were needed. Level of technical knowledge that was required for the implementation of this Technology for land user was low. Main causes of land degradation in this area were:Improper land management, deforestation/ removal of natural vegetation، over-exploitation of vegetation for domestic use, overgrazing، population pressure، poverty and lack of education and access to knowledge and support services. The main technical function were the following: control of dispersed runoff, control of raindrop splash, improvement of ground cover, spatial arrangement and diversification of land use، increase of infiltration, increase of groundwater level, recharge of groundwater, increase of biomass, sediment harvesting, increase of organic matter, and the Secondary technical functions were: control of concentrated runoff, improvement of water quality (buffering/filtering), increase of surface roughness ،increase of organic matter ،stabilization of soil, improvement of topsoil structure, increase in nutrient availability. Most of these measures had been implemented in the hills with slopes between 2 and 16%. The soil fertility in this area was low and surface soil organic matter before implementation was 0/1, and after the implementation was 0/9 to 1/4 percent. The depth of Ground water table is less than 10 meter and surface water is flowing on land and it is good and suitable for drinking. The average rate of erosion in this basin, before and after the implementation was respectively 917980/6 and 122141/85m^3/year. Market orientation of production system (of crop land and gardens) is mixed (subsistence and commercial). This project was implemented by watershead management in Abade city with cooparation of stockholders. The average Size of cropland per household was between 2 to 5 hectares and a small number of land users had 15 to 50 hectares cropland. The results of this assessment indicated the success of this project in view point of economic, cultural and ecological.

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Identify the Degree of Farmers Knowledge on Soil and Water Issues Case study in Mazandaran, Iran

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Abstract

Knowledge and identify of farmers on soil and water issues have important effect on improvement of agricultural productivities. The purpose of this study was to identify the degree of farmers knowledge on soil and water issues. The target population in the study was the farmers and authorities of soil and water issues in Mazandaran province, northern of Iran. This project was implemented during 2008-2009 in designed questionnaires for farmers. The reliability analysis was conducted and Cronbach's alpha values for the various sections of instrument were estimated to be between 0.73 and 0.86. For calculation and analysis of data SPSS 14 and Excel 2003 soft wares were used and mean, frequency, percent were calculated and analysed. Results showed that around 90% of the farmers had personal lands. 51.7% were crop growers and 24.2% fruit producers. For 91.3% of the farmers agriculture eas the primary job. The role of governmental extension agents about the scientific information sources of the farmers were only 41%, radio had less role about 5.8% and minimum contribution belonged to print media (2.6%). The results of descriptive findings showed that farmers (more than 50%) used fertilizer (amount and time) based on their own experiences. 68.4% of studied farms were not consolidation. 83.2% of the farmers used surface irrigation methods and 16.8% used pressurized irrigation systems. Around 95% of the quastioned farmers don't use internet, computer and computer softwares for agriculture purposes (especially irrigation schedules). Results showed that only 36% of the farmers were knowledgeable about surface irrigation methods and 40% had less to moderate knowledge about fertilizer application.

Keywords: Water and soil Management, Farmers' Knowledge, Extension, Education, Research

Introduction

Agricultural productivity reduces when ecosystems are changed and water resources decrease (Chen, 2005). The success of sustainable agriculture depends on the motivation, skills and knowledge of farmers (Ommani, 2006). According to various studies, the agri-food sector in Iran has not yet shown significant development during the last decades. Despite the advancement of infrastructural services made available to rural people over the past 20 years, the still, live in unequal social and cultural environments. The most important challenges may fall in the following categories: Inadequate resource management for production and insisting degradation of soil or water resources and the associated ecological consequences and inadequate job opportunities (Safaei, 1999). Nevertheless, there is various evidence that agriculture is still far behind the real potential of the country considering its available resource. On the other hand, sustainable land and water use has not yet been reached in Iran (Darvishi, 2003). In Iran, like other developing countries, agriculture is one of the most important economic sectors and comprises a considerably high percentage of production and employment. Since, farmers, land and water users are the primary active human resources in the agricultural sector, increasing their competence is necessity to improve the efficiency and productivity of farming. Hoseini et al. (2011) found that successful adoption of indigenous of knowledge in agricultural water management by farmers in dry areas of Iran will depend on the social, extension/education, economic and managerial factors. The results demonstrated that social factors are the most important factors influencing the adoption of indigenous knowledge. Based on the research of Karami & Rezaei-Moghaddam (1998), both socio-economic characteristics and environmental conditions of the farm have increased the poverty of Iranian farmers. They suggest that smallholder farmers with under-developed socio-economic and environmental conditions are relatively poorer. They concluded that poverty is a major reason for

unsustainable agriculture. Lack of sufficient farm management competencies effectuate higher soil erosion, over-fertilization, inadequate application of manure, lack of fallow, overgrazing, burning of crop residue, and over-use of pesticides. The purpose of the present study was to identify the degree of farmer's knowledge on soil and water issues in north of Iran.

Matrials and Method

The study was performed in Mazandaran province. The Mazandaran province is located in the north of Iran, within 31° 47' and 38° 05' north latitude and 50° 34' and 56° 14' east longitude and with 23,833 km2 (9,202 sq mi) area (Fig. 1), equal to 1.46 percent of the country and has a population of 3,000,000 being 4 percent of the population of the country. The province also consists of 52 cities, 3600 villages and 45 sections. There is often snowfall during most of the seasons in the Alborz regions, which run parallel to the Caspian Sea's southern coast, dividing the province into many isolated valleys. The province enjoys a moderate, subtropical climate with an average temperature of 25 °C in summer and about 8 °C in winter. Although snow may fall heavily in the mountains in winter, it rarely falls around sea lines. The target population in the study was the farmers and authorities of soil and water issues in Mazandaran province. This project was conducted during 2008-2009 in designed questionnaires for farmers. Questionaires reliability was estimated by calculating Cronbach's alpha and estimated to be between 0.73 and 0.86. A random sampling technique was used for selecting samples in 3 cities (Behshahr, Amol and Tonekabon) within the province. The total samples were 127 (N=127). Data were collected by personal interviews with farmers in their farms. The data were coded and analyzed by using the statitical pakages for the social science. Descriptive statistics (frequency, percent, mean, standard deviation, minimum and maximum) were used to analyze the collected data.

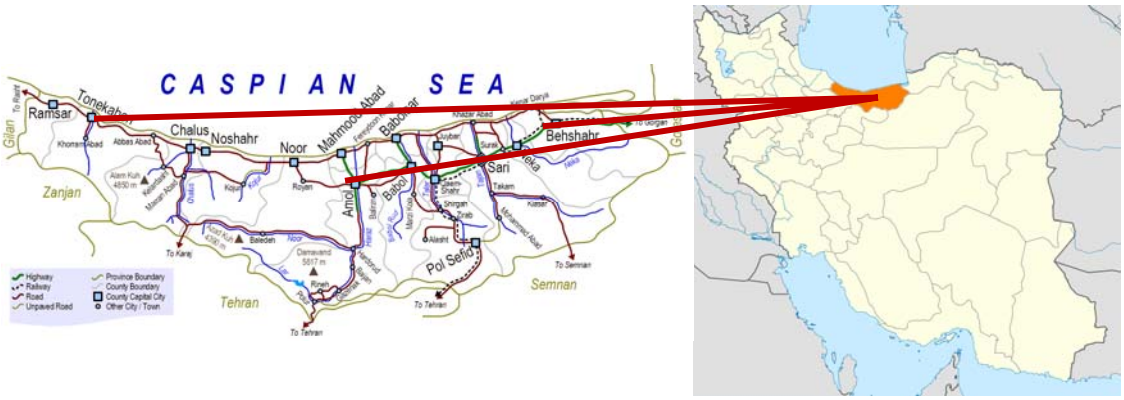


Fig. 1. Location of the study area in Mazandaran province, Iran

Results and discussion

Personal charachterity

Results showed that 51.7% and 24.2% of the farmers were crop growers and fruit producers respectivly. Agriculture was the main job for 91.3% of the interviewed farmers. The average age of surveyed farmers was about 47.2 and minimum and maximum ages were 24.7 and 79.1, respectively and 100% of them were men. As average age of surveyed farmers was high, we can conclude that the population of agriculture in this area trend to elderly. Around 90% of the farmers had personal lands, 94.5% were married and only 22.8% had college education.

Crop and land distribution

The crop distribution of agricultural lands were coverred with wheat and barley (11.8%), rice (72.5%), corn (1.4%), cereal (0.3%), oil seeds (9.5%), vegetables (1.6%), kitchen garden (1.7%) and grass (1.2%). Mazandaran province is the main rice producer in Iran. Most gardening land cultivation belonged to citrus (56.8%), followed by pomes fruit (like apple and pear) (16.5%) and finally stone fruit (like plum, peach and apricot) (14.1%). As showed in Fig. 2, more than 66% of the farmers in Mazandaran province have scattered land. Land fragmentation limit usage of modern irrigation systems and mechanization of agriculture and therefore it causes more water losses.

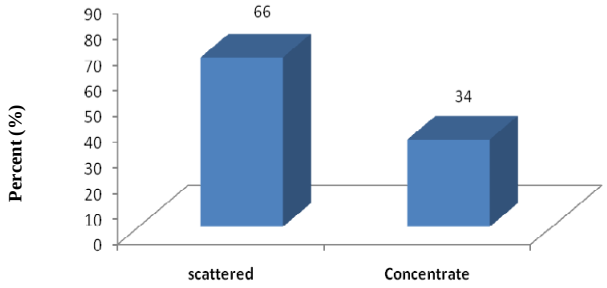


Fig 2. Comparison of land consolidation and distribution in the Mazandaran province

Fertilizer application and management

Education gives farmers better access to information about the fertilizers and more knowledge of how much fertilizer to use. Thus education is expected to favorably affect fertilizer decisions. Results of soil test by farmers indicated that farmers knowledge about correct and technical use of chemical fertilizer is gradually growing up. About 19% of the answers in this subject were related to soil test before cultivation. 64.4% of surveyed farmers did soil test in farm and garden at least once and 60.6% did not do soil test for any reasons. Most farmers did not have enough information about the soil test. Finance problems (13.6%) and soil test unnecessary (8.9%), lack of information (12.4%), lack of experimental facilities (4.5%) were other reasons of not to do soil tests. About 56% of the farmers believed that they had enough experience about amount of fertilizers to be applied. 30.7% answered that they used experts suggestions. Most fertilizer consumption was chemical fertilizers (64.1%) and distributed in the field by hand (58%). About 31% of the farmers used animal fertilizers and 5% green manure. Surveyed farmers had low information bout green manure. The latter can be associated to high age, low education and less participation in extension programs.

Water distribution and irrigation methods

Water conveyance system was earth ditch in 74% of the questioned farmers. Concrete channels played less roles in the farmers field (Fig. 3). Totally, concrete channels and pipe role in water conveyance to the field were 9% and 15%, respectively. This highlighted key role in accelerate of development and completion of thirtry irrigation networks in the studied area. The result also showed that 77% of the surveyed farmers used simple and traditional methods for water distribution to the field, such as earth open ditch (Fig. 4). More than 96% of the surveyed operators used surface irrigation methods and only 4% used pressurized irrigation systems. Surveyed farmers mentioned that the main reasons of not using pressurized irrigation systems were financial issues and facilities (68.4%), uncertainty related to the systems (22.6%) and lack of information (10%). Consumption of water by agriculture sector in Iran has always been an issue of concerns, which is caused by high water losses in farm fields, farms inappropriate shape and size, lack of knowledge of farmers about making optimum use of water, rapid destruction of water infrastructure, loss in quality of irrigation networks, inappropriate methods of irrigation, irrigation efficiency and loss of water in irrigation systems (Keshavarz, 2000). Ommani et al. (2009) citing Keshavarz et al. (2003)

pointed out that the overall irrigation efficiency in Iran ranges from 33 to 37%, which is lower than the average for both developing countries (45%) and developed countries (60%).

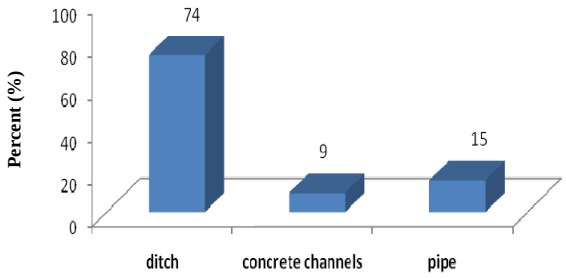


Fig. 3. Comparison of water conveyance methods

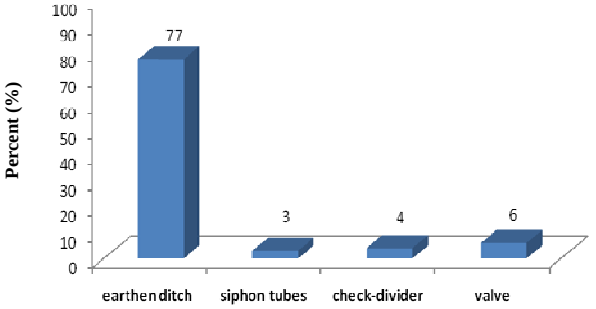


Fig. 4. Comparison of water distribution methods

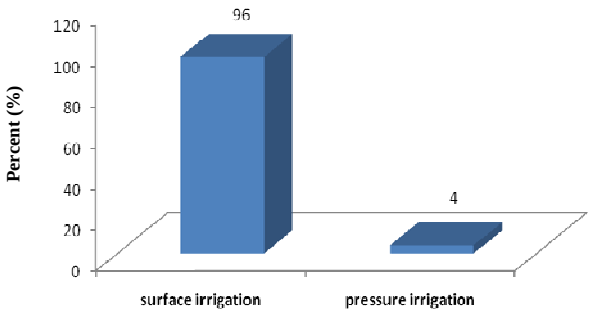


Fig. 5. Comparison of irrigation methods

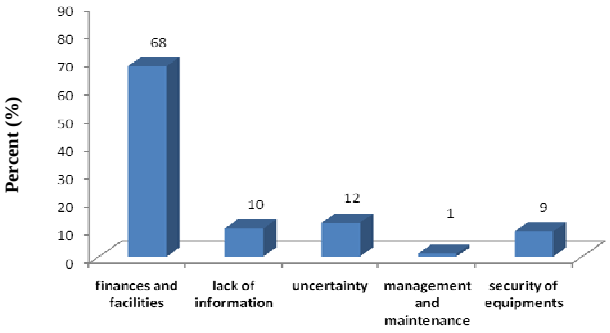


Fig. 6. Reasons of non use of pressurized irrigation methods

Sources of agricultural information

Fig. 7 shows the main sources of agricultural information that farmers used in the studied area for improving their knowledge. The main sources were extension agents (41%), extension field staff (22.9%), others (11.7%), radio (5.8%), print media (2.8%). Studies indicated that Iran's sustainable agricultural extension contents are not favorable and the extension system does not pay enough attention to them. These conditions necessitate rethinking of extension contents to accomplish sustainable agriculture (Ommani and Chizari, 2010; Allahyari et al., 2008). Khushk and Memon (2004) stated that production and distribution of printed material helps farmers in the transfer of new information and technologies also radio is a tool for delivery of quick information to stakeholders. Small percentage of farmers surveyed in the radio and magazine named as their information sources. Because it seems to lack the practical applications of these media are.

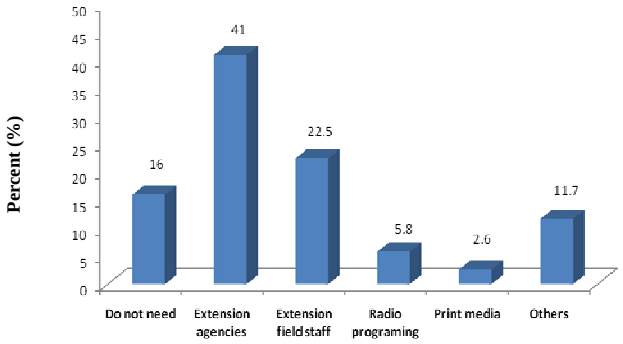


Fig. 7. Sources of farmers information

Degree of farmers knowledge

Degree of farmers knowledge in this case study was very low for most of water and soil problems such as pressure irrigation methods, optimal surface irrigation methods, water optimal operation methods, estimate of water requirement and irrigation frequency. However, degree of farmers knowledge from some subjects that farmers pay cost such as use of chemical fertilizers and pesticides and tillage methods was low to moderate. The main reasons could be associated to lack of the education, high age of the farmers and lack of training programs (Table 1).

Table1: Degree of farmers knowledge

Evaluated Subject	Number of answer	Farmers knowledge average	Classification
Optimal surface irrigation methods	127	36.3	Low
Sprinkler irrigation methods	127	6.7	Very Low
Trickle irrigation methods	127	10.9	Very Low
Pressure irrigation methods	127	0.7	Very Low
Water optimal operation methods	127	9.8	Very Low
Estimate of water requirement and irrigation frequency	127	10.7	Very Low
Land consolidation	127	44.2	Moderate
Control of soil moisture methods	127	15.1	Very Low
Meteorology information	127	39	Low
Physical and chemical soil analysis test	127	25.7	Low
Chemical fertilizers and their applications	127	40.2	Low
Benefit of using organic fertilizers	127	37.7	Low
The use of chemical pesticides	127	32.6	Low
Tillage and determine the depth of correct planting	127	42.5	Low

Conclusion

Agricultural extension in Iran such as many developing countries is mainly focused on common extension approach. Studies showed that traditional extension system have not been sufficiently effective in promoting adoption of sustainable agricultural practices. For receiving favorability in content of sustainable agricultural extension programs in Mazandaran province of Iran, there is a need for reorientation in content of agricultural extension systems. Iran's agriculture is facing serious environmental pollution and degradation problems and extension has a key role to improve it, but current extension systems in Iran does not have a sufficient competency for the achievement of sustainability and needs to shift toward new approaches with new objectives.

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Assessment of potential soil and land resources of agricultural organizations in the Perm region

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Abstract
The great length of the Perm region (from north to south – 600 km from west to east -400 km) contributes to the manifestation of latitudinal zonality, where the landscapes of the middle taiga landscapes give way to the southern taiga and broadleaf taiga forests. A variety of soil and land resources in the Perm region, due to significant differences in environmental conditions between the northern, central and southern provinces of the soil-ecological and within them, necessitates a differentiated approach to the integration and evaluation of modern environmentally and economically efficient condition.The purpose is to determine the resource potential of agricultural enterprises. The objects of research are the territory of the agricultural organizations *Severnyi* APC (the northern part of the Perm region), *Rusakovskiy* LLC (Central), *Druzhnyi* LLC (southern part).
The potential of soil and land resources is the integrated value, which includes qualitative and quantitative assessment of the state as far as possible all agrilandscape elements, the closest relative influence is reflected in the soil. Low soil and land resources potential has an establishment located in the northern part of the Perm Krai due to heterogeneity of parent material, soil cover and low points of site. Companies located in the central and southern parts, despite the high degree of erosion, have a high potential of soil and land resources due to the greater magnitude of site soils and less heterogeneity of soil cover. Land use, preservation of soil fertility, increase in the soils productive capacity is not possible without an objective assessment of their resource potential.

Keywords: agricultural enterprises, environmental conditions, potential assessment, soil and land resources

Introduction

Efficient use of land and land resources involves two essential steps that lead to objective economic entities typing soil-ecological diversity, accounting, or inventory, the entire distribution of the resource and its comprehensive evaluation of the position of use (Chernysh et al, 2011).
In modern conditions increases the need for land-based agro-typing of land, as substantiated economic, technological and economic efficiency of farming systems that are embedded in natural landscapes (Agri-environmental assessment of land ..., 2005).
An adaptive approach to improving farming systems allows the development of each company to develop its agricultural strategy based on an assessment by assessing the productive capacity of land and real conditions for economic activity, selecting the most profitable option of using arable land. Land management, conservation of soil fertility, increase the productive capacity of soils is not possible without an objective assessment of their resource potential (Kiryushin, 2000, 2010). Modern agricultural science improved the adaptive approaches well-known in the past, offering practical applications of adaptive-landscape systems of agriculture (ALSZ). The natural features of a particular area should be considered with the help of agro-ecological of assessment, which includes the characteristics of migration and accumulation of substances, geomorphological, lithological, agrochemicals, soil conditions, soil structure, land records and qualitative characteristics of soils, including the appraisal.
The great length of the Perm region (from north to south – 600 km from west to east – 400 km) contributes to the appearance of latitudinal zonality, which is most clearly represented in the plains, where the landscapes the middle taiga give way of landscapes the southern taiga and deciduous-taiga forests (Korotayev, 1962). A variety of soil and land resources in the Perm region, due to significant differences in environmental conditions between the northern, central and southern soil and ecological provinces and within them, necessitates a differentiated approach to the integration and evaluation of their modern environmentally safe and efficient state (Samofalova, 2011). In the current economic conditions should be more carefully taken into soil and environmental conditions as they may determine specialization, yield and profitability of agricultural enterprises
Purpose – to determine the resource potential of agricultural enterprises and to develop proposals for the rational use of land.

Materials and methods

The object of the study are agricultural organizations APC *Severnyi* of Solikamsk District, LLC *Rusakovskiy* of Il"insk district, LLC *Druzhnyi* of Chernushenska district of the Perm region. Agri-

environmental assessment and typing of lands was carried out by the method of V.I. Kiryushin (2000). The system of agro-ecological land evaluation includes the following items: landscape-ecological analysis of the territory, agro-ecological assessment of soil, agro-ecological classification and typing of land.

The territoryes are different under soil-geographical and agro-climatic conditions belong are different of agro-ecological sections: APC *Severnyi* – the Vyatsko-Kamskiy of middle taiga; LLC *Rusakovskiy* – Vyatsko-Kamskiy of southern taiga, LLC *Druzhnyi* – Ufimsko-Sylvenskiy subtaiga (coniferous broad-leaved forests). According to the of soils zoning Perm territory APC *Severnyi* included in the zone of sod-podzolic soils in the subzone of podzolic and bog soils in the area of sandy and loamy podzolic and sod-podzolic and peat soils on glaciofluvial and ancient alluvial deposits; territory of the state farm *Rusakovskiy* – In the zone and subzone of sod-podzolic soils in the area of sod-medium- and weakly podzolic and sod-calcareous soils on the eluvial-diluvial clays and eluvium marl and limestone of the Permian system; territory LLC *Druchnyi* included into the zone and subzone of sod-podzolic soils in the sub-area of sod-medium, light-gray forest-steppe podzolic and sod-brown of soils of heavy granulometric composition on eluvial-deluvial deposits bedrock (Korotayev, 1962).

Agri-environmental assessment of land shall be based on landscape analysis area, whose mission is to identify the territorial units, characterized by the homogeneity of environmental conditions, and their of the place in the hierarchy of structural and functional landscapes. We were drawn by the primary cartographic basis for agro-ecological assessment of land which contains information on soil structure and soil, geomorphological, lithological, hydrogeological, geochemical and micro-climatic conditions of the landscape and its elements. When preparing the soil-landscape maps were used: 1:10,000 scale topographic map (1:25,000), aerial photographs, soil materials *Roszemproekta* large-scale surveys, soil maps of the agricultural organizations (M 1:10000), land management plans, stock materials (soil reclamation, geologic , hydrological) data of the last round of agrochemical research, additional field studies materials, annual reports on the results of the agricultural organizations of economic activity. On the territory of households were selected key areas, for which were built the soil-geomorphological profiles.

Results and Discussion

Potential of soil and land resources – the value of the integral, which includes qualitative and quantitative assessment of the state as far as possible all elements agrolandscape, the closest mutual influence which is reflected in the soil. Invariant of condition of the soil cover serves its structure, analysis of which is the basis for the type of inventory, evaluation and monitoring.

Landscape analysis showed that the territory of LLC *Druchnyi* is more erosion-dangerous area than the territory APC *Severnyi* and *Rusakovskiy*. The territory of the farms have all categories of landscapes (eluvial, transeluvial, transit, transeluvial-accumulation, accumulation), which determines the direction of agricultural land use, taking into account the limiting factors: lithology, grain size (sandy and sandy loam for the APC *Severnyi* and the heavy, clay for LLC *Druchnyi* and *Rusakovskiy*), low soil fertility, soil erosion, waterlogging the soil. Constraints are manifested in varying degrees depending on the soil-geographic and agro-climatic of conditions.

The soils of studied areas are medium of soil fertility and requiring the systematic application of organic and mineral fertilizers. There are analysis of soil cover.

Agro-ecological types of land (association areas of homogeneous under agro-ecological requirements of crops and growing conditions) possible to distinguish on the basis of the prevalence of various factors limiting the utilize of the agri land (Table 1).

I Group. Zoned land. Agri-environmental types are characterized by non-contrast soil combinations. Earth of this type are suitable for the cultivation of more demanding crops using intensive and highly intensive agricultural technologies.

Group II. Erosive of the land. The soil cover is represented by combinations of not erosive soil , low and medium erosive of the soil. As part of this group are found lithogenic soils differing grading (sands and loam sandy 3.4 % in the APC, *Severnyi*), and clay loam, silty clay (33 % in LLC *Druzhnyi*, including 14 % medium erosive of the soil).

In the system of use of these lands is limited to the proportion of pure steam, the share of crops, it is desirable to expand cultivation of perennial grasses, the introduction of crop cultivation, soil conservation is necessary to introduce protective elements of the conservation tillage with conservation of crop residues under cereals and annual grasses, the use of slit, deepening the topsoil, agricultural activities under regulation of surface runoff, essential holding of snow retention, planting across the slope.

Table. Agri-environmental groups and types of land in farms

Agrienvironmental groups	Agrienvironmental types	Species	% of total area
APC *Severnyi* of Solikamsk District			
Zone	Sod melkopodzolistye loamy in combination with heavy loamy soddy-brown (not more than 10% of eroded soils); spots sod-weakly podzolic sandy and of sandy loamy sod-calcareous	I	77.3
Erosion	Spot sandy sod-short podzolic and sod- not deep podzolic clay loam with varying degrees of erosion; complexes sod- not deep podzolic loam and sod-calcareous sandy loam	II-2	3.4
Floodplain	Spot low-humus heavy-loamy alluvial sod and sod alluvial heavy-; tachets alluvial sandy and alluvial meadow turf humus heavy-	III-1	14.3
Land gullies and ravines	Complexes of soils of gullies and ravines of the system: sod-medium podzolic and sod inwashed	VI	6.0
LLC *Druzhnyi* of Chernushenska district			
Zone	Sod-podzolic loamy slightly in conjunction with the sod-podzolic medium loamy slightly eroded slightly (no more than 10% of eroded soils)	I	40.7
Erosion	Spot sod melkopodzolic srednesuglinistye and sod-neglubokopodzolistyh srednesuglinistye with varying degrees of erosion	II-2	33.0
Semihydromorphic-erosion	Sod neglubokopodzolistye combined with heavy-sod-gley (varying degrees of erosion and gleying)	III-1	10.1
Floodplain	Spot low-hummus heavy-loamy alluvial sod and sod alluvial good humus	III-1	4.7
Land gullies and ravines	Complexes of soils of gullies and ravines of the system: the sod and the sod-medium inwashed	VI	12.2
LLC *Rusakovskiy* of Il"insk district			
Zone	Sod slightly fine-loamy podzolic not deep	II-1	43.1
Erosion	Sod-podzolic weakly and moderately eroded	I-2	20.3
Semihydromorphic-erosion	Sod-podzolic in conjunction with the sod-glee podzolized small and medium-weak moderately eroded	IV	13.0
Semihydromorphic-flood	Alluvial sod acidly little and a lot of humus loam	III-3	8.0
Gidromrgfno-flood	Alluvial marsh clay	III-3	4.0
Land gullies and ravines	Inwash turf and sod-podzolic	VI	11.6

Group III. Semihydromorphic-erosion of the earth. They are confined to the apical watersheds of major gullies and ravines, the slopes of complex shape with alternating convex and concave elements and soil are very complex structures. Soil combinations have a typical tree- pattern figure and defined by a network of gullies with different depth of incision. Soils of areas had little contour and make up the soil structure, which is characterized by a large number of components, including the contrast. The predominant combinations are mosaics of sod-podzolic and sod inwashed soils.

IV group. Floodplain land (semihydromorphic-flood, flood-gidromrgfno). Common in the floodplains and are geochemically superaqueous elementary landscapes, storage surface, subsurface, and groundwater runoff. There are present patchiness – alluvial-sod, alluvial-rich, alluvial humus and alluvial-marsh soils. Suitable for cultivation of crops with limitations that can be overcome by mid costly hydraulic, chemical, forestry, land reclamation complex.

V group. Earth gullies and ravines of the complex (LGR). Not suitable for cultivation because of the unavoidable limitations and possibilities of minor adaptations.

Within the groups are identified different agro-ecological land types specific to each farm, which determines the possibility of using the land for the specific soil and climatic conditions.

Consequently, in the farms need to redistribute land in view of the selected groups and agro-ecological land types in order to more efficiently use it and improve the growing conditions, as well as the adaptive capacity of agricultural crops, resulting in the stability of agricultural landscapes as a whole increases.

Agro-ecological assessment types of land are as follows: the original score of soil quality soil erosion and soil heterogeneity, the estimated specific score (on a scale of 1 to 5 on the severity factor) to calculate the

overall average score for each type of land. The total ball of agro-ecological assessment agrolandscape obtained on the basis of interest like land in total area. Agri-environmental component of the capacity of the soil and land resources is calculated for each types of land.

Thus, the highest potential has a territory of LLC *Druzhnyi* Chernushinska district where the average score 16. Lower potential (13.3 – average) soil and land resources is an enterprise located in the northern part of Perm kray position determine by the inhomogeneity of parent rocks, soil and low soil quality score. Businesses located in the central and southern parts of the region, despite the high degree of manifestation of erosion, have higher potential for soil and land resources due to the greater magnitude of soil and soil quality at the inhomogeneity of the soil cover.

Land management, conservation of soil fertility, increase the productive capacity of soils is not possible without an objective assessment of their resource potential. Assessing the potential of the soil and land resources of agricultural enterprises need for determine the possibility of organizing in their territory with a priority of environmental management for sustainable agricultural production.

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Effect of tillage methods and use magnetic water on greenhouse tomato yield in north of Khuzestan, Iran

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Abstract
The purpose of the tillage is creating the optimum environment from seed germination to root growing and mechanization ability and also soil and water management. The set of implements which are chosen for tillage operation are depend on local customs , tape of soil and crop and cultivation systems which are using. Plough has been a traditional method of primary soil cultivation over the past centuries in all around the world. Genarally tillage is considered as the most fundamental operation in global agriculture and also it has a great influence on performance of the crop producing system. Tomatoes is one of the crops which is transferred from farms to large greenhouses. The yield of tomatoes increased from 15 to 700 tones per hectare respectively in the field by comparison with greenhouses. Land preperation is one of the most important steps of crop producing in greenhouses, it is not only effective on increasing and conversion but also it is effective on alkaline substance balance and land nutrition directly. When soil electrical conductivity (EC) is between 3-4 mmhos/cm then the yield production is reduced from 10 to 35 and if EC grows up to 4-6 mmhoos/cm, yield will be decreased to 45 percent. Also, tillage and magnetic water irrigation effected on land preparation costs. Therefore this research was conducted to evaluate the effect of tillage and irrigation methods on tomato yield in greenhouse conditions. Four different tillage methods which are including a moldboard plow followed by rotivator, once rotivator, twice rotivator, no tillage and finally direct seeding. Two methods of tomato irrigation which were applied, they are included magnetic water and conventional irrigation. The experiment was conducted by completely randomized block design in split plot with 4 replications and 8 treatments. The results have shown that EC is reduced to 30 percent in magnetic water. The crop yield was shown which are more when they are harvested from field that had been appling magnetic water irrigation. The interaction between tillage and conventional irrigation could produce 3200 grams tomatoes per each plant. Tillage and magnetic water have had the most yield with 6000 grams per each plant with EC 1.30 mmhos/cm. Moldboard plowing followed by rotivator and in magnetic water irrigation decreased soil EC and also it increased the number of flowers about 9.80 percent and the number of Tomatos to 10 percent in comparison with magnetic water irrigation under the experiment conditions.

Keywords: Tillage, Greenhouse, Magnetic Water, Rotivator, Tomato Yield

Introduction
The purpose of the tillage is to create the optimum environment from seed germination to root growing and mechanization ability and also soil and water management. The set of implements which are chosen for tillage which depend on local customs, soil and crop types, and the cultivation system that are used. Ploughing has been a traditional method of primary soil cultivation over the past centuries all aroun the world. The mouldboard plough has one of the most complex shapes of tillage implements and has been developing over the centuries. Its main advantage that has made it different from other tillage tools is soil cultivation which is including soil inverting in order to bury weeds. Ploughing is very effective in controlling weeds, especially perennial weed species. Since the middle of last century various forms of shallow tillage have emerged in order to reduce energy consumption and to increase work rates. Mainly economic and environmental factors are the reasons that why minimum tillage is popular in agriculture [1]. Minimum tillage practises do not include the use of mouldboard ploughs and also allow farmers to minimize costs and increase output. The combination of tines or discs and various kinds of harrows are the major types of implements which are used for secondary or minimum tillage. As the soil is not inverted, more organic matter is accumulating in the top of soil layer, which needs more attention in terms of

weed, pest and disease control [2, 9]. As a mechanical tillage operations are done on soil in order to prepare the soil [7]. The proper operation of tillage improves the soil structure, increasing porosity, and finally a better distribution of soil physical properties can be modified. One of the important factors in greenhouses, nurseries, and land preparation is suitable seed and ground preparing. In recent years, by growing of mechanization, tillage equipments and working in greenhouse comfortably have been replaced garden shovels and manpower [3, 10]. One of the products from crop farming that has transferred to the large greenhouse gradually, and also its performance level has increased from 15 ton to 700 ton per hectare is called tomato or tomato tree [5]. Jamshidi and Asoodar reported, the problem of soil salinity on seed germination is impaired. This problem often occurs as a result of water evaporation and salt concentration in a few centimeters of soil surface. If they were high, so that the seed does not germinate well [6]. Franzen showed that Soil salinity is reduced delivery of nutrients to plant roots [4]. Lithourgidis et al, reported that by using different tillage methods which were as follows: Conventional tillage, reduced tillage, and no tillage on tomato, results showed that after two years of using no tillage, germination has reduced about 16 and 21 percent [7]. Thompson showed that with salinity level of 3.5 mmhos/cm, plant growth was reduced by 25 percent. As control solution they cultivated soil which was around the roots by a suitable tillage method and also rinse with fresh water soil layers which were hard [11]. Jamshidi and Asoodar have considered that the effects of magnetic water on the soil is salt removing and also implementation of the magnetic pieces can be reduced water salinity considerably [6]. Therefore, selecting tillage and irrigation methods is the most important factor to have a good performance [6, 11].

Materials and Methods

Mechanism of Action of Magnetic Field

Magnet science is very simple. One pole emits a positive charge of itself and the opposite pole is negative. These electric charges are made of excited electrons in the magnetic field. The laws of quantum physics, Particles with no charge are in normal and para condition. When the particles are charged magnetically excited electrons change their orbits parallel with the surface of magnetic pole. This state that is full of energy is known Orto in this state the protons will shift to the opposite magnetic poles that this is cause of forming the bipolar mode (26).

Electromagnetic Devices

This magnetic field is produced by electromagnetic. This way that by putting pipe in a coil which electricity is passed through wire. As result a comprehensive magnetic field is produced (Figure 1).

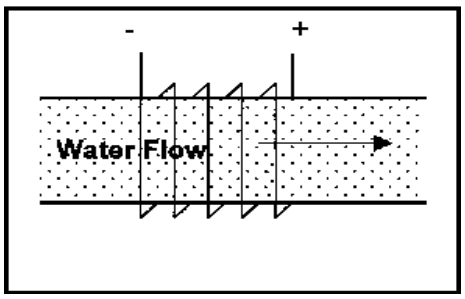


Figure 1 - The Electromagnetic Device

Types of Magnetic Water

This is a fact that a magnet has two separate fields which are called north and south poles. The water which is treated by magnetic field is belonged to each of these poles that they are separate forms of magnetic water. In addition, there is another kind of magnetic water that is bipolar which means, it is treated by both poles. Therefore, there are three types of magnetic water, North poles, South poles, and bipolar which must be considered. Generally, using of magnetic treatment for plants is done in two ways which is as follows:

1 - Magnetic treatment of seeds 2 - Irrigation with magnetic water

The experiment was conducted at Shuoshtar region (49º 14′ E and 23º 2′ N),where is located in 90 Km from north of khozestan province, Iran. In order to determine the physical and chemical features of soil land which is under the test, soil samples were taken in depth of 0-30 and 30-60 cm with the electric conductivity (EC) 2/1 and 7.02 PH before planting. Therefore this research was conducted in order to evaluate the effect of tillage and irrigation methods on tomato yield in greenhouse condition. Four different tillage were including a moldboard plow followed by rotivator, once rotivator, twice rotivator, no tillage and finally direct seeding. Two methods of tomato irrigation were including magnetic water and conventional irrigation which were applied. The experiment was conducted by completely randomized block design in split plot with 4 replications and 8 treatments and two kinds of water irrigation (regular and magnetic) were tested on greenhouse tomatos. The performance characteristics, yield, the number of flowers, fruits, and its weight were measured in 1000 m^2. Calculations and statistical analysis have done by SAS and MstatC and drawing charts by Excel 2010 ,and also LSD was used to compare the mean-least significant difference test [8].

Results and Discussion

The variance of average weight of fruit is shown in Table 1. According to results of experience, tillage and irrigation water factors were significant at 1% and the interaction between these two factors was significant at 1% in average weight of fruit per square meters.

Table 1: Analysis of variance of the average weight of fruit per square meters

S.O.V	DF	TS	MS	f
Repeat	3	24	8.0	0.60^{ns}
Tillage	3	6957.1	229.0	128.30**
Error	9	126.43	13.38	
Type of irrigation water	1	227.21	228.21	44.4**
Irrigation water and tillage	3	189.32	64.44	12.0**
Error	12	630.5	7.311	
Total	31	7453.9		

* means significant at 5% level, ** significant at 1% and the mean ns means not significant
CV=3.89

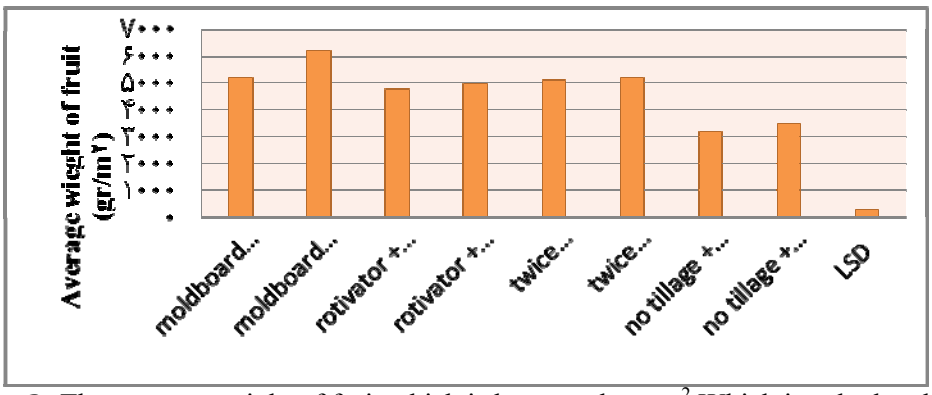


Figure 2: The average weight of fruit which is harvested per m^2 Which is calculated from average weight of 2 days period in effect of intercation between tillage and irrigation water precatices.

According to Figure 2, interaction between the methods of tillage and irrigation water are shown that by using moldboard plow, once rotivator, and magnetic water became caused of reducing EC about 30.53 percent. Performance functions of magnetic water practice was reported 25 percent more than regular water practice. The most and the least EC are related to the interaction of no tillage and regular water with 3.25 mmhos/cm with 3200 grams performance per

plant and tillage with moldboard rotivator and magnetic water with 1.30 mmhos/cm that its performance was 6200 grams per plant, respectively. Total number of flowers and fruits were 9.80 and 10 percent respectively more than control treatment. So, moldboard plowing and then rotivator and also irrigate with magneict water increased 15 percent in crop yield and irrigation efficiency by 30% in compare to control treatment.

Therefore, it was determined that water with magnetic treatment has a high solubility. This state was cause of increasing soil ability for releasing salt which leads to better absorption of nutrients and fertilizers by plants during the growth cycle. Plants and trees need mineral salts and they obtain mineral material from the soil for growing and producing food. Food must be in balanced and suitable PH conditions and then can be used by plants and trees. Plants irrigation with magnetic water can solve more food. Because, it reduces the surface tension of water and causes of that more nutrients to be water-soluble.

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The analyses of sustainable soil management in the Dezful Township orange gardenes

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Abstract

Sustainable agriculture is an important principle in sustaining soil health and sustainable agricultural production is related to. All methods include crop rotation effects on soil stability and productivity, Cultivation of legumes in crop rotation, The use of animal manure and green manure, Using crop residue and straw, Crop water, Optimal use of fertilizers and chemical pesticides, Use of micronutrients, Test soil to determine fertilizer recommendations and soil quality assessment, Management conservation tillage and Using modern methods of irrigation are under pressure. Selection of soil management practices can have a significant effect on the environment and farm productivity. Since soil have a major role in sustainable development, appropriate productivity conservation and soil control will raise power, prosperity and stability of society. One of the problems in agriculture sector is poor in the farm soil management practices and economic deficiency in the operational units now. Lack of proper utilization more than anything related to low farmers technical knowledge, attitude and skills, particularly in the little operations. Since investment in planting orange is long-term and for obtain economic production in the future should be to be taken decisions need at the present time, so soil and water studies and provide need information to farmers is necessary. The main aim of this research, the analysis of sustainable soil management and explain the most important social, economic, extension, farm and individual in the Dezful Township. The research instrument was a structural questionnaire with close-ended questions, which validity and reliability confirmed. A surrey was conducted using multi- stage cluster sampling technique to collect data from orange growers. The results of descriptive findings showed that sustainable management level between 0.4 % studied orange growers in highly unstable, 14.8 % in the unstable level, 67.4 % of the average level, 16.2 % in the sustainable level and 0.4 % level are very stable.

Keywords: soil, sustainable management of soil, orange, orange farmers workin

Introduction

The concept of "sustainability" has been associated with a wide range of human activities related to the use of resources, including natural, human and financial, implying long-term continuity and ability to carry on with these activities indefinitely [3, 4]. According to Hasna [6], sustainability refers to a development of all aspects of human life affecting sustenance. Undoubtedly, economic growth and development of each country is subject to development and agricultural growth That could be infrastructure development in other sectors. But the country's ability to expand and develop human and social capital is not And fails to use them best in the national economy, The farmers will not be able Sustainable resource management practices in agricultural investment has improved And natural capital (soil, water and low productivity), along with their physical and financial capital to solve society (Sreedevi, 2005).

a major role in the development of the soils are stable ,Proper utilization, protection and control of soil strength, prosperity, security and stability of communities took up. One of the problems in the agricultural sector currently, Poor soil management practices by farmers and deficiency can be exploited for economic units. take advantage of low technical knowledge to correct more than anything, attitude and skills of farmers, especially small farmers are concerned about is That a large part of the country farmers have (Mousavi, 2000). Lut Desert with vast deserts and dry weather conditions and the great desert of, The weather also affected the marginal areas have. The dry weather led to the emergence of land Nmkzdh (sodium salt) is added. The two major areas of land in agricultural production and development of poor quality have be. take advantage of them will be very difficult and expensive. The cultivation of any plant In such circumstances, the low water and poor water quality and soil, the salt has more resources, Is not practical or cost effective and must choose plants that grow in their economic situation. Orange is one of the plants most suitable is the most product areas, particularly in Dezful province. Located in the province due to the orbit of 30 degree The climate is extremely dry, The drought has severely affected agricultural. Fahim Dezful farmers to experience the product economic region can be nuts (keshavarz, 2009).

1- Sreedevi

Cultivation of orange in Iran, about 380 thousand hectares and total production is about 304 thousand tons. Dezful province, about 35 percent and 36 percent of cultivated area under production is allocated to the (Center for Agricultural Research and Education, 2009). This is due to the rapid expansion of Orange Acreage Orange plants that are resistant to salinityand Horticultural crops can be found under That can tolerate the salinity and alkalinity of soil and water(Farmer and Sadegh Zadeh, 2000). Orange production in Dezful province, important sources of income is agriculture and the national economy. In many households, particularly in Dezful province, Dezful Orange directly and indirectly through the production make money And are engaged in productive business. The proceeds of the various aspects of the product is important for the Iranian economy. Orange cultivation and development in areas of comparative advantage is high brine. Because of the long-term investment in plant products And to obtain economic production in the future should be to adopt the necessary decisions on time, Thus, soil and water studies and provide information to farmers is essential (Zinedine, 2009).

But now the kind of unbalanced use of fertilizers, , Irrigation and other tillage methods, using appropriate The most important factors of soil and climate variability is low yield in orange orchards. Garden performance figures compare with a maximum production of orange Iranian orange progressive farmers (10 ha) to be Optimize the management of the total consumption of fertilizers in the soil and water Interrupt unchanged, Optimize the management of the total consumption of fertilizers in the soil and water Interrupt unchanged, As you optimize the management of soil and water (to remove carbonate B) and optimal use of fertilizers, Other horticultural operations such as pruning, pest and disease management, grass and weed and harvest, in accordance with the amended soil and water management, The average yield will rise to more than triple. Each year nearly 2,000 tons of toxins in the work of Iranian orange be used for pest control products This amounts to nearly 60 percent of the city of Dezful is (Department of Statistics and Information Technology, 2004)

2000 million hectares during the last centuries of erosion have. According to the other continents of Asia is grappling with soil erosion. According to statistics provided by the UN World Food The rate of soil erosion in Iran in 1980, 1.5 billion tons In recent years, the 2.5billion tons is reached, 100 million hectares of erosion-prone land in our country 25 million hectares, subject to wind erosion and 75 million hectares is prone to water erosion (Najafi Nejad, 1993).

The rapid increase in area under orange cultivation in the city of Dezful in Dezful province in northern And increasing the number of wells And remove excessive water from the aquifer The sharp drop in ground water sources under And thus reduce the flow as the only source of water supply wells in orange orchards and They are poor quality roam, so salt water in this area has reached 19,692 and mouse micro and According to research conducted at the Institute of Soil and Water and Orange Research Institute approved If salt water reach to 25 micro Mouse (25 ds Siemens ¬ m) function is nearly zero. Due to low water reserves and, most importantly, the poor water quality, the resources and capital investments in the construction of several hundred thousand acres of orange orchards destroyed and Plagued the region and the country's economy and it will follow income was horrible. Knowledge of the adverse effects of irrigation on soil quality And the growth of orange seedlings and mature trees can be better management practices performance The conditions are the main factors affecting the production of salted water to help And prevents drying and destruction of gardens (Naqavi, 1996).

Sustainable agriculture is an important principle in sustaining soil health and sustainable agricultural production is related to. All methods include crop rotation effects on soil stability and productivity, Cultivation of legumes in crop rotation, The use of animal manure and green manure, Using crop residue and straw, Crop water, Optimal use of fertilizers and chemical pesticides, Use of micronutrients, Test soil to determine fertilizer recommendations and soil quality assessment, Management conservation tillage and Using modern methods of irrigation are under pressure. Selection of soil management practices can have a significant effect on the environment and farm productivity. So adopt the best practices for the exploitation of the soil is an important part of soil management (Kasvl, 2001). Indiscriminate exploitation of a orange farmer, who often have low literacy What makes a wide range of products in a wide range of processes of land degradation is declining. This lack of knowledge and attitudes of orange growers in the area of soil management The performance and product quality and soil stability and reduce total. In this regard, the main

purpose of this study Sustainable management of soil and explain the most important social, economic, extension, farm management and personal impact on them was in the city of Dezful.

Specific research objectives include:

1 - describe the personal characteristics, social and economic of orange growers

2 - determine the correlation between the independent variables of sustainable soil Bamdyryt

3 - Comparison of features on sustainable management of soil, agricultural, social and economic

Materials and Methods

Method used in this study is in practical purpose, Because the results for policy planners and those involved in agricultural development can be used. The data collection and description of the types of research are Ghyrtjrby. Therefore, this study is a descriptive - is correlated And research and survey has been conducted using questionnaires. It examines the distribution of a systematic, objective and accurate facts and features of a society deals with statistical And the independent variables associated with variables related to the research tries to measure And to determine the relationship between them. Dezful city of the country's orange production is the main poles, The research area has been selected And orange farmers work with the city as 50,000 people were selected. In this study, the study population included a sample selection of the statistical limitations of the study, Geographical extent And in the unavailability of accurate statistics orange farmers work of cluster sampling is used Chndmrhlh And samples of Dezful, pomegranate, and the sources were selected. Given the number and size of the study population, the number of samples n = 381 study subjects, according to the study (Boat and Morgan, 1970) was estimated.

In each city, a multi-stage approach was selected as the first stage. In the second stage of each section, select a county And the third sample to the specified number of rural villages were selected randomly. In the final stage, the number of farmers were selected randomly and were given a questionnaire study. The main tool for collecting data and information requirements of orange growers in the area of research questionnaires and This study is a series of field studies.

For ,Face and content validity of questionnaire in order to achieve, Several versions of the questionnaire prepared by the management faculty of agriculture, Soil, and promote agriculture and agricultural education And Agriculture Organization of the experts were in the city of Dezful And that the questionnaire was asked to express their views and After several stages of revision and editing the final version of the questionnaire, And the reforms needed Revised questionnaire was ready for validation. . In this study, Cronbach's alpha for the validation of the method used for measuring**.** Cronbach's alpha coefficient varies between zero and one. Questionnaire to determine the validity of the questionnaire of 30 questions that determine their validity and the necessary reforms were made, In the same study population and The preliminary tests were completed on the outside. After completing the questionnaire, Replies were eventually collected and evaluated through Cronbach's alpha coefficients were calculated SPSS software. After the reforms required by the alpha Research for the different variables between the 0.71 until 0.89, respectively, which indicates acceptable reliability for the collection in question was large.

Results and discussion

1 - describes the characteristics of orange growers

Research findings showed that the average age of 40.55 years of orange growers SD 8.14 were in the age range between 24 to 72 years. 4.7% of orange growers in the study of 18 with patients**,** In terms of educational level, illiterate, 17.3% with a frequency of 66 percent, the level of reading and writing,18.6 with a frequency of 71 percent at the elementary level, 23.6 with a frequency of 90 percent in tips, 20.7 with a frequency of 79 percent in the high school level and With 15 percent of the diploma and 57 were higher.

Average farming experience in the statistical population, 18.74years, SD 8.38 respectively. 381 of the orange business, farm, 31.8percent of its 121 lots with less than 5 km And farm 68.2 percent of 260 people with more than 5 km away from the centers of agricultural extension services. The average number of household labor, 6.32 persons. Average total land owned in the statistical population, 25.05 acres with a standard deviation of 2.12 respectively. Orange Growers annual gross income of between 2.5 to 660 million USD (average 16.3, SD 1.11) was variable.The findings in Table 1 to 7 show that Knowledge, attitude, degree of extension classes, The use of

communication channels, Social participation, social status, and application of sustainable soil management in orange growers in what has been studied.

Table 1 - Distribution of business products group in terms of technical knowledge on sustainable management of soil:

Technical knowladage	Frequency	Percent	Cumulative percent
low	2	0.5	0.5
mediuom	84	22	22.6
high	295	77.4	100
sum	381	100	

Table 2 - Distribution of business products group in terms of attitude in the field of sustainable management of soil:

Attitude	Frequency	Percent	Cumulative percent
Quite agree	29	5.5	100
Agree	331	86.9	94.5
Apathetic	21	7.6	7.6
Sum	381	100	

Table 3 - Distribution of business products group in terms of usefulness and extension classes

The impact of class	Frequency	Percent	Cumulative percent
Very low	24	6.3	18.9
low	95	24.9	93.7
Average	7	1.8	99.2
High	1	0.3	100
sum	127	100	

Table 4 - Distribution of business products group in terms of access and use of communication channels

Access levels	Frequency	Percent	Cumulative percent
Very low	1	0.3	0.3
low	135	35.4	35.7
Average	245	64.3	100
sum	381	100	

Table 5 - Distribution of business products group in terms of level of social participation

Level of social participation	Frequency	Percent	Cumulative percent
Very low	168	44.1	44.1
low	183	48	92.1
Average	29	7.6	99.7
High	1	0.3	100
sum	381	100	

Table 6 - Distribution of business products group in terms of level of social status

Level of social status	Frequency	Percent	Cumulative percent
Very low	246	64.6	64.6
low	86	22.6	87.1
Average	38	10	97.1
High	10	2.6	99.7
Very high	1	0.3	100
sum	381	100	

Table 7 - Distribution of business products group in terms of sustainable management of soil surface stability

Sustainable levels	Frequency	Percent	Cumulative percent
Very unstable	1	0.3	0.3
Unstable	60	15.7	16
Average	261	68.5	84.5
Stable	58	15.2	99.7
Very stable	1	0.3	100
sum	381	100	

2 - Correlation between the independent variables of sustainable soil BamdyrytResearch hypotheses based on the results of tests to investigate the correlation of independent variables Features include a study of orange growers with sustainable management of soil variables are as follows: (Table 8).

3 - Comparison of features on sustainable management of soil, agricultural, social and economic:

According to Table 9 to 13 test results showed the Kruskal-Wallis and Mann-Whitney that the independent variables in the research Dependent variables included characteristics of orange growers with sustainable management of soil, There is no significant difference.

3-1 - personal characteristics:

Correlation with the economic analysis shows Between age (r = -0.345) and labor (r = -0.120) and a significant negative relationship with the sustainable management of soil And education (r = 0.614) with the sustainable management of soil and there is a significant positive relationship.

3-2 - Economic characteristics:

The total land owned by farmers and orange utilizing the sustainable management of soil, a significant relationship was found Orange Growers of annual gross income (r = 0.197) and applying the sustainable management of soil and a significant positive relationship exists.

3-3 - agronomic characterist:

The total distance between the centers promote Mrzh Orange Growers and Agricultural services and sustainable management of surface soil by applying significant relationship was not found Orange growers in the term and experience in agriculture (r = -0.296) and the application of sustainable management of soil and a significant negative relationship exists.

3-4 - social features:

Between social participation And social status of orange growers and sustainable management of soil by applying the significant relationship was not found. Orange growers access to communication channels between (r = 0.140)And sustainable management of soil by applying a positive and significant relationship exists.

3-5 - attitude, knowledge and orange growers:

Orange growers in the level of technical knowledge (r = 0.279) And sustainable management of soil by applying a positive and significant relationship exists. Orange growers in the attitude Sustainable management and utilization of surface soil by the There is no relationship.

Table 8 - Correlation between the sustainable management of soil variables

Row	first variable		second variable		Spearman	Level Significant
	Variable	Scale	Variable	Scale		
1	Age	Relative	Sustainable Soil Management	Distance	-0.345	0.01
2	Education	rating	Sustainable Soil Management	Distance	0.614	0.01
3	Family members	Distance	Sustainable Soil	Distance	-0.120	0.019
4	Technical	rating	Sustainable Soil Management	Distance	0.279	0.01
5	Attitude	rating	Sustainable Soil Management	Distance	-0.039	0.446
6	Experience in agriculture	Distance	Sustainable Soil Management	Distance	-0.296	0.01
7	The field of promotion centers	Relative	Sustainable Soil Management	Distance	-0.066	0.196
8	Gross product	Distance	Sustainable Soil Management	Distance	0.197	0.01
9	Total land owned	Distance	Sustainable Soil Management	Distance	0.081	0.115
10	Social Participation	rating	Sustainable Soil Management	Distance	0.019	0.705
11	Social status	rating	Sustainable Soil Management	Distance	0.087	0.089
12	Access channels	rating	Sustainable Soil Management	Distance	0.140	0.006

Table 9 - Comparison of orange growers in terms of sustainable management of soil by the agronomic

Independet variable	Group	Frequency	average rating	Chi-square statistic	Significance
Farming system type	Gardening	170	191.84	0.270	0.966
	Gardeing and Animal Husbandry	107	187.37		
	Agriculture and horticulture	28	191.86		
	Mixed	76	193.91		
Sum		381			

Table 10 - Comparison of orange growers in terms of sustainable management of soil by cultivation

Independet variable	Group	Frequency	average rating	Chi-square statistic	Significance
How culture	Traditional	296	191.30	0.015	0.993
	Semi-mechanized	84	189.95		
	Mechanized	1	192		
Sum		381			

Table 11 - comparison of soil management, sustainable source of water used by orange growers

Independet variable	Group	Frequency	average rating	Chi-square statistic	Significance
Water source	River	0	0	0.124	0.725
	Aqueduct	98	193.77		
	Spring	0	0		
	Well	283	190.04		
sum		381			

Table 12 - Comparison of orange growers in terms of sustainable management of soil by irrigation method

Independet variable	Group	Frequency	average rating	Chi-square statistic	Significance
Irrigation methods	Surface	0	0	6.385	0.012
	Joey and Stack	280	198.01		
	Pressure	101	171.55		
sum		381			

Table 13 - Comparison of orange growers in sustainable management of soil by type of operation

Independet variable	Group	Frequency	average rating	Chi-square statistic	Significance
Type of operation	Civilian	270	188.99	2.651	0.449
	Rental	68	186.67		
	Berry shares	7	191.86		
	Mixed	36	214.10		
sum		381			

Table 14 - Comparison of orange growers in terms of sustainable management of soil by attending education and promotion

Independet variable	Group	Frequency	average rating	My statistics-Whitney	Significance
Attending education and promotion	YES	127	164.36	1.570	0.607
	NO	254	189.32		
SUM		381			

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Using Bayesian Decision Network for Assessing the Socio-Economic Impacts of Integrated Watershed Management

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Abstract
This paper outlines one component of a study being undertaken to provide a new tool for integrated watershed management. The Hablerood Catchment in the Iran Central Plateau is used as a case study. A Bayesian decision network (BDN) approach integrates the various system components, social, ecological, and economic. The method of integration of the system components is demonstrated through an example application showing the impacts of various management scenarios on terrestrial and riparian ecology. The socio-economic impacts of management scenarios are assessed using a probabilistic approach to evaluate ecological criteria which are compared with those for the present situation. In investigation different socio-economic indices, the direction and magnitude of change under different management scenarios varies because of the diverse influence of habitat fragmentation.
Keywords: Surface water quality, Bayesian decision network, Semi-arid, Iran.

Introduction

Water quality is a major environmental problem in most parts of the world. There have been attempts to manage this issue worldwide, through implementing vegetative and/or engineering management options. Land and water salinity is increasing in Iran (Ministry of Agriculture, 2004) and has serious negative effects on the environmental health of catchment systems. Addressing this complex problem, at both large and small scales, requires an integrated catchment modeling approach, in which key socio-economic drivers, processes and impacts are all considered.
In Iran, since encountering the outbreaks of human-induced quality of water over the past few decades, land cover alternatives suitable to manage water quality have been explored. It is very important to use an integrated methodology for the modeling of such a complex issue and provide a decision-making tool for assessing how to manage water quality (Sadoddin et al., 2009). Main goal of this paper is to evaluate the value of Bayesian decision networks as an integrative approach for assessing how to manage water quality at a catchment scale.

Materials and Methods

Study area

The study area is Hablerood catchment (35° 13′ to 35° 57′ N, 51° 39′ to 53° 8′ E) where located north of the Iran Central Plateau, which belongs to the continental semi-arid climate (Figure 1). Mean annual precipitation is 318 mm, and the mean annual temperature is 7.8°C. Because some part of the research area about 25% is covered by marl geological formation and also water erosion in these regions are high, so the salinity hazard in at the outlet of catchment has been identified as being in a very high class anticipated. Because of substantial rainfall through the summer, there is a need to maintain vegetation cover during this period in order to avoid excessive runoff, soil erosion and deep drainage (Rangelands, Forests and Watershed Management Organization, 2000). Degraded range is the dominant land cover in the Hablerood catchment.

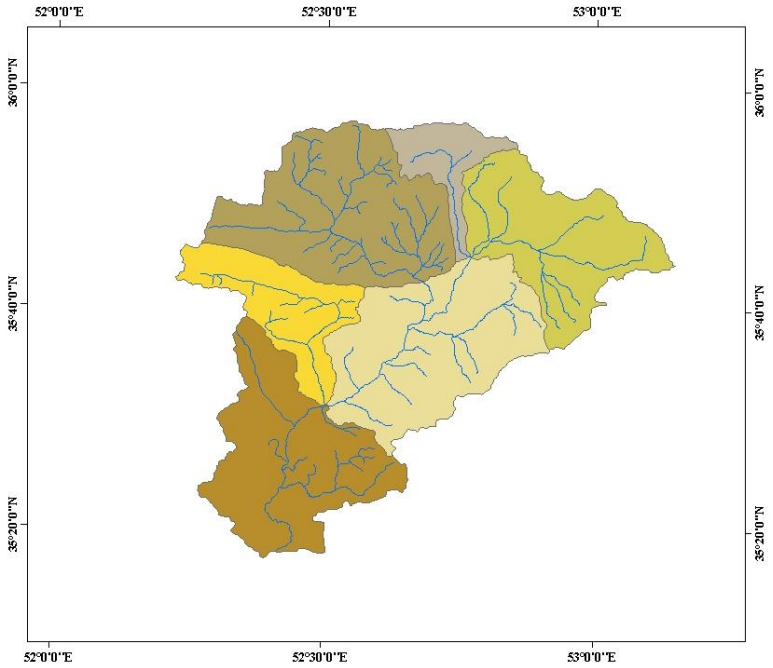


Fig. 1. Hablerood catchment the study area

Bayesian networks

Pearl (1988) defines Bayesian Networks (BNs) as direct acyclic graphs (DAGs). BNs are capable of representing and considering uncertainty in system knowledge. Krieg (2001) considers the conditional probability as a basic concept in the Bayesian treatment of uncertainties. A substantial number of applications exist in environmental and watershed resource management, mostly completed recently (Varis, 1997; Varis and Kuikka, 1999; Ames and Neilson, 2001; Ames, 2002). BNs are furthermore a useful tool for representing the decision process and relationships between variables, and for analyzing the expected effects of management decisions while accounting for the associated uncertainties (Ames and Neilson, 2001). Bayesian Decision Networks (BDN) is defined as Bayesian Networks that have been modified to include decision (management option) variables and utility (benefit-cost) variables. A Bayesian Network approach has been used to consider effects of management options in the catchment.

Developing scenario for water quality management in Hablerood catchment

To simulate potential land cover patterns under different management options, significant effort was made to determine the areas in the catchment suitable for each of the land cover options (Keshtkar, 2011). Table 1 summarizes the scenario rules for each water quality management action in the catchment.

Table 1. Scenario rules for surface water quality management actions

Vegetation management	**Rules for distribution**	**Extent of implementation**
Rangeland improvement	Only in areas currently under rangelands	Implemented at 95% of study area
Lucerne growing	Only in areas currently under rainfed	Implemented at 3% of study area
Tree plantation	Only in areas currently have tree cover	Implemented at 1.6% of study area
Riparian restoration	Only in potentially riparian areas	Implemented at less than 1% of study area

Modeling socio-economic impacts of water quality management options

A catchment hydrology model has been used to evaluate the impacts of some possible surface water quality management scenarios on total stream flow. The hydrology model was developed in order to assessment the effects of different land use and soils on baseflow and runoff in each subcatchment. Then the probability distributions of flow discharge predicted by the model for all water quality management scenarios were presented. The analysis of flow was conducted for surface runoff and also total stream flow as different variables of the physical sub-network of the BDN. Observed data of precipitation, flow discharge, TDS, SAR and EC, at Bonkooh hydrometry station were used to estimate the probability distributions. These constitute another end point in the physical sub-network of the general Bayesian Decision Network (BDN) structure for the catchment.

To investigate the economic impacts of surface water quality management options, an economic sub-network of the BDN framework for water quality management in the catchment was developed. This sub-network comprises three types of economic impacts on the farming community resulting from the implementation of the surface water quality management options. These are: 1) Total gross margin, 2) Fencing costs, and 3) Establishment costs. To investigate the social impacts of surface water quality management options, the social sub-network in the conceptual model framework for water quality management in the study area was considered. In analyzing the community acceptance, using the binomial distribution, four levels (classes) of acceptability were considered: zero, low, moderate and high.

Results and Discussion

The results of socio-economic modeling of the surface water quality management scenarios have shown that scenarios related to range improvement placed in the first and were strongly selected among the 16 management scenarios. Tree plantation, Lucerne growing and riparian restoration scenarios were ordered follow performance from the 16 surface water quality management scenarios. It's because of implementation area and productions price of each actions, and also stakeholders interesting to range improvement and related scenarios.

Conclusion

Cause and effect relationships and spatial links between upstream and downstream are important features of catchment systems. In watershed resource management types, integration includes integration across disciplines, data and models, scales, and stakeholders (Jakeman et al., 2005). The Hablerood BDN is available to stakeholders in the catchment and to policy makers as a management tool that can help them comprehend scenarios and explore the possible outcomes of scenarios being tested. It will also inform policy makers and downstream interests of the likely scope for, and catchment scale outcomes of altering land cover in the Hablerood. This can assist policy makers by suggesting the preferred management options and also setting targets and deciding on policy instruments such as incentives/penalties at a catchment scale. For instance, the analysis of results suggests that riparian restoration with relatively low establishment costs, high influence and of course low acceptability is the best water quality management scenario in the catchment.

The BDN approach described here has enabled the rapid and comparatively easy integration of several complex and diverse processes. This approach has also enabled communicating uncertainty of the parameters throughout the subnetworks of the BDN model and also to the users by characterizing the outcomes of the surface water quality management scenarios in a probabilistic context. The generic approach presented here to developing and using a BDN for assessing surface water quality management at a catchment scale is applicable to a variety of catchments with similar characteristics.

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Land suitability evaluation for sunflower by parametric method at west Azerbaijan province in Iran

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Abstract

Land suitability evaluation has been determined for oilseed crops in an area about 52000 ha in Orumieh region in West Azerbaijan Province. In order to have more confident soil data, particularity to control the old soil map of the area, a new soil survey studies were done. Soils were classified based on soil taxonomy (1998) and six subgroups and ten families and twenty one phases were identified. Climatic data from Orumieh synoptic meteorological station have been used for climate evaluation of crops. Based on yield coverage and climatic conditions, oilseed crops have been considered and compared in the present land suitability evaluation on the basis of irrigated agricultural system. In this region, the most important limiting land characteristics have appeared to be topography, Soil depth, %TNV, Gravel, Soil salinity and alkalinity and flooding. In surveyed area the climatic classes are suitable (S1) for Sunflower, Analysis of rainfall and ETO data reveals that the growing period is about 98 days, starting on October 29 until May 8. Comparing the two parametric methods (ie.storie and square root methods) for determination of land indexes for Sunflower, the square root method was considered to be more realistic for land suitability evaluation in the studied areas.

Keywords: Land suitability evaluation, sunflower, parametric method, Iran.

Introduction

The increasing growth of the population and relies of level standards of primary needs of the supply-demand enhances for life, Therefore, recognizing the potential of land production and assign them to the best and at the same time and place of the sustainable. One of the ways that psychological intervention in the provision of this Constitution are increasing production corresponds to the unit level is an important factor of the contributing factors, identifying application and covers up this appropriate use of land by taking their talents and potential .system efficiency of regional importance .In order to prevent land degradation also that others both of these resources for maintaining and therefore it was a further characterization of morphological, chemical and physical properties of soils of the South Plains of Urmia and the determination of the suitability of sunflower in 2009.

Materials and methods

This research in the southern part of the Urmia plain area 52 000 HA in the province of The mean annual rainfall in the area 376.3 mm. at Urmia synoptic . Azerbaijan do is accepted station . The average annual temperature region is 10.8 ° c. Climate zones on the basis of study of area classification is the semi-arid cold by Ambergeut method. Qualitative suitability was based on detailed soil survey studies of the region. In which case the 28 soil series profiles area to do in three stages, In is selected. Evaluation of the qualitative land suitability study of the first stage the climate information required , including temperature, precipitation variables, wind speed, relative humidity (%), the radiation of the Sun were collected and Wat software, crop modified and equipped with the analyzed. And using Penman mantis evapotranspiration potential area were calculated. And on the basis of climatic data (rainfall

and evapotranspiration potential) growth period and the most suitable seeding date was specified. And on the basis of other climatic characteristics climatic suitability index for sunflower plant was determined. Soil characteristics and landscape obtained from Urmia soil survey detailed studies. In the second steps of climatic conditions of the sunflower plant requirements, soil and landscape including of tables using foreign and Iranian references, and according to the conditions of the study area obtained. In the third steps, sunflower plant requirements with land characteristics of south of Urmia plain comparison and using the square root of parametric method , suitability classes determined for sunflower yield.

Results and discussion

By taking the information and calculations of growth period determine, in Urmia for dry farming development there is one growth period That began the eighth of November and the end at the 18 April is equal to 191 days and after reduce the days with temperatures less than 5 ° C growth period is 72 days, therefore, not recommended for dry farming it. Since most of the product in the area of irrigated farming is the beginning of the planting at mid of April and harvesting it mid-September in may according to local cultivation calendar.

Evaluation of the climatic characteristics of the meteorological station of Urmia for Sunflower

Climatic characteristics of the growth period	**Climatic information**	**Rating (parametric)**
The mean temperature of growth period	19.7	95
Relative humidity (growth period)	51.7	97
Climatic index(second root)	95+√0.97	93.6
second root rating	-	100

The results of climatic suitability evaluation by parametric method show that this area is suitable for cultivation of sunflower product (S1). it's reason is long daylenght in the development stage . Principal characteristics of the unit of land area restricted to the following table object:

Futures suitability classes & subclasses	Land reclamation needs	Current suitability classes & subclasses	Soil families	area to HA	The percentage of %
S1	G	S2t	2.1	1750	3.4
S1	R	S2f	7.1-7.2-7.3	2550	4.9
S2s	R	S2sf	3.1-3.2-4.1-5.1	1850	3.5
S2s	R-SP	S2sf	6.1	1600	3.1
S1	D-R	S2fw	7.4-8.1-10.1-10.2	6900	13.2
S2s	G-R	S2fst	1.1	1750	3.4
S2s	G-R-SP	S2fst	3.3	1600	3.1
S2s	D-R	S2sfw	7.5-8.2	2825	5.5
S2fs	R	S3f,s	9.1	1225	2.4
S2t	G-R	S3t,f	1.2-1.3	1500	2.8
S2t	D-R	S3w,f	10.3-10.4-11.1-11.2	8925	17.2
S2fs	D-R	S3f,ws	12.1	1900	3.7
S3n,s	D-L-R	N1n,w	13.1-13.2	3650	7.1
S3n	D-L-R	N1fn,w	14.1-14.2	700	1.4
S3sn	D-L-R	N1n,fws	15.1-15.2	3050	5.9
-	-	-	T	200	0.4
-	-	-	M	400	0.8
-	-	-	U	9625	18.2
	Total			52000	100

G =	grading	S =	Land physical characteristics limitation	f =	Soil pH & fertility limitation
D =	drainage	T =	Topography limitation		
F =	Flooding protection	N =	Soil salinity & alkalinity limitation	R =	Application of reclamation material
L =	leaching	W =	Water level stability limitation		

According to the contents of the above conclusion is that the optimum use of land should exploit land according to land suitability classes for each unit land is achieved And for modifying the effects of negative characteristics of the land than do land reclamation operations and technical, economical and social evaluation is being.

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Application of potential yield estimation and land suitability method to recognize farm level management in wheat farms of Khoy plain at West Azerbaijan province-IRAN

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Abstract

Khoy plain is one of the most important agricultural areas in W.Azerbaijan with 53000 Hectare area, of that 10000 hectare is under wheat production that have 4000kg mean yield per hectare. To estimate the potential yield of this crop the agro ecological method of FAO was used. In this method farm management level can defined as proposed 3 classes of good, medium and fair that affected by capital, use of agricultural inputs,… . To estimate the maximum gross biomass yield, the data on climate and water use efficiency was used. The result was showed these lands are able to product of 7800 kg/ha. So, the soil survey at semi-detailed scale was carried out to evaluate the land suitability for wheat. Then the actual production was compared with potential yield. In this case, if the actual yield is more than expected yield, farm management is classified as good class, otherwise it may classify as a fair class, the results of this research work were showed out of 1 recognized soil series, and farm management level is good in recognized soil series.

Key words: potential yield estimation method, farm level management, land suitability, Khoy, IRAN.

Introduction

About Application of potential yield estimation and land suitability method to recognize farm level management ever research of the world's not done yet and researcher about potential yield estimation and land suitability method this has assessed. Basically the production of yield for different land restricted and climatic characteristics and soils of a region in short period were of assistance isgiven .

Environmental elements with management determine land quality. Production potential for the long period can be sustained therefore it should be calculated currently. in this study Wheat potential production with climatic characteristics of Sys and eta... method determined and land evaluation by parametric method on wheat production has been done on the 400 HA of these area. The purpose of this study is recognition of farmer management level in the field with this method.

Materials and methods

Khoy area located in northwest of Iran at 38 degree of north latitude and 44 degree of east longitude. In accordance with the Khoy synoptic station data, mean of annual temperature in this station is 11.6 degree of centigrade and soil temperature regime of this region is Mesic and soil moisture regime is Xeric.

Table 1: Khoy synoptic station data:

Month	**Jan**	**Feb**	**Mars**	**Apr**	**May**	**Jun**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Total**
parametre	31	29	31	30	31	30	31	31	30	31	30	31	365
presipitation	27	18	28	42	57	20	7	4	9	22	19	16	269
Mean min.temp	-5.5	-3.8	1.5	5.4	10.3	13.4	16.7	16.2	11	6.4	1.8	-2.4	5.9
Mean max.temp.	3.1	5.9	12.7	17.7	24.5	29.7	33	33	28.4	20.6	13.3	6.9	19.1
Mean temp.	-1.2	1.1	7.9	11.5	17.4	14.8	24.8	24.6	19.7	10.5	7.5	2.2	11.7
Humidity	77	78	71	72	69	65	61	62	65	72	76	78	71
Wind speedKm/day	225	173	216	181	207	156	156	156	130	130	130	216	173
Sun hour	2.9	3.9	3.9	6.8	5.1	7.1	7.6	10.1	8.8	6.4	4.6	4.1	5.9
Day lenght	10	11	11.5	13.2	14.2	14.7	14.5	13.6	12.4	11.3	10.2	9.5	
Evapotrans. Mm/month	27.9	31.9	62	90	120.9	144	164.3	170.5	123	74.4	39	31	1078
Daqy temp.	1.7	4	10.3	14.4	20.7	24.9	28.1	27.9	23.9	17.5	11.1	5.3	

Land suitability evaluation by parametric method:

In the parametric method for any land character and land quality have grade, If a land character for a land type be optimum grade productivity. Compactness 100 is given to it in the comments. If land limitations to the creation of the grade as lower character for the data to be. After that all land characters was rated, to be use for determine forland index . In accordance with the propose methods , first climatic assessment is donewhich climatic data aggregation in ten year period. Information includes rainfall, precipitation, day length… and for plant growth period, date of planting, date of harvesting and of those adaptation with climatic characteristics should self-respect.

Root square method: in this method highest limiting factor as minimum rate and other rates for climate, soil, land, topography multiple together and after square rooting multiple to minimum rate and for determining of final land evaluation class we use from evaluation class index table.

Table 2: Determination of the suitability class using index achieved the second root method

Suitability classes	Index
Suitable(S1)	75-100
Moderately Suitable(S2)	50-75
Marginaly Suitable(S3)	25-50
Non Suitable(N)	0-25

Estimation of climate potential:

To calculate the potential water production should mean day temperature and night and will also determine the growth period and Produced potential is estimated. Thus, having information reference evapotranspiration, crop coefficient, maximum evapotranspiration, water use efficiency and yield response factor is essential the maximum rate of gross biomass production so as to know the yield can be calculated according to leaf area.

Determine growth period:

Growing period is the period of the year that agricultural products be without limitation of water temperature to be culture. FAO reported that during the growth period of the year, rainfall is and more than half of potential evapotranspiration and assuming that the amount of water stored after the end rainfall is 100 mm and number of days that the water will evaporate to this volume is added.

Linear method of calculation of the growth period with monthly data is as follows:

Consider two consecutive months. RainfallR1, R2, and.E1,E2 First and second months of potential evapotranspiration If you start growing in R1 <E1 / 2 and R2> E2 / 2 or rainfall end are R1> E1 / 2 and R2 <E2 / 2 .
We show that a linear function of time we evapotranspiration (t today) the start of growth period or end of rainfall at middle of first month is determined by the following equation
[(E1/2) 30/(R1-R2+E2/2-E1/2 – t = int [(R1
Similarly, we determine the beginning and end of the wet period Consider two consecutive months at the start of the wet period, R1 <E1 / 2 and R2> E2 / 2 in the wet end R1> E1 / 2 and R2 <E2 / 2 is the beginning or end of the first wet day of the month will be determined through the following equation:
[(E1) 30/ (R1-R2+E2-E1 – t = int [(R1

Leaf area index:

Large amount of bgm in a given Pm depends on the amount of leaf area index (LAI). Be assumed that the effect of age on leaf photosynthesis with depth for the product is negligible. Relationship between the maximum leaf growth and LAI has created. The maximum growth rate as a correction factor (KLAI) in the formula and to compensate for the bgm at LAI is the gross production rate of biomass is less than 5 square m/m on the meters used. The amount of leaf area index can be obtained from resources in the region or from the table.
(Bn = 0.36 * bgm * KLAI/)(1/L)+0.25*ct
Table3 : Wheat characteristics

Crop	Moisture %	Ky of the growth periods					LAI	Hi
		Veget.	Flow.	Yi.f	.Rip	Total GP		
Wheat Winter	Grain 12-15	0.2	0.6	0.5	-	1.0	4-5	0.45

Yield production:

Harvest index is biomass ratio of net product that is economically. The amount of harvest index depends on the genetic potential of varieties water regimes and agricultural operations. This model has been considered varieties with high yield. Yield can be calculated from the following equation:
Y = Bn *Hi

Results and discussion

Based on the information and calculations to determine rainfall and evapotranspiration there is one growth period for wheat cultivation at Azerbaijan But since culture is the basis of the local calendar as irrigated farming start growing period of October 15 and end of June 31, With taking into account the months that average temperatures less than 5 ° c is the length of the growing period in equal 160 days.
Khoy Meteorological station, which climatic information for estimation of productivity of water used is located in the geographical positions: 38 °latitude and44 ° longitude. Elevation of this station is 1300m That on the basis of this information the start of growth is October 15, the end of 31 June and growing period is 160 day And the mean of various parameters calculate according to table no. 6 for the growth cycle:

Table 4: Climatic characteristics of Khoy meteorological station:

Months	Oct.	Nov.	Mar	Apr.	may	jun	Mean
Temperature mean	10.5	7.5	7.9	11.5	17.4	14.8	11.6
Temperature day	17.5	11.1	10.3	14.4	20.7	24.9	16.5
(n)Sun hours	6.4	4.6	3.9	6.8	5.1	7.1	5.7
N)(Day length	11.3	10.2	11.5	13.2	14.2	14.7	12.5
bc	330	260	365	430	478	500	394
bo	165	125	185	225	252	265	203

Suggestions and solutions

Due to the fact that the production potential of irrigated wheat is 7800 kg/ha and its production in the Khoy region is 4000 kg/ha, to achieve the production potential that 3800 kg/ha higher than current production the following can be mentioned:

- One of the restricted factors is soil texture that can be used with the use of fertilizers, manure produced in addition to the soil fertility to amend soil texture suitable for wheat and the conditions of growth of wheat do.
- Wheat for germination in salinity less than 6dS/m is not reduction of product and if soil salinity is 10-13 dS/m, 25-50% will be drops of the product and if the exchange sodium percentage be equal or more than 20%, the product will be reduce 50%(Sys etal.1993).
- The best range of wheat growth is soil pH range is 6-8.2but until pH 8.5 it is tolerated. So doesn't any limitation for soil reaction under the wheat product in the Khoy plain.
- Wheat up to 30%limes to be tolerating without reduction of production.
- Flood plains and lands with high water stable level are not suitable for wheat cultivation and to use this land should attempt to solve the problems of the flood and drainage.
- The use of fertilizer with experienced experts recommend be done.

Hope is a production of wheat in all fields has increased production potential.

Estimation of climatic production potential for all the above products in Khoy region has been used but the production potential of land resources for each product should be estimated separately In the case of wheat product listed in the following:

Product name: wheat
Harvest index: Hi 0.45
Type of product: non-legum

Number of days to ripening: 160 day
% Moisture: 12

The production potential of irrigated wheat, according to the calculations have been carried out for Khoy region is estimated 7800 kg/ha.

Table 5. Estimation of potential of irrigated wheat yield in Khoy region

1-Calculation of the maximum amount of total gross biomass production(bgm)	
20	)The maximum rate of photosynthesis of leave (Kg CH2o/ha/h) (p m
394	The maximum total rate of biomass production in gross weather smooth Bc (Kg/ha/day)
203	weather The maximum total rate of biomass production in gross cloddy Bo (Kg/ha/day)
0.54	n / N) - The ratio of days that the air is cloddy(1
0.46	(n / N)The ratio of days that the air is smooth
290.8	The maximum amount of total gross biomass production) (Bgm bc(bo+(1-f bgm= f((Kg CH2o/ha/day)
2- Calculate the total rate of net biomass production	
0.0108	(Respiratory coefficient for non-legum) C30
0.00216	0.0019t+ 0.001t² (+0.0014) ct = c30 (Respiratory coefficient) Ct
160	(The number of days until rippening) L
1	Correction factor for LAI< m² / m² (KLAI)
6932.5	total net biomass bn = 0.36 * bgm * KLAI / ((1/L) +0.25+ct) Bn (Kg/ha) production
0.45	Harvesting index Hi
6933	Y (Kg/ha.dm) Y = bn *Hi production potential of wheat yield
7800	production potential of wheat yield with 12%humidity (Y (Kg/ha.fm))

Table 6. soil series and classification in Khoy region.

Physiography	Soil No.	USDA Soil Taxonomy 1998		Order
Piedmont Plains	6.1	Fine Loamy, active ,Mixed,Mesic	Typic Haploxerepts	Inceptisols

Table 7. land characteristics and landscape of typical soil pedon properties

Map unit	Water logging	Drainage class	Water level	micro relief	Slope %	Tex.	Gravel %	Soil depth	Lime%	pH	Ec
6.1	No hazard	good	deep	0-15cm	0-2	L.	-	>130cm	9	8.1	0.3

Table 8. Levels Of production in different suitability classes

	N	S3	S2	S1
0	40	60	85	100
Rails	3.5	4.5	6.5	

Yield per unit area has been question by random from farmers per each map unit, if the performance is minimum, the management level is faire and if the production is high and performed the management class is high. Because in this region in the form of wheat half-mechanized cultivation is, therefore, a medium level of management and homogeneous has been evaluated.

Table 9. Investigation and determine the farm management

Farm management level	Max. level of class ton	Min. level of class ton	Yield/ha ton	Land suitability class	Land unit
good	7.8	4.8	6.5	S1	6.1

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SOIL AND WATER CONSERVATION

ORAL PRESENTATIONS

Soil Salinity under Deficit Drip Irrigation of Potato and Millet in Arid Conditions of Tunisia

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Abstract

The influence of deficit irrigation (DI) with saline water on soil salinity in a drip-irrigated potato and millet fields was investigated. We had compared proportional soil salinity developed under Full and DI under drip irrigation. For both experiments, the treatments were (1) Full, control treatment where rooting zone soil water content was increased to field capacity at each irrigation; (2) DI80; (3) DI60 and DI40; 20, 40 and 60% deficit irrigation compared to Full treatment were applied, respectively. Soil salinity was assessed using the isosalinity maps constructed with grid soil sampling of plant root zone at harvest. Results show that high spatial variability was observed in salinity along soil profiles when applying saline water with drip irrigation for potato. For the DI40 and DI60 treatments, high soil salinity was recorded in the upper soil layer close to the emitter. Increase of soil salinity within soil depths of 30 cm or below was also observed under DI60 and DI40 treatments. The lowest increase was noted under the full treatment. Surface soil salinity was somewhat higher under DI60 and DI40 compared with that of full and DI80 irrigation treatments. The distribution of salts around the dripper changes during the crop season according to applied irrigation treatments, with overall higher concentrations between the drippers and towards the margin of wetted band. Iso-salinity maps at harvest of potato showed that the surface layer of 30 cm depth had the lowest salinity which gradually increased at deeper zones irrespective of the treatment. Salt accumulation essentially occurred at wetting front between the drippers and the plant row. Although salt accumulation was relatively highest along the row under DI treatments, the area of accumulation was relatively shifted toward the center between the rows and the drip line. The results also show the importance of the potato cropping season to benefit from the leaching of soluble salts with the received rainfall. For millet experiments, salinity was lowest under emitters and highest midway to the margin of wetted bands and higher soil salinity was maintained in the root zone with deficit irrigation treatments than full irrigation. Millet and potato yields were highest under Full treatment. Yields decreased almost linearly when applied water was reduced. However, reduction in quality was significantly important for DI60 and DI40. The analysis outcome of the crops sensitivity to salt indicated respectively for autumn, winter and spring potato and millet crops that thresholds are close to the value calculated from published salt tolerance data (1.9, 1.55, 1.85 vs. 1.7 dS m^{-1} for potato and 3.46 vs. 3.65 dS.m^{-1} for millet) but the slopes are considerably steeper (34, 54, 47 vs. 12%; 17 vs. 6.7%), apparently because of the combined effect of salinity and water stresses. The results provide information's to farmers for formulating improved planning regarding irrigation management practices. The results support the practicality of using the full irrigation (100% of ETc) methodology to optimize irrigation with saline water for potato and millet production and to control soil salinity. Under situations of water shortage, the deficit irrigation strategy (DI80 and DI60) is recommended as a tool to schedule irrigation of potato and millet crops in arid regions of Tunisia.

Keywords: arid, soil salinity, deficit irrigation, drip irrigation, potato, millet, yield

Introduction

Limited supply of good quality water is the most important factor limiting crop production in arid Tunisia but there are considerable resources of saline water that has been included as an important substitutable resource for fresh water for agricultural irrigation through suitable irrigation management. The salinity of the water varies in the range of electrical conductivities (ECi) between 3 and 9 dS/m. This water was considered not suitable for agricultural irrigation. However, the current water scarcity, primarily in the arid regions, has forced farmers to extensively explore the possibility of including saline water in the irrigation regimes of agricultural crops.

Applying saline water continuously for irrigation might result in salt accumulation close to the soil surface (DeMalach and Pasternak, 1993; Oron et al., 1995). This problem can be overcome by

applying saline water through a drip-irrigation system. It is anticipated that under drip irrigation, the salt front is partially driven down into the deeper soil bulk media and to the periphery of the root zone, thus minimizing the risk of damaging the main roots of the plants. Moreover, the improved moisture conditions in the vicinity of the emitter offsets the inhibiting effects of the presence of the salts in the saline water (Michelakis et al., 1993). Additionally, it can result in water saving if the correct management procedures are applied. Whereas, if management is not properly practiced, irrigation with low quality water can compound existing problems with soil salinity.
In arid regions of Tunisia, irrigation with waters having an ECi more than 3 dS/m is commonly practiced on a routine basis without scheduling and provision drainage and it carries the danger of a rapid soil salinization because of increased salt input. Therefore, innovations are needed to increase the efficiency of use of the water that is available. One way to address the issue of water shortage and soil salinization is through development of new irrigation scheduling techniques such as deficit irrigation (DI), which are not necessarily based on full crop water requirement. Deficit irrigation, widely investigated as a valuable strategy for dry regions (English, 1990; Pereira et al., 2002; Fereres and Soriano, 2007), is particularly important for crops which are frequently subject to chronic water shortages. Due to chronic water shortage and soil degradation hazards in irrigated areas, there is a need to develop strategies that may help to save water and control salinity. In the absence of drainage systems and under conditions of high evaporative demand and chronic shortages of water, techniques based on irrigation restrictions during the whole growing period without substantially affecting yields seem to be reasonably appropriate. One consequence of reducing irrigation water use by DI is the greater risk of increased soil salinity due to reduced leaching, and its impact on the sustainability of the irrigation (Schoups et al., 2005). The evaluation of soil salinity developed under drip irrigation with DI practice should be investigated. Therefore, various deficit irrigation strategies have been applied to pearl millet and potato crops considered as moderately tolerant and relatively sensitive to water stress caused by deficit irrigation or salinity (Hajor et al., 1996; Maas and Hoffman, 1977). The purpose of this study is to verify the effect of DI with drip irrigation on the salinity distribution in the soil profile and eventually the crop yield in order to develop an irrigation strategy that save water in irrigated millets and potatoes, and reduce salt input. The possibility of using saline water through DI for vegetable and cereal crops irrigation is being examined in the field experiments.

Materials and methods

The experiments were carried out at farmers' sites in the Southern East of Tunisia. Potato (Solanum tuberosum L. cv. Spunta) and millet (Pennisetum glaucum (L.) R. Br.), native of the region, were planted on sandy soils with low organic matter content, and an ECe of 1.35, 2.01 and 3.45 dS m^{-1} for spring, winter and autumn potatoes, respectively, and 2.50 and 1.74 dS m^{-1} for first and second year of millet crop, respectively. The total soil water, calculated between field capacity and wilting point for an assumed potato and millet root extracting depth of 0.60 and 0.70 m, was 75 and 62 mm, respectively. Planting took place on 5 February 2000, 1 November 2001 and 1 September 2002 for the spring, winter and autumn potatoes respectively, in 70 cm rows with tubers spaced 40 cm apart, and on 25 May 2005 and 1 June 2006, with plant and row spacing 0.5 m x 0.40 m in a randomized complete block design with four replicates and four irrigation treatments. Both experimental areas were divided into four blocks with four elementary plots per block. Each elementary plot consisted of four and ten rows, respectively, for potato and millet crops.
Potato and millet crops were drip irrigated with water from a well having an ECi of 3.25 and of 7.6 dS m^{-1}, respectively. Each dripper had a 4 l h^{-1} flow rate. Water for each block passed through a water meter, gate valve, before passing through laterals placed in every millet and potato row. A control mini-valve in the lateral permits use or non-use of the dripper line. Fertilizers were supplied for the cropping periods in the same amounts; before planting of potato and millet crops, soil was spread with 17 and 15 t ha^{-1} of organic manure. Nutrient supply included N, P and K at rates of

300, 300 and 200 kg ha^{-1} for potato crops and 300, 200 and 150 kg ha^{-1} for millet crop, which were adopted from the local practices. The P and K fertilizers were applied as basal dose before planting. Nitrogen was divided and delivered with the irrigation water in all treatments during early vegetative growth.

The experiments consisted of four distinct irrigation treatments: Full treatment irrigated when readily available water in the root zone has been depleted and plants in that treatment received 100% of accumulated crop ETc; three additional treatments were irrigated at the same frequency as Full treatment, but with quantities equal to 40, 60 and 80% of accumulated ETc (DI40, DI60 and DI80). These treatments were identified as deficit irrigation treatments. The crop evapotranspiration (ETc) was estimated for daily time step by using reference evapotranspiration (ETo) combined with millet and potato crop coefficient (Kc). The ETo was estimated from daily climatic data collected from the Institute meteorological station (data not presented) by means of the FAO-56 Penman-Monteith method given in Allen et al. (1998). The potato and millet crop coefficient (Kc) was computed following the recently developed FAO-56 dual crop coefficient approach, the sum soil evaporation (Ke) and basal crop coefficient (Kcb) reduced by any occurrence of soil water stress (Ks), that provides for separate calculations for transpiration and soil evaporation. For irrigation scheduling, the method used was the water balance, by means of a spreadsheet program for Excel, developed according to the methodology formulated by Allen et al. (1998). The program calculates the soil water depletion on daily basis using the soil water balance and projects the next irrigation event based on the target depletion: 35 and 60% of TAW for potato and millet crops. At physiological maturity potato and millet yields were obtained. Twenty and ten plants per row within each plot were harvested by hand, respectively for millet and potato, to determine millet and potato yields and yield components. Soil samples were collected after harvest of potato and millet crops and analyzed for ECe. The soil was sampled every 15 cm to a depth of 60 and 70 cm, at four sites perpendicular to the drip line and at four sites between the emitters. Conceptually, these should be areas representing the range of salt accumulations (Bresler, 1975; Singh et al., 1977).

Results and discussion

Soil salinity

Figures 1, 2 and 3 demonstrate the salinity distributions, ECe, in the soil in the autumn, winter and spring potatoes along the row and across row for each treatment. High spatial variability was observed in salinity along soil profiles when applying saline water with drip irrigation. The trends of salinity distribution in the soil as expressed by the ECe were similar for the three cropping seasons. For the DI40 and DI60 treatment, high soil salinity was recorded in the upper soil layer close to the emitter. Increase of soil salinity within soil depths of 30 cm or below was also observed under DI60 and DI40 treatments. Extra leaching is thus required to shift the salt front into deeper soil layers. For a new cultivated area, probably an intense leaching will be required prior to planting. As expected, the lowest increase was noted under the Full treatment because of proportionally high leaching occurred. It was interesting to note that surface soil salinity was somewhat higher under DI60 and DI40 compared with that of DI80 (Figures 1, 2 & 3). In the immediate vicinity of the emitter for full and DI80 irrigation treatments, the soil salinity was relatively low. This finding is important, since it means that for full drip irrigation, the soil salinity for potatoes in the active root zone remains quite low and full drip irrigation maintains continuous soil leaching not only downwards, but also radially. The full and DI80 drip irrigation treatments facilitated sufficient leaching below the area wetted by emitter and don't contribute to extra accumulation of salts in the active root zone of the plant.

The distribution of salts around the dripper changes during the crop season according to applied irrigation treatments, with overall higher concentrations between the drippers and towards the margin of wetted band, and this for the three cropping periods. Iso-salinity maps at harvest showed

also that the surface layer of 30 cm depth had the lowest salinity which gradually increased at deeper zones irrespective of the treatment. Salt accumulation essentially occurred at wetting front between the drippers and the plant row. Salinity below 30 cm depth proportionally was higher compared to surface layers. Although salt accumulation was relatively highest along the row under DI treatments, the area of accumulation was relatively shifted toward the center between the rows and the drip line. For potato experiments, the results also show the importance of the cropping season to benefit from the leaching of soluble salts with the received rainfall. For the spring crop, a clear increase in the salinity of the root zone of 60 cm was observed, the ECe increased from 1.35 at the plantation in February to approximately 2 dS/m after harvest in May. For the winter crop which takes place from November to February, the soil salinity remains in levels comparable with an ECe of about 1.5 dS/m. However, for the autumn crop the ECe decreased from 3.45 dS/m in September to about 2 dS/m after harvesting in January.

The application of deficit irrigation with reductions of 20, 40 and 60% of the water supplies causes salts accumulation increasing with the level of water reduction. ECe passes from approximately 2 dS/m for the full irrigation to 3.2 dS/m for the DI60. The increase in the soil salinity for the autumn and winter crops seems however less important than that of spring season. A deficit of 20% seems to constitute a good compromise to maintain low soil salinity values with limited impact on the yield. More important reductions do not make it possible to create favourable conditions to evacuate salts apart from the root zone and this whatever the cropping period. The reduction of irrigation water beyond 20% reduces the salts quantity brought on the soil, but it does not contribute to an effective soil leaching. Our results showed that risks of salt accumulation under the deficit irrigation treatment DI80 would not be much different than under Full irrigation. Therefore in areas of limited irrigation water, the deficit irrigation practice of DI80 should be preferred over Full irrigation.

For millet experiments, the final ECe values at different distances from emitter and drip line under the different irrigation treatments are presented in Figure 4. On the row, the highest ECe values were found to have occurred at a distance of 7 and 15 cm from the emitter when DI40 treatment was used. Values of 6.10 and 4.92 dS m^{-1} were recorded below the emitter respectively in the first and second year. With DI60 treatment, ECe values of 4.03 and 3.33 dS m^{-1} were recorded below the emitter respectively for 2005 and 2006, and reached the maximum at a distance of 15 cm from the emitter. Between rows, the greatest values of ECe were recorded at distances of 15 and 25 cm from drip line with DI40 treatment. With Full and DI80, ECe values decreased to 2.75 and 3.14 dS m^{-1} respectively beneath the emitter in 2005 and to 1.95 and 2.38 dS m^{-1} in 2006. The zone of highest ECe was moved out to 20 cm from the emitter. Soil salinity was highest midway between the emitters and towards the margin of wetted band. Nagaz et al., (2007) and Singh et al. (1977) reported similar result.

The mean ECe values under the different irrigation treatments were lower than the EC of the irrigation waters used (Figure 5). Singh & Bhumbla (1968) observed that the extent of salt accumulation depended on soil texture and reported that in soils containing less than 10% clay the ECe values remained lower than ECiw. Low values of ECe under the prevailing climatic conditions were due to the leaching of soluble salts with the received rainfall during the cropping seasons of potato (winter: 59 mm; spring: 26 mm and autumn: 72 mm) and to the low initial soil salinity at planting of millet crop in first and second year (2.50 and 1.74 dS m^{-1}).

Yields

The data concerning the yields of millet and potato crops, observed for all irrigation treatments, are presented in Figure 6. The data shows that for both crops the maximum yield occurred in the Full treatment. The decrease in water applied from 100 to 80% of ETc decreased the millet and potato yields. A significant reduction in grain and fresh tuber yields occurred with the DI60 and DI40 treatments (Figure 6). The reduction in yields was mainly attributed to reduction in yield

components (data not presented) as a consequence of water supply shortage during potato tubers initiation and development, and during panicle initiation, flowering and millet grain filling. Previous studies have shown that adequate irrigation water supply during panicle initiation, flowering and grain filling increases the panicle number and kernel number and weight (van Oosterom et al., 2002; Bidinger et al., 1987; Mahalakshmi and Bidinger, 1986). Adequate water supplies before and during tubers initiation increases the number of tubers per plant (Shock et al., 1992); whereas, after tubers initiation, it increases their individual sizes (Shock et al., 1998).

Note that the deficit irrigation treatments results in higher salinity in the rooting zone than the full irrigation treatment (Figure 5). One consequence of reducing irrigation water use by deficit irrigation is the greater risk of increased soil salinity due to reduced leaching, (Schoups et al., 2005). A higher salinity associated with deficit irrigation caused important reductions in millet yield and its components. A higher salinity associated with deficit irrigation caused important reductions in yield and yield components of millet and potato. These results, obtained under actual farming conditions, support the practicality of using the Full methodology to implement an efficient use of saline water for millet and potato production. Under severe shortage of water irrigation could be reduced voluntarily. There is a quantitative indication of the yield loss associated with deficit irrigation (Figure 6).

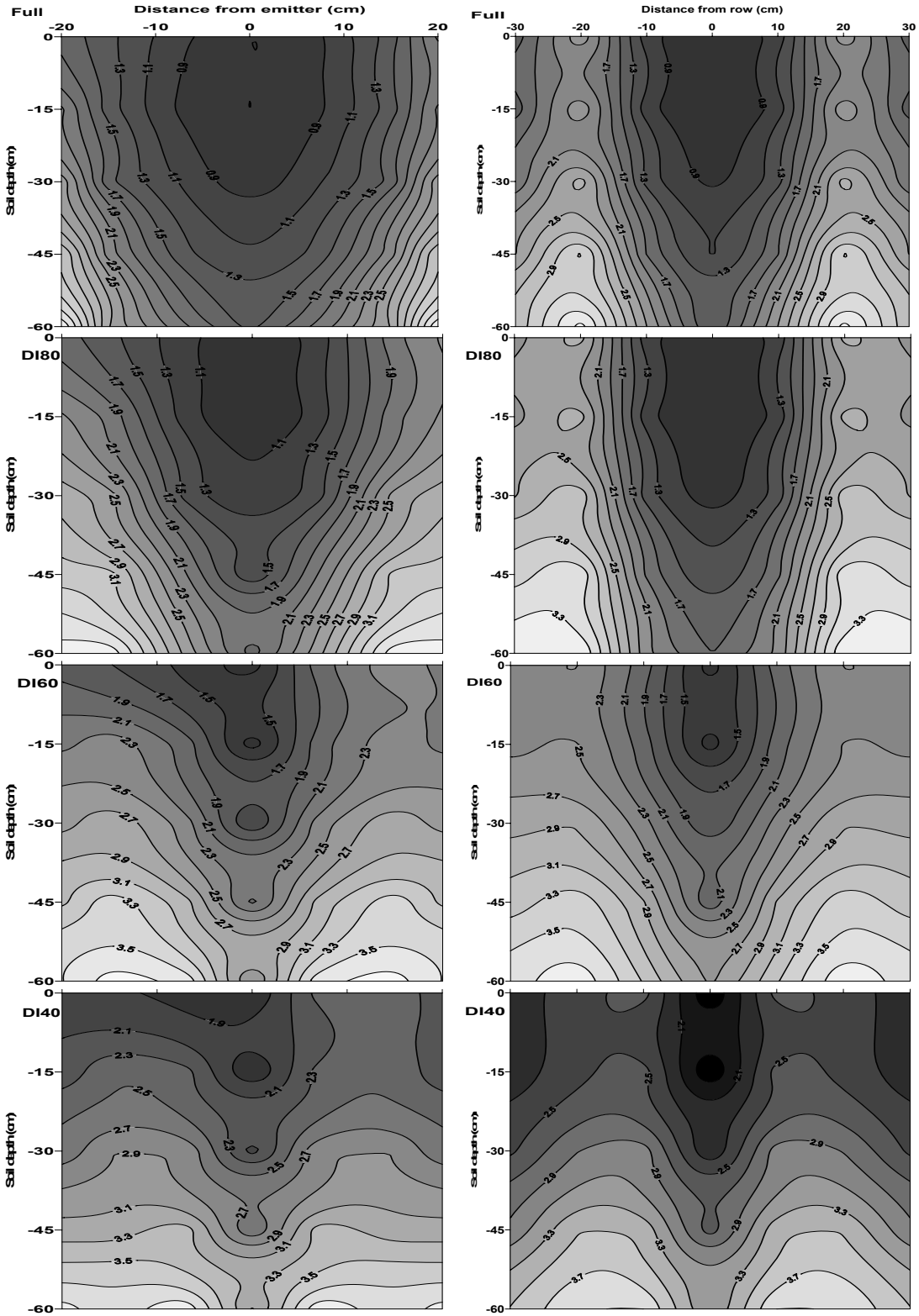


Figure 1. Soil salinity (ECe, dS/m) under different irrigation treatments along the row and across row: Autumn potato

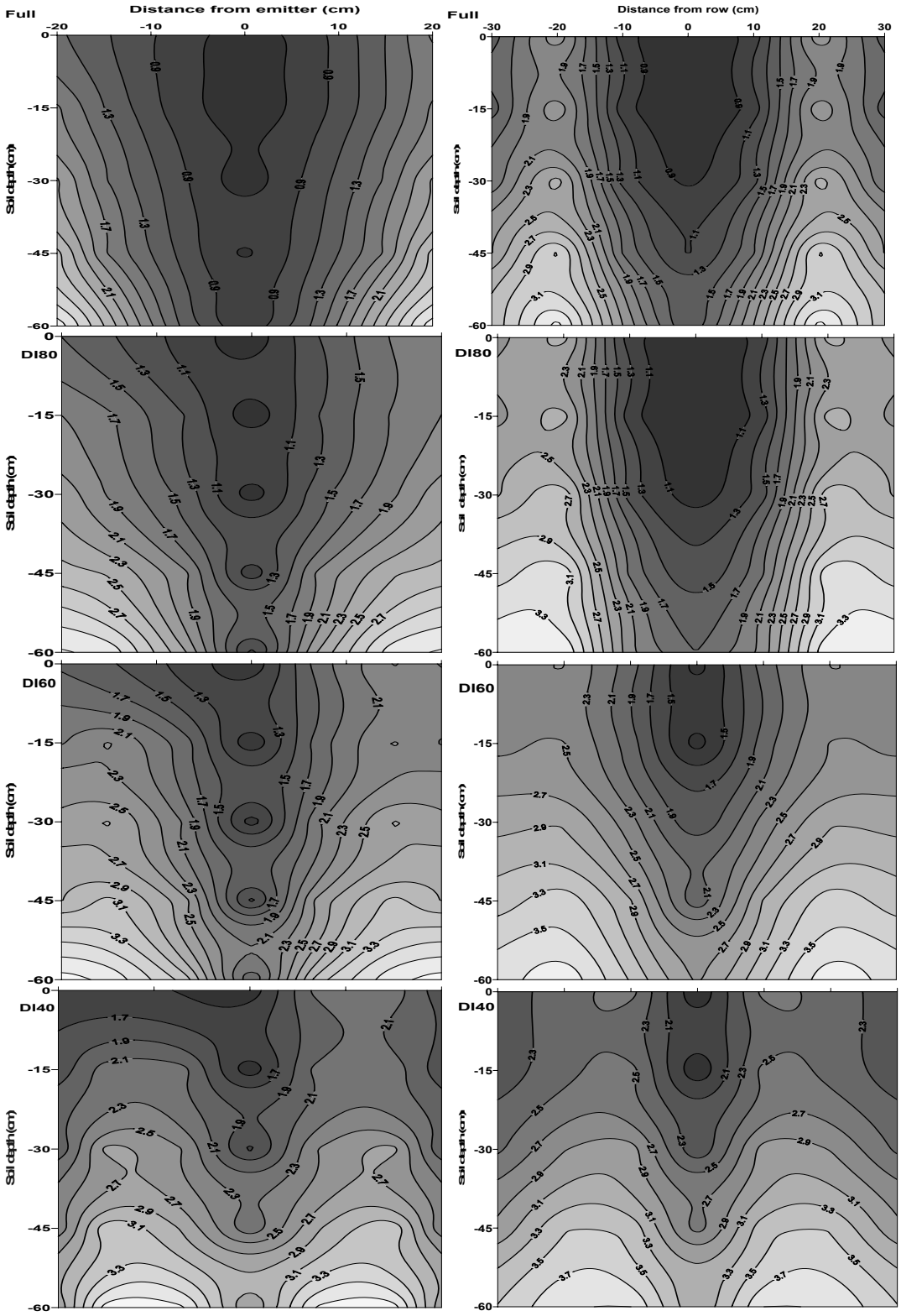


Figure 2. Soil salinity (ECe, dS/m) under different irrigation treatments along the row and across row: Winter potato

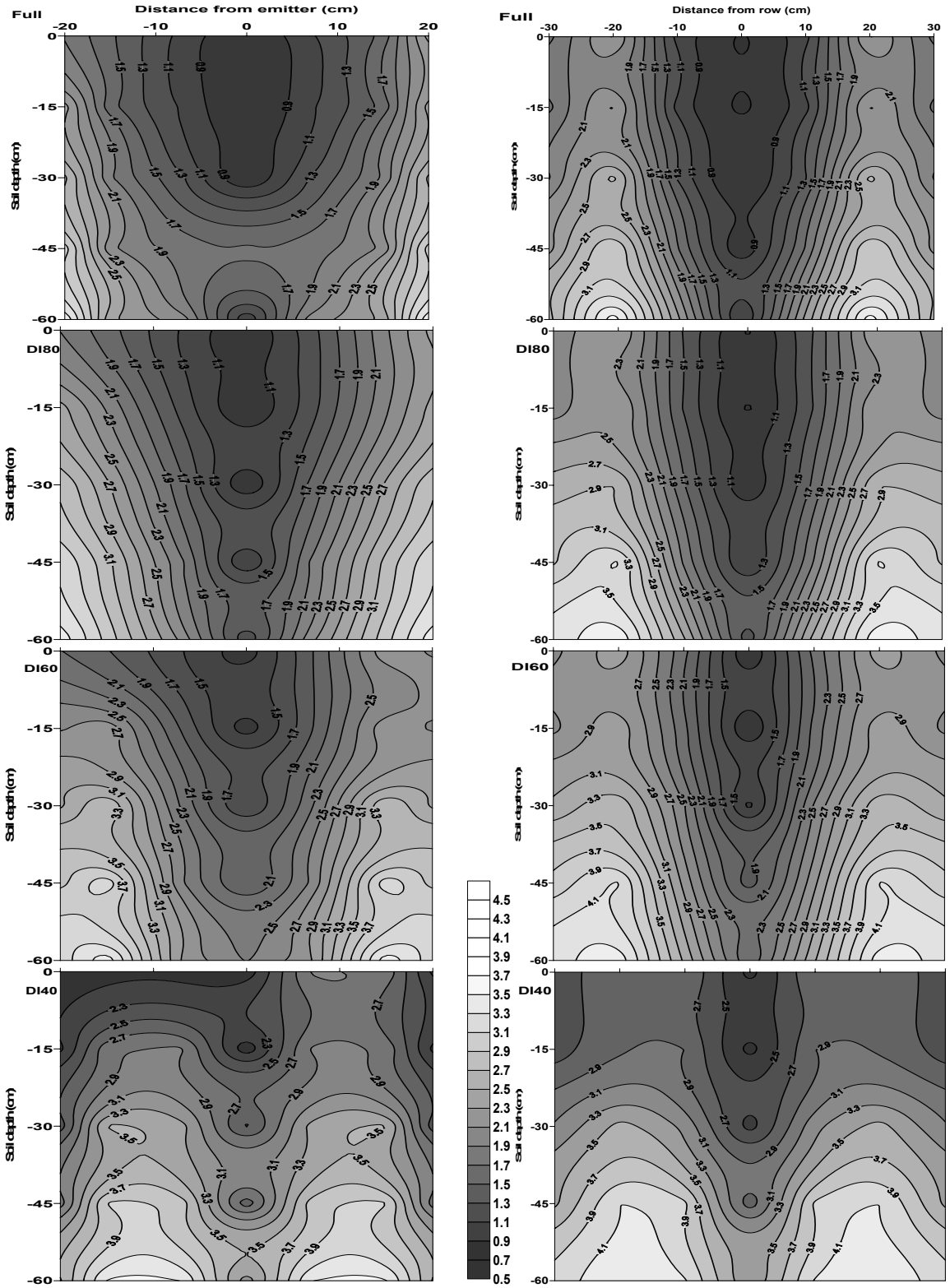


Figure 3. Soil salinity (ECe, dS/m) under different irrigation treatments along the row and across row: Spring potato

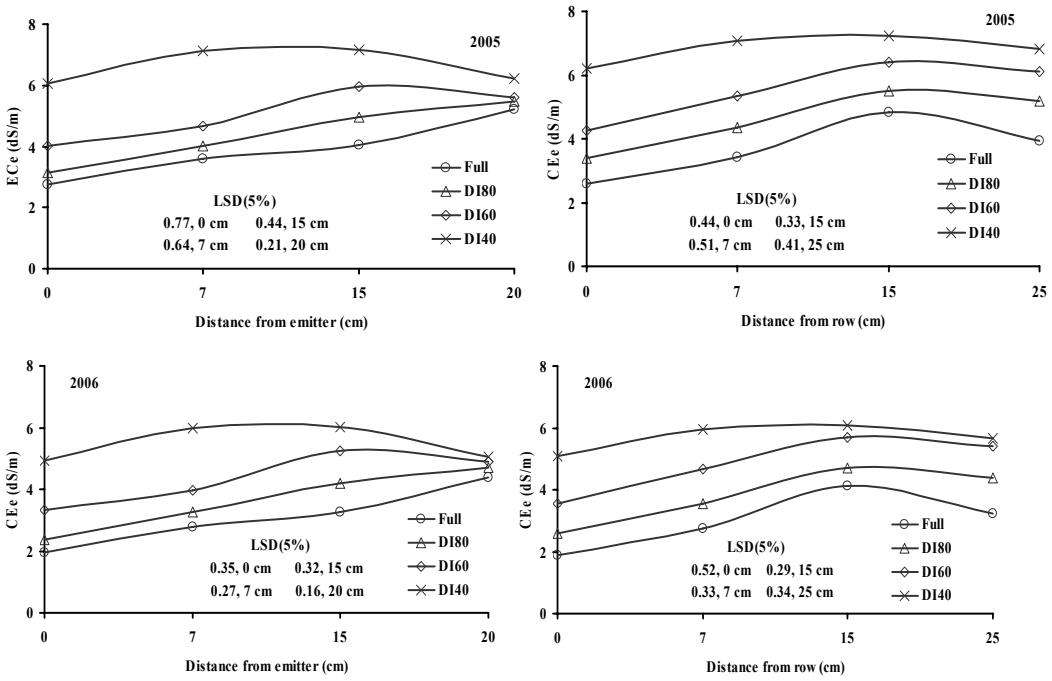


Figure 4. Soil salinity (ECe) under different millet irrigation treatments along the row and across row.

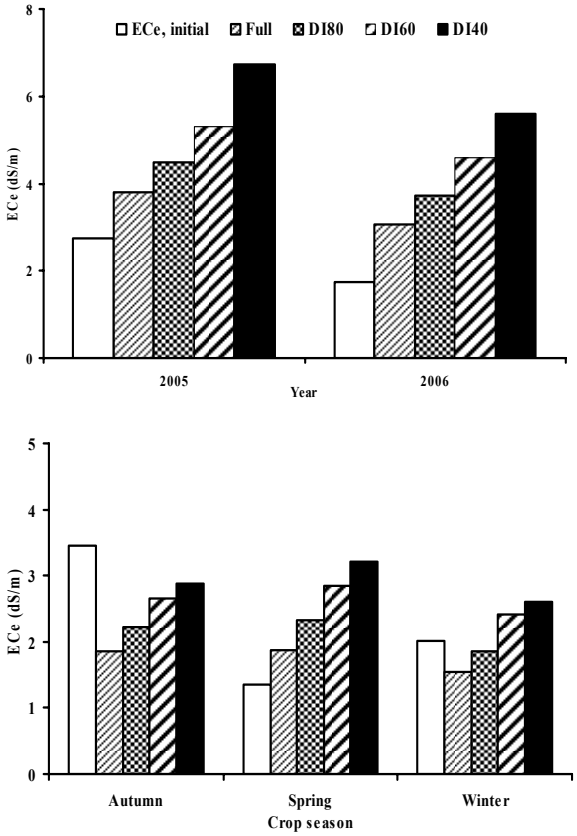


Figure 5. Mean soil salinity values under different irrigation treatments.

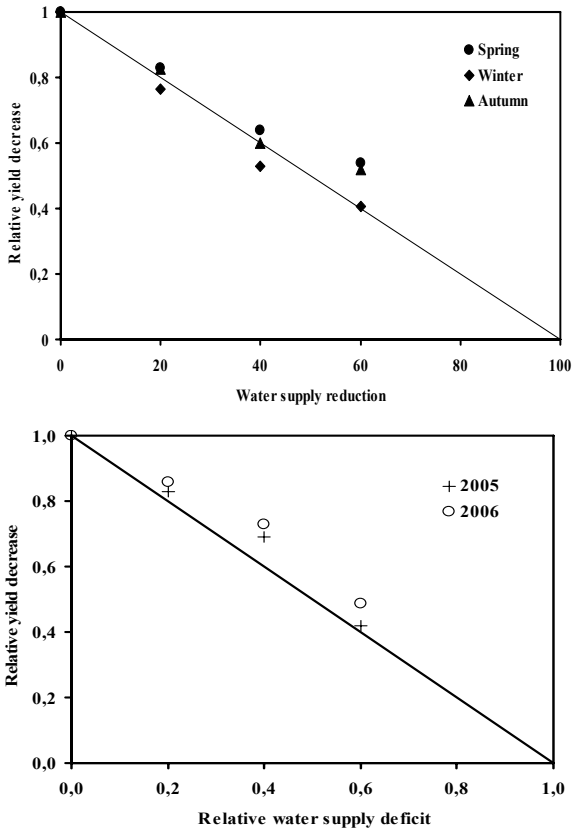


Figure 6. Relative potato and millet yields (Y/Y100-L) decrease in relation to relative water supply deficit.

There were differences between experiments in millet and potato yields. To assess their respective sensitivity to salt, yields data for each experiment were statistically analyzed with a piecewise linear response model (van Genucthen, 1983). The model uses a non-linear least square regression to determine the slope and threshold for the salt tolerance equation. The equation coefficients are given in figure 7. Based on these data it can be stated that under our conditions Yr = 100- 54 (ECe-1.55) for ECe greater than 1.55 dS/m and Yr= 100 for ECe less than 1.55 dS/m for the winter season. The salt tolerance of potato is Yr = 100- 47 (ECe-1.85) for ECe greater than 1.85 dS m^{-1} and Yr= 100 for ECe less than 1.85 dS/m for the autumn season, and Yr=100 - 34(ECe-1.82) for ECe greater than 1.90 dS m^{-1} and Yr=100 for ECe less than 1.9 dS m^{-1} for the spring season.

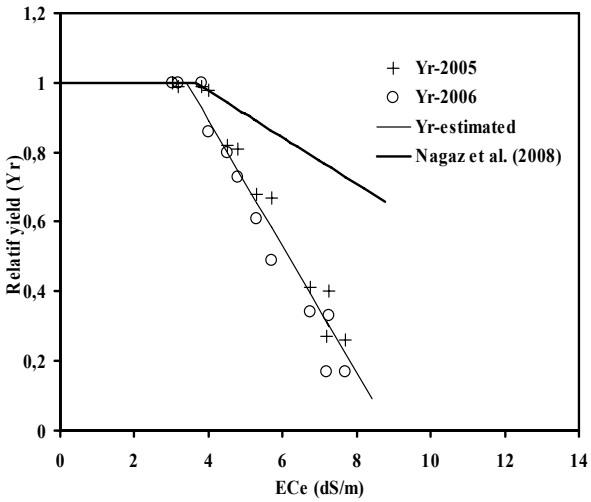


Figure 7. Relative millet grain yield in relation to soil salinity (ECe, dS/m)

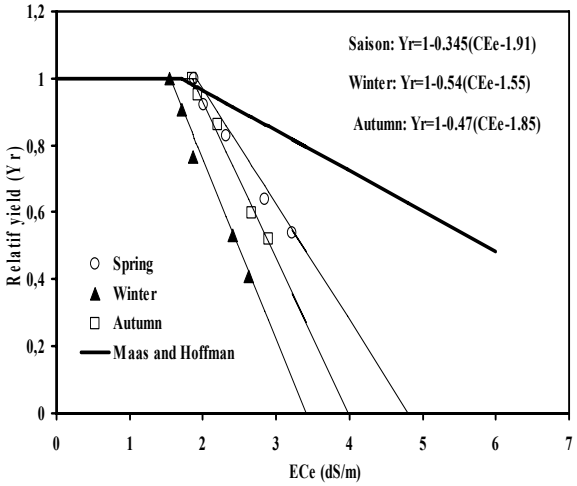


Figure 8. Relative fresh tuber yields in relation to soil salinity (ECe, dS/m)

The analysis outcome indicated that thresholds were nearly the same for both millet experiments. Therefore, both yield sets were combined and analyzed (Figure 8). Based on these data it can be stated that under our conditions Yr = 100- 17 (ECe-3.46) for ECe greater than 3.46 dS/m and Yr= 100 for ECe less than 3.46 dS/m. The threshold is close to the value calculated from published salt tolerance data (3.46 vs. 3.65) but the slope is considerably steeper (17 vs. 6.7) (Nagaz et al., 2008), most likely because of the combined effect of salinity and water deficit for sandy soil in an arid climatic context characterized by a high evaporative demand.

Conclusion

Results of this study indicate that the full irrigation treatment (100-L) decreased the soil salinity beneath the emitter as the zone of salt accumulation moved away from the emitter. Salts were concentrated midway between the emitters and towards the wetting front. Relatively high values of soil salinity were observed beneath the emitter for DI40 and DI60 treatments; whereas, the highest soil salinity occurred at a distance of 7 and 15 cm from the emitter, and 15 and 25 cm, 10 and 20 from the millet and potato drip line, respectively. Millet and potato yields were influenced by

irrigation treatments. For both experiments, yields of deficit irrigated treatments (DII80, DI60 and DI40) were significantly lower than those in full irrigation treatment. The full irrigation treatment produced the highest grain and tuber yields. Treatment DI80 gave also good yields. Note that the deficit irrigation treatments gave lower yields and resulted in higher salinity in the rooting zone than the full irrigation. The higher salinity associated with the deficit irrigation treatments were sufficient to cause reduction in millet and potato yields.

The yield and quality obtained under these treatments do not allow opting for such important reductions. The relatively high yields noted under full irrigation in both experiments indicate the high potential of the potato and millet crops to valorize irrigation waters of limited quality, provided that good management is applied. The results suggest that in the arid Mediterranean conditions of southern Tunisia, Full irrigation strategy is recommended for potato and millet cultivation. Deficit irrigation practices can be a feasible option for improving irrigation schedules and thereby to increase efficient use of restricted water resources. Thus, irrigation of millet could be scheduled using DI80 or DI60 irrigation strategy, but DI80 could be a promising irrigation strategy to potato when irrigation water is limited.

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Comparison of Empirical Models to Estimate Soil Erosion and Sediment Yield in Micro Catchments

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Abstract: Assessment of sediment yield in soil conservation and watershed Project and implementation plan for water and soil resources management is so important. Regarding to somewhere that doesn't have enough information and statistical data such as upper river branches, Empirical models should be used to estimate erosion and sediment yield. However the efficiency and usage of these models before calibration isn't clear. In this research, the measurement of erosion and sediment yield of 10 basins upstream of reservoirshas been estimated by RUSLE and MPSIAC empirical models.In order to compare means between measured and estimated datat-test method was applied.Theresults indicated no significant differences between means of measured and estimated sediment yield in MPSAIC model in 5% level. In contrast, T-test showed contrary results in RUSLE model. Then the applicability and priority of two models were examined by statistical methodssuch as MAE and MBE methods. By regarding to accuracy and precision, MPSIAC model placed in first priorityto estimate soil erosion and sediment yield and has minimum value of MAE=0.79 and MBE = -0.59.
Keywords: Erosion-Sediment models, MPSIAC, RUSLE, Micro Catchments.

Introduction

Soil erosion is the most widely recognized and most common form of land degradation and, therefore, a major cause of falling productivity (Stocking and Murnaghan, 2001). It is a natural process and generally aggravated by human intervention, and exceeds the rate of soil regeneration. Estimating soil erosion and sediment yield needs complete recognize of affected factors, but cognition of these parameters are so difficult because of complexity of soil erosion phenomena.

In recent decades, models have been built (empirical, conceptual, or physically based) in order to represent and to quantify the processes of detachment, transport, and deposition of eroded soil, with the aim of implementing assessment tools for educational, planning, and legislative purposes (Renschler and Harbor, 2002). Since the phenomena are complex and depend on many parameters, calibration of models is difficult, especially because field data are usually not sufficient and relate to small spatial and temporal contexts.

Methods for estimating sediment yieldwere first developedfor the analysis of the effects of agricultural practices. using empirical models to evaluate soil erosion and sediment yield in watersheds without statistical data and information is inevitable. Empirical models have been and are still used because of their simple structure and ease of application. One of the most important problems with empirical models of soil erosion is its lack of accuracy in processing the huge number of data which should be digitalized by GIS system and analyzed by mathematical models MPSIAC is an empirical model to estimate the quantity and quality of sediment. In fact quantifying and digitalizing the sediment data is an important breakthrough in sediment assessment models development (Nearing et al., 1999). This problem could be partially solved by estimating models (Lufafa et al., 2003). Since soil erosion is a product of few different interacting factors, there is not a simple model to assess all the contributing elements in the same time (Daroussin and King, 2001). The Universal Soil Loss Equation (USLE) is the most widely used empirical erosion model (Wischmeier and Smith, 1965). It estimates soil erosion from an area simply as the product of empirical coefficients, which must therefore be accurately evaluated. Originalvalues of such coefficients were derived from field observations in different areas within the eastern part of the U.S., but they have been expanded with time using information gathered by researchers who have applied the USLE (and derived models) in different countries in the world (Renard et al., 1997). The MPSIAC model (PSAIC, 1986) was developed primarily for application in arid and semi-arid areas in the southwestern USA, and is believed to appropriate for the same environmental conditions in Iran (Sadeghi, 1993). Both the MPSIAC and the RUSLE models are factor-based,

which means that a serious of factors, each quantifying one or more processes and their interactions, are combined to yield and overall estimation of soil loss. As a consequence,attention must be paid to the reliability of results whenan application is made outside the range of experimentaland calibration conditions. This research aimed to assess the evaluation of empirical models, MPSIAC and RUSLE, to estimate soil erosion and sediment yield in comparison with measured sediments deposits in basins upstream of reservoirs over West Azerbaijan province, Iran.

Materials and Methods

In this study 10 basins upstream of reservoirs were selected in west Azerbaijan province, Iran. All sediment yields from the reservoirs have been caught and they don't have the time to overflow. The properties of micro catchments presented in table 1.

Table 1. The properties of basins upstream of reservoirs

rows	micro catchments	Drainage Area(ha)	basin perimeter(m)	Basin Length(m)	Basin slope	channel slope	drainage density
1	Ghaziabad	495.6	4008	4008	39.67	11.3	1.1
2	Emamkandi	181.7	2284	2284	50.61	20.9	2.03
3	Rabat	689.2	5690	5690	23.1	7.02	1.24
4	Kulij	780.9	3025	3025	27.24	6.3	1.30
5	Ashtarmol	344.5	1923	4951	23.76	10.9	1.82
6	Silveh	79	3350	3350	11.5	11.1	2.78
7	Khre	117.5	1923	1923	17.00	10.9	1.88
8	reyhanloo	136	2425	2415	10.80	4.9	1.68
9	gharaaghaj	125.8	1024	1024	25.92	13.7	2.06
10	Gulehguleh	122.7	2880	2880	14.72	10.4	3.00

For estimating soil erosion and sediment yield in micro catchments, MPSIAC and RUSLE empirical models were used and factors affecting sedimentation counted and evaluated.

- **The RUSLE model**

RUSLE was developed to incorporate new research since the earlier USLE publication in 1978 (Wischmeier and Smith, 1978). Agriculture Handbook 703 (Renard et al., 1997) is a guide to conservation planning with the RUSLE.

The underlying assumption in the RUSLE is that detachment and deposition are controlled by the sediment content of the flow. The erosion material is not source limited, 34 but the erosion is limited by the carrying capacity of the flow. When the sediment load reaches the carrying capacity of the flow, detachment can no longer occur. Sedimentation must also occur during the receding portion of the hydrograph as the flow rate decreases. The basic form of the RUSLE equation has remained the same, but modifications in several of the factors have changed. Both USLE and RUSLE compute the average annual erosion expected on field slopes and are shown in equation 1.

$$A = R.K.L.S.C.P \quad \text{(Eq. 1)}$$

Where: R is the rainfall factor, computed on the basis of rainfall energy and the maximum 30-min intensity of a rainfall, K is the soil erodibility factor, which is function of soil characteristics; L is the slope length factor, S is the slope steepness factor; C is the cropping-management factor, that is function of land use type, and P is the erosion-control practice factor (usually contours, strip cropping, or terraces).However, significant changes to the algorithms used to calculate the factors have been made in the RUSLE (Renard et al., 1994). The *R* factor has been expanded to include the Western United States and corrections made to account for rainfall on ponded water. RUSLE to be applied at smaller time scales.

- **The MPSIAC model**

This model was created to estimate the soil erosion according to nine factors consisting of, geological characteristics, soil, climate, runoff, topography, vegetation cover, land use and present soil erosion (PSIAC, 1968).Johnson and Gembhart(1982) improved the original model to have a more accurate estimate of the sedimentation (equation, 2).

(Eq. 2)

Where: Qs= sedimentation (t/ha/year), R= sedimentation rate, e = 2.718.

The relationship between soil erosion and sedimentation in MPSIAC model and the specific erosion in MPSIAC model is calculated by SDR Coefficient (Sediment Delivery Ratio) by the following equation 3.

(Eq. 3)

Where: A= the area of watershed (mail^2)

Table2: The effective factors and their points calculation formula in MPSIAC model

The effective factors	The points calculation formula	Explanation Parameter
Geology	Y1=X1	X1: stone sensitive point
Soil	Y2=26.67K	K : erodibility factor in USLE
Climate	Y3=0.2X3	X3 : precipitation intensity with 2 year interval return
Runoff	Y4=0.006R+10Qp	R : annual runoff depth (mm), Qp:annual specific discharge
Topography	Y5=0.33S	S : average watershed slope (%)
Land vegetation cover	Y6=0.2X6	X6 : bare soil (%)
Land use	Y7=20-0.2X7	X7 : canopy cover (%)
Surface erosion	Y8=0.25X8	X8 : points summation in BLM model
Gully erosion	Y9=1.67X9	X9 : point of Gully erosion in BLM model

Sediment yield of basins upstream of reservoirs was determined by mapping. For this purpose, over sediment reservoirs divided to equal networks and depth of sediment in each of the intersection points of the network through the reservoir was measured by borehole and auger. The volume of sedimentation obtained by topography maps. Than to determine the weight of sediments, specific bulk density of sediments was obtained by digging in few points in several depth of soil profile. Finally the weight of deposits obtained from multiplying of specific bulk density and the volume.
For comparison the estimated amount of sediment yield of empirical models with measured in the reservoirst-student test was used. To evaluate empirical models, two MAE and MBE statistical parameters were used. MAE is an indicator of error in the results and MBE indicates the biass of the results obtained through the applied models. When MAE and MBE are 0.00 or near to naught, the applied model simulates the fact well. However, as far as its amount is farther than 0.00, it implies to less precise and more bias. How the parameters MAE and ME are calculated, has been indicated as follow:

$$MBE = \frac{\sum_{i=1}^{n}(Rs - Ro)}{n} \quad \text{(Eq. 4)}$$

$$MAE = (\Sigma_i(1=1)^{\uparrow}n \blacksquare |Rs - |\text{-}Ro\text{-}|\,|\text{-}|\,)/n \quad \text{(Eq. 5)}$$

Where: R_s is the estimated value, R_o is the measured value and N is No. of the data.

Results and Discussions

Shapiro-wilk test conducted to see if the data were of normal distribution, indicated that the data of measured sediment yield were normal and coefficient was less than 0.05 and skewness coefficient less than 1.Results of measured sediment yield in each of basins upstream of reservoirs presented in table 2. Specific sediment yield for all micro catchments showed the minimum sedimentation inKhere micro catchment with 0.274 m^3/ ha/ year and maximum specific sediment yield in Rehanloo micro catchment with 12.04 m^3/ ha/ year.

Table 3. Measured sediment yield in basins upstream of reservoirs

Micro catchments	Total sedimentation(m3/ha/yr)	Annual sedimentation(m3/ha/yr)	Specific sediment rate(m3/ha/yr)
Ghaziabad	3051	399	0.68
Emamkandi	1316	188	1.03
Rabat	6727	1121.2	1.62
Kulij	4183	380.3	0.487
Ashtarmol	4597	574.6	1.67
Silveh	620	77.5	0.98
Khre	355	32.27	0.274
reyhanloo	13100	1637.5	12.04
gharaaghaj	5019	456	3.62
Gulehguleh	1470	210	1.71

The points of effective factors on sedimentation MPSIAC and RUSLE model for micro catchments shown in table 4 and 5.Results of table 3 showed that minimum sedimentation is 1.12 m^3/ ha/ year in Ashtarmol micro catchment and maximum sedimentation is 4.21 m^3/ ha/ year in Rehanloo basin. The correlation coefficient of sedimentation between estimated and measured values in MPSIAC model is 0.91. T-test results between estimated data in MPSIAC model and measured one equal to 0.48 and indicated no significant difference in 5% level. According to RUSLE model, minimum sediment yield equal to 0.79m^3/ ha/ year for Silveh micro catchment and the maximum is 7.52 m^3/ ha/ year in Ghaziabad basin. In RUSLE model the correlation coefficient between measured and estimated data is -.031 and shows negative relation.
Based on the information presented in table 5, it is confirmed that MPSIAC model with the lowest MAE and MBE(MAE=0.79 and MBE = -0.59) would be the most superior model to estimate soil erosion and sediment yield in micro catchments.

Table 4. Evaluation points for nine affecting factors in MPSIAC model in basins upstream of reservoirs

factor	Micro catchments									
	Ghaziabad	Emamkandi	Rabat	Kulij	Ashtarmol	Silve	Khre	Reyhanloo	Gharaaghaj	Gulegule
Geology	4.5	4.80	5.5	4.00	4.10	4.00	4.50	7.40	6.60	5.50
Soil	5.33	5.00	5.17	6.83	4.67	6.83	5.67	6.67	5.83	7.17
Climate	0.61	0.72	0.65	0.65	0.65	0.65	0.72	0.37	0.72	0.47
Runoff	8.98	10.84	6.86	8.29	9.95	10.19	10.96	11.09	10.86	7.72
Topography	13.06	16.70	5.38	8.97	7.82	3.79	5.61	2.61	8.54	4.85
Land vegetation cover	13.00	11.80	8.20	11.00	8.00	8.00	13.00	15.00	16.00	12.00
Land use	5.00	9.34	6.60	4.40	5.40	6.00	5.00	9.00	11.00	6.00
Surface erosion	7.75	9.00	11.00	7.75	10.25	9.00	8.25	17.25	13.25	11.00
Present soil erosion	1.68	1.67	6.68	3.34	1.67	6.68	1.67	20.04	6.68	5.01
Sediment rate	5.93	69.86	59.03	55.24	52.50	55.15	55.38	89.04	79.48	59.72
Sediment yield (m3/ha/yr)	1.46	2.09	1.27	1.23	1.12	1.22	1.24	4.21	2.95	1.45
Sediment yield (t/ha/yr)	2.18	3.13	1.9	1.84	1.67	1.84	1.86	6.3	4.42	2.17

Table 5. Evaluation points of six factors in RUSLE model in basins upstream of reservoirs

factors	Micro catchments									
	Ghaziabad	Emamkandi	Rabat	Kulij	Ashtarmol	Silve	Khre	Reyhanloo	Gharaaghaj	Gulegule
R	27.09	24.45	49.85	24.75	50.56	24.22	30.80	26.55	25.19	24.93
K	5.33	5.00	5.17	6.83	4.67	6.83	5.67	6.67	5.83	7.17
LS	26.35	24.75	18.30	16.23	21.88	10.90	17.50	12.64	18.13	10.91
C	0.45	0.4	0.2	0.23	0.2	0.2	0.44	0.4	0.56	0.35
P	1	1	1	1	1	1	1	1	1	1
Erosion rate(m3/ha/yr)	13.19	9.31	7.25	4.86	7.94	2.78	10.34	6.88	11.48	5.25

Based on the information presented in table 6 and 7 has been indicated that the correlation coefficient between measured and estimated data obtained 0.91 in MPSIAC model and the t-test results become 0.48, indicated there was no significant difference in 5% level. In contrast, T-test showed contrary results in RUSLE model.

Table 6. The correlation coefficient and significant difference test in MPSIAC and RUSLE models

Pairs	Models	N	Correlation	Sig.
Pair 1	MEAS & PSIAC	10	0.91	.000
Pair 2	MEAS & RUSLE	10	0.13	0.972

Table 7. The t-test results in MPSIAC and RUSLE models

pairs	Models	Paired Differences Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Pair 1	MEAS - PSIAC	0.62	2.73	0.86	0.72	9	0.48
Pair 2	MEAS - RUSLE	-3.66	4.38	1,33	-2.64	9	0.027

According to the information presented in table 8, it is confirmed that MPSIAC model with an error rate -.59 and bias rate 0.79 is more preciseness for the estimation of sediment yield, while RUSLE model is more bias compared to MPSIAC model, therefore considering the preciseness and bias in MAE and MBE, MPSIAC model would be the most superior model. The rate of bias and preciseness has been shown in table 8 and 9.

Table 8. The error and bias values in MPSIAC model to estimate sediment yield

Micro catchments	Measured sediment yield	Estimated sediment yield	MAE	MBE
Ghaziabad	0.68	3.15	0.78	0.78
Emamkandi	1.03	4.64	1.06	1.06
Rabat	1.62	2.85	0.16	-0.35
Kulij	0.49	2.72	0.74	0.74
Ashtarmol	1.67	2.62	0.38	-.055
Silveh	0.98	2.62	0.24	0.24
Khre	0.27	2.59	0.97	0.97
reyhanloo	12.04	8.97	3.3	-7.83
gharaaghaj	3.62	4.73	0.22	-0.67
Gulehguleh	1.71	3.13	0.04	-0.26
Total results of MAE and MBE value			0.79	-0.59

Table 9. The error and bias values in RUSLE model to estimate sediment yield

Micro catchments	Measured sediment yield	Estimated sediment yield	MAE	MBE
Ghaziabad	0.68	3.29	3.97	2.12
Emamkandi	1.03	3.10	1.77	1.4
Rabat	1.62	9.07	1.61	7.27
Kulij	0.49	6.45	1.34	5.83
Ashtarmol	1.67	3.95	4.65	1.56
Silveh	0.98	2.58	0.72	0.72
Khre	0.27	2.60	8.61	1.55
reyhanloo	12.04	12.73	3.04	-3.04
gharaaghaj	3.62	9.42	1.19	3.58
Gulehguleh	1.71	6.61	5.49	2.94
Total results of MAE and MBE value			3.24	2.39

The results obtained with the present investigation, namely the selection and recommendation of MPSIAC empirical model are agreed with those published by Renard et al., (1997) and Rahmani et al., (2006). Studying on soil erosion and sediment yield in micro catchments showed Khre and Rehanloo sub basins have minimum and maximum annual sediment yield respectively. Khre sub basin with pasture land use and sandstone lithology has minimum sediment yield (0.247 m3/ha/yr) and Rehanloo with land use under cultivation and Marn lithology has maximum sediment yield(12.04 m3/ha/yr). This variation of sediment yield based on land use and lithology, they are two base factors affected soil erosion and sediment yield. This results are Compatibility with those published by Rastgoo(2007) and Rahmani et al.,(2006). Essential performances to control soil

erosion in micro catchments are forest and pasture reclamation, accurate tillage, restricts burning herbaceous leftovers and terracing gradient area. The relation between estimated sediment yield in MPSIAC model and measured one (%91) indicated MPSIAC model has high capability to assess soil erosion and sediment yield in basins upstream reservoirs

This research totally showed MPSIAC empirical model has the capability to estimate soil erosion and sediment yield in micro catchments. The results of this model can be used for schematization and watershed project with high accuracy and precision.

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Relationships among environmental factors influencing soil erosion using GIS (Khiav Chay Watershed, Ardabil Province)

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Abstract
One of the biggest problems of natural resources is soil erosion. Effective land management to prevent soil loss requires prediction for large areas. Usually, empirical relations are used for investigating soil erosion in watershed areas. The case study is took place in Khiav Chay Watershed, Ardabil Province. In the current study, environmental factors, influence in water erosion of the area, investigated in four categories, including topographic, soil & ground, vegetation and human factors. From environmental factors influencing soil erosion, NDVI, land use and drainage density were studied and related maps produced and compared in two time series using aerial photos (1968) and satellite images (2007). For estimating specific erosion, EPM model was used. Work unit map was made and crossed with environmental factors map as independent variables (NDVI, land use and drainage density) and specific erosion map as a dependent variable and then effective areas of each parameters specified. Using regression models obtained specific erosion equations for two time sequences as multiple regressions.
Keywords: Soil erosion, environmental factor, EPM, GIS

Introduction

Soil erosion by water is the most important land degradation problem worldwide (Eswaran et al., 2001). Water erosion is controlled by climatic characteristics, topography, soil properties, vegetation, and land management. Detachment of soil material is caused by raindrop impact and drag force of running water. Detached particles are transported by overland flow (sheet- or interrill erosion) and concentrated flow (rill erosion) and deposited when flow velocity decreases (Lal, 2001). Gullies can develop as enlarged rills, but their genesis is generally more complex, involving sub-surface flows and sidewall processes (Bocco, 1991).
Satellite images and the parameters derived from their composite bands such as Normalized Difference Vegetation Index (*NDVI*) (Momeny and Saradjian, 2007 and Jong *et al*, 1999) and Geographic Information System (GIS) are used so widespread in the soil erosion researches (King *et al*, 2005; Bou Kheir *et al*, 2006 and Miller et al, 2007).
In the study area, due to high precipitation and high slope probably and geological situation in the region, various types of water erosion is seen. Thus the aim of this research is to find the relationships among environmental factors influencing soil erosion in Khiav Chay watershed and estimates of water erosion in two time series and compare them with each other to evaluate the erosion risk.

Materials and methods

The study area is located in the southeastern regions of Sabalan Mountain in Ardabil Province between longitudes 47°-38' to 47°-50' and latitudes 38°-12' to 38°-32'. It covers approximately 800 km^2 with 2325 m.s.l of mean elevation. The mean annual precipitation is 400-60 mm, increasing with elevation. The outlet of watershed is connected to Gara su river and discharge of all runoff is through this way.

Research for this study was as follows:

1- Investigation of variable environmental factors causing water erosion in 1968 and 2007

Vegetation cover, land use and drainage density are three important variable factors affecting the soil erosion which studied in this research.

1-1 Vegetation cover

Vegetation cover is one of the very changeable factors during the time. During 39 years (1968-2007), vegetation cover has been changed spatially and has been decreased remarkably. Study of vegetation cover condition has been done via aerial photos, satellite images and *NDVI*.

Vegetation maps were prepared in two time series, in the first section(1968) using aerial photos and in the second section (2007) using satellite image, GIS software and remote sensing capabilities to reach out.

Prepared NDVI for the region was calculated and classifieds according to equation [1] which was performed by using GIS and ILWIS software, bands 3 and 4 of Landsat images and "NDVI" algorithm.

$$NDVI = \frac{ETM\,4 - ETM\,3}{ETM\,4 + ETM\,3} \qquad [1]$$

where ETM3 and ETM4 is respectively visible (red) and near-infrared region in Landsat images. This relatively simply algorithm produces output values in the range of -1.0 to 1.0. Increasing positive NDVI values, shown in increasing shades of green on the images, indicate increasing amounts of green vegetation. NDVI values near zero and decreasing negative values indicate non-vegetated features such as barren surfaces (rock and soil) and water, snow, ice, and clouds.

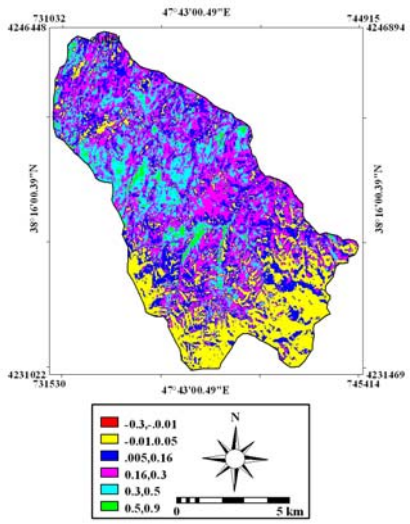


Figure 1. NDVI map (1968)

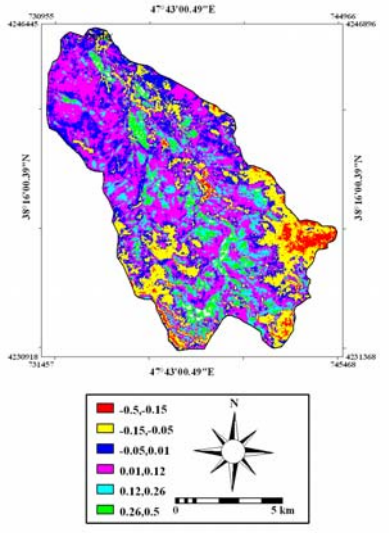


Figure 2. NDVI map (2007)

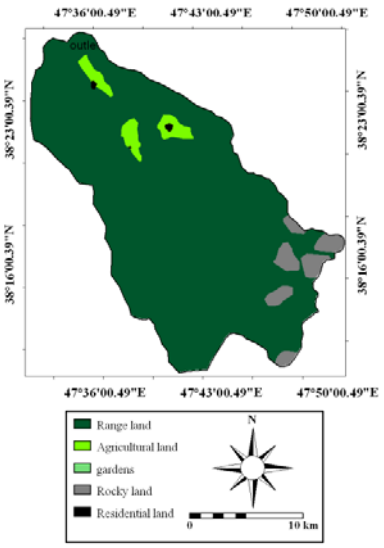


Figure 3. Land use map (1968)

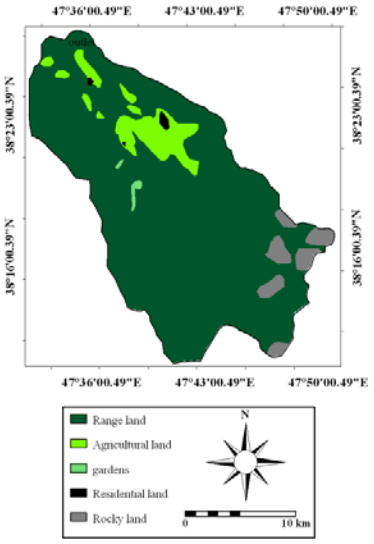


Figure 4. Land use map (1968)

2-1 Land use

Land use describes the various ways in which human beings make use of and manage the land and its resources. The study of land use changes in two time sections 1968 and 2006 was done. Land use maps in 1968 were prepared from the aerial photos at a scale of 1:20,000 and in 2006 were generated by the use of satellite images, Landsat Enhanced Thematic Mapper (ETM+) data, and five different users like as range land, agricultural land, gardens, residential and rocky land were derived.

3-1 drainage density

Drainage density is the total length of all the streams and rivers in a drainage basin divided by the total area of the drainage basin. It is a measure of how well or how poorly a watershed is drained by stream channels. It is equal to the reciprocal of the constant of channel maintenance and equal to the reciprocal of two times the length of overland flow. Drainage density maps in two time sections1968 and 2006 were prepared by using topographic map (1:50,000 scale, 20 m contour interval), aerial photos and satellite images in GIS environment.

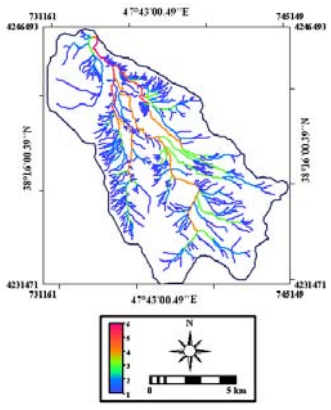


Figure 5. Drainage density map (1968)

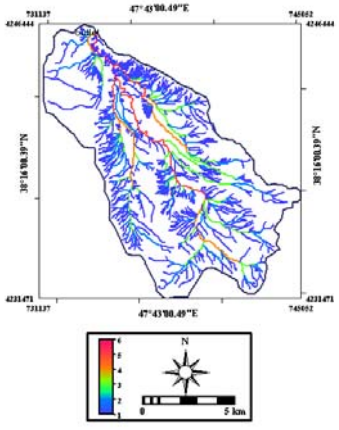


Figure 6. Drainage density map (2007)

2- Assessment of soil erosion by using EPM model

The erosion potential method is a model for qualifying the erosion severity and estimating the total annual sediment yield of a catchment area. This model is initially developed in Yugoslavia by Gavrilovic (1988). EPM considers six factors such as; surface geology and soils, topographic features, climate (including mean annual rainfall and mean annual temperature) and land use. From these factors; exposed rock and soil, topography and climate are limited in natural class, but land use effect is depended on the human activities. The erosion potential method calculates the coefficient of erosion and sediment yield (Z) of a catchment area using the following equation:

$$Z = y * Xa * (\psi + I^{0.5}) \quad [2]$$

Where, *y,* is the coefficient of rock and soil resistance, from 2.0 to 0.25; *Xa,* is the land use coefficient, from 1.0 to 0.05; *Ψ,* is the coefficient value for the observed erosion processes, from 1.0 to 0.1, based on the severity of erosion. The factor *I* is the average land slope in percentage (Solaimani, 2007). For sediment production, the following equation was used:

$$Wsp = T * H * \pi * Z^{1.5} \quad [3]$$

Where, *Wsp,* is the average annual specific production of sediment per m3/km2/y, *T* is temperature coefficient, which is calculated as:

$$T = (t/10 + 0.1)^{0.5} \quad [4]$$

With t = the mean annual temperature in degrees Celsius, *H* = the mean annual amount of precipitation in mm/y, and *Z is* the coefficient of erosion which was calculated from Eq. 2.

3- Comparison of soil erosion's result in two time sections

At this stage, soil erosion's result in two time sections were compared and changes were determined.

Results

According to analyzes of land use maps in mentioned two time sections, the percentage of range land in 1968 (92.23%) has changed to 88.25% in 2006. Agricultural land has been changed from 2.7% in 1968 to 6.8% in 2006 and residential land due to 39 years increase from 0.16% to 0.33% which is show that during the last 40 years with increasing population, residential land increased and range land decreased.

Drainage density in 1968 was 2.96 km/km^2 whereas this parameter was increased to 4.16 km/km^2 in 2006 that represents an increase of erosion as rill erosion in the area.

The results of the risk of erosion (Z coefficient in EPM model) showed that in 1986, 46.03% of lands were in class of very severe erosion, 30.92% in severe erosion class, 18.4% in mediocre class, 2.47% in low erosion class and 2.16% in very low erosion class. In 2006 45.01% of lands were in class of very severe erosion, 31.25% in severe erosion class, 18.08% in mediocre class, 2.33% in low erosion class and 2.22% in very low erosion class and comparison of erosion intensity in mentioned times showed that amount of erosion during the time has increased.

By placing prepared maps in the erosion equation, specific erosion map in two time section obtained and amount of specific erosion in these times calculated (figure 7and 8).

According to figure 7and 8 determined that amount of specific erosion in 1968 was 2237.49 m^3/km^2.yr while this amount in 2006 has increased to 12252.44 m^3/km^2.yr.

Discussion

Study of environmental factors and water erosion changes during the 39 years showed the remarkable variations in spatially distribution patterns of erosion types In most times, because of need to studying as time series and for its problems, these factors are studied incompletely, while we must regard to their inherent variability during the time. Factors of vegetation cover, land use and drainage density are very changeable in the study area that cause remarkable variations in the area percentage of each water

erosion types. In the study area, during the time, the drainage density factor has been increased and with its increasing, the percentages of each type of water erosions have been increased, too. According to decreasing of vegetation density, sheet and rill erosions have been increased, but no well-defined relations were detected in channel and riverbank erosions. Also, land use type and its changes during the time, had been a significant rule in formation of different types of water erosions. This study showed that using GIS and RS capabilities with together and applying them in related with the time variations, could help effectively in studying water erosion and land management.

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Topographic Threshold Conditions for Initiation of Gully Erosion in the Reyhanlou Region of West Azerbaijan- Iran

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Abstract

Soil is one of the most important natural resources of each country. Recently, soil erosion is considered as a threat to human welfare and even his life. Gully erosion is one the major kind of soil erosion and it causes to loss the significant amounts of the soil in different climate and produce abundant quantities of sediment. However, no studies, have attempted to analyses under which conditions gully erosion in West Azerbaijan is initiated. For this reason this study was conducted to determine topographical threshold of gully initiation in Reyhanlou region. For this reason 20 gullies in study area were selected. Boundaries of the gullies and gullies drainage-basins were delimited using aerial photographs (1:40000), topographic maps (1:25000) and global positioning system (GPS). Mean slope of gullies drainage-basins (S, %) and gullies drainage-basins areas (A, m^2) at the point of gullies initiation were determined by Arc-GIS software using topographic maps. Results showed that in Reyhanlou region, seepage and subsurface processes are responsible for gully ignition. However in this region there were direct relation ($S=3.82A^{0.187}$) between mean slope of gullies drainage-basins and gullies drainage-basins areas (S-A). Therefore it can be implied that exponent in S-A relation is controlled by sub surface erosion process.

Keywords: Gully erosion, Subsurface runoff, Topographic threshold

Introduction

Gullies are formed by water erosion and consist of several characteristics including a steep incised channel with an active head cut, unstable side wall and temporary water flow (Nordstrom, 1988; Poesen et al., 2003). More than 60% of Iran's area is located in arid and semi-arid regions, with about 100 million ha at high risk of desertification (Ahmadi, 2004). Gully erosion in dry-land regions of Iran, is the main responsible factor for degradation of arable lands and construction. Despite the importance of gully erosion in arid and semi-arid regions of Iran no study has been conducted to understand the threshold conditions of gully incipient (Nazari samani, 2008). Surface runoff, soil freezing, melting of the gully head and water seepage are the factor of the gully head expansion in the Saskatoon and Saskatchewan catchments (Archibold et al., 2003).

The slope is one of the most important factors in determining the topographic threshold conditions for Initiation of gully erosion. If other conditions being similar, steep slopes (of course some degree of slope), provide more erosion. Because on steep slopes the water is flowing down more quickly and therefore kinetic energy and the erode power of it, will be more. Zakhar (1982) reports that most gullies are made up in slope 17 %, and 90 percent in slope 2.5 to 27 %, in Czechoslovakia. According to Vandaele et al. (1996) topographic Threshold equation is Exponential for gully erosion. This relationship between area and upper slope of the gully head is $S = \alpha A^{\beta}$, where α and β are empirical coefficients.

Exponent β is controlled by erosion process and, possibly, predominated mechanisms of incipient gullying, i.e. overland flow, land sliding and seepage, whereas the influence of the methods used to assess A and S as well as characteristics of study areas are believed to be reflected in the value of constant α (Vandaele et al., 1996, Poesen et al., 2003). Values of $\beta \geq 0.2$ in the S–A relationship are generally associated with erosion by overland flow, while values $\beta < 0.2$ may indicate subsurface processes and mass movement (Montgomery and Dietrich, 1994).

The aims of this research were to study gullying processes by using threshold S-A relationship and evaluation of the effects of processes controlling incipient gullying on topography threshold condition in the north west of Iran.

1. Study area

Reyhanlou is located in the north west of Azerbaijan province in Iran (39□ 05' N & 44□ 21' E). The study regions area is about 16 Km^2 (Fig. 1).

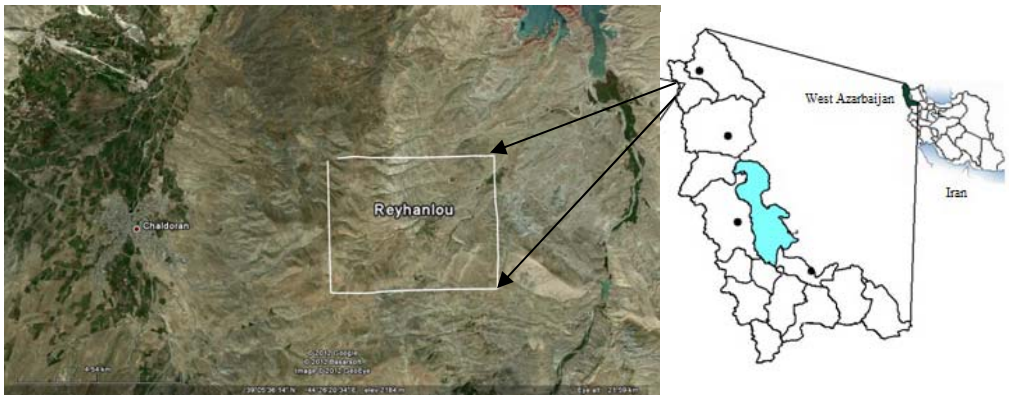


Figure 1: Reyhanlou of West Azerbaijan province – Iran

The Study area includes semiarid climates. according to data from the nearest weather station at Baron (5 km to the north), in this region rainfall is uniformly distributed throughout the year with an annual mean of 380 mm; minimum and maximum temperatures are -20 °C and 29 °C, respectively.

Reyhanlou region topographic condition is composed of four geomorphologic units: 1) The western highlands, 2) Central flat section, 3) South rugged section, and 4) The eastern highlands. Digital elevation model of this region is shown in Figure (2).

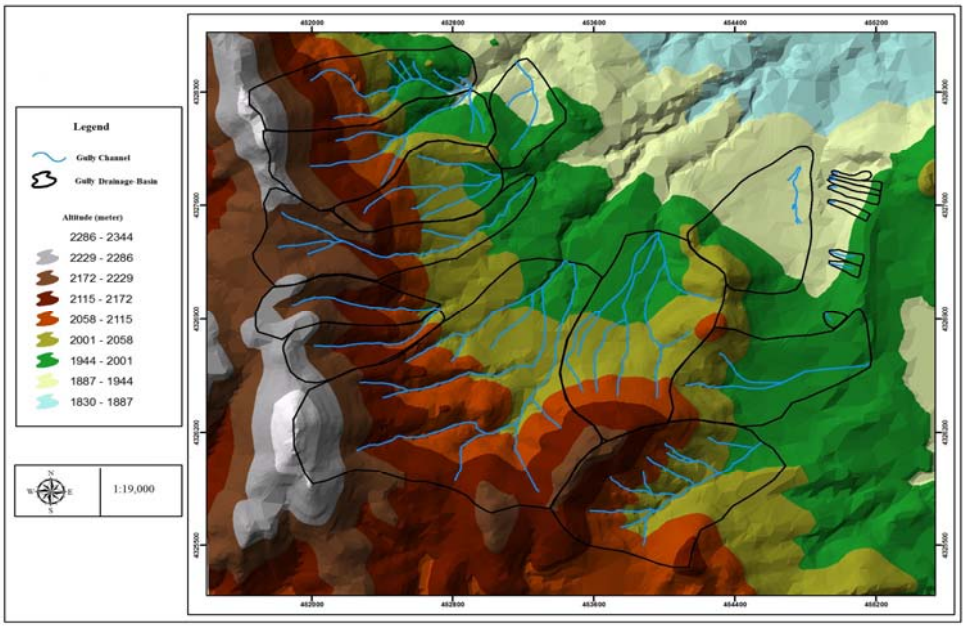


Figure 2: Topography map of study area

2. Methodology

Among characteristics that have been considered in the creation of gully erosion are the topographic characteristics of the study area. To determine topographical threshold of gully initiation in Reyhanlou region, 20 gullies were selected. Boundaries of the gullies and gullies drainage-basins were delimited using aerial photographs (1:40000), topographic maps (1:25000) and global positioning system (GPS). Mean slope of gullies drainage-basins (S, %) and gullies drainage-basins areas (A, m^2) at the point of gullies initiation were determined by Arc-GIS software using topographic maps. Perimeter and length of gully were determined by Google-Earth software.

All of the collected data obtained from field studies were transferred to spreadsheet and Geographic Information System (GIS) to extract the gully channel network map with high accuracy. The further analysis of these data was based upon the ($S= \alpha A^{\beta}$) relationship introduced by Vandaele et al. (1996), Desmet et al. (1999) and Vandekerchkhove et al. (2000).

3. Results and Discussion

Gully erosion process is often activated in this study area (Figs. 3, 4, 5 and 6). Some of gullies head were cavernous (Fig. 3), that showed gully head extension process is active by groundwater seepage (Ahmadi, 2006). In this region crevice tunneling process due to seepage can be observed (Fig. 4). Some of the gullies head was curved (Fig. 5), indicating that the surface runoff is effective in gully extension (Balandeh, 2011).



Figure 3: Gully head was cavernous & extension by groundwater seepage



Figure 4: Gully head crevice tunneling



Figure 5: Gully head curved & extension by seepage & Surface runoff

Although Ahmadi (2007) stated that gully erosion is created on up to maximum 15% of slopes, But mean slope of the drainage-basins of most gullies in this region have the slope of 20-25 % (Fig. 6). Slopes over 20% that are more prone to gully erosion, are seen in two section namley in the rugged western and southern highlands of the study area. Central flat section is seen without the risks associated with gullying.

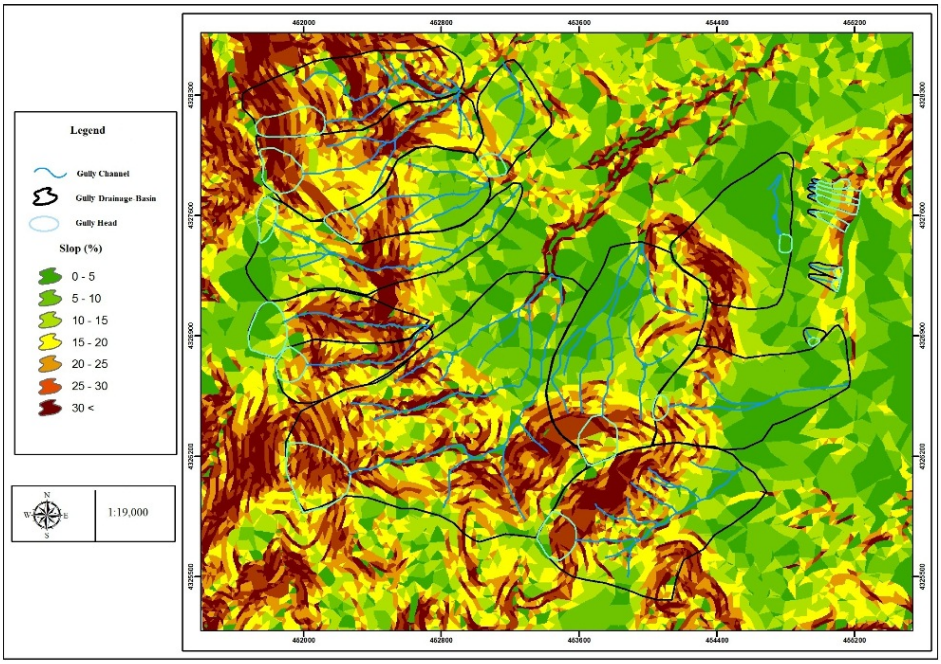


Figure 6: channel, drainage-Basin, Head and Slope map of Gullies in study area

The average values of the gully morphological descriptors presented in Table 1. As shown in Table1 gullies were continuous and occurred in drainage-basins areas ranging in size from 9100 to 106300 m^2. Gullies length varied from 45 to 2620 m and perimeter 179 to 1251 m. Gullies were 'V' shaped in profile (Fig. 7).



Figure 7: 'V' shaped gullies in profile

Table 1: Gully morphologic descriptors and topographic attributes for sub-catchments of gullies

Gully Number	Gully Perimeter (m)	Gully Length	Gullies drainage-basins areas (A, m^2)	Mean slope of gullies drainage-basins (S, %)
1	431	45	6325	21.60
2	597	45	8875	26.99
3	572	63	8675	22.67
4	582	65	12150	24.64
5	481	33	9100	27.81
6	866	751	53850	9.74
7	596	800	26450	25.47
8	1251	2620	109300	38.35
9	825	1340	50000	33.50
10	783	1250	45050	32.95
11	384	1320	10275	29.96
12	192	157	2425	22.82
13	196	145	2500	28.39
14	179	64	2300	8.64
15	463	645	15375	18.42
16	310	440	6775	6.56
17	599	1042	24100	33.40
18	632	1855	22350	16.03
19	828	1025	47800	43.18
20	977	920	52750	40.93
Average	**587.2**	**731.25**	**25821.25**	**25.60**

Results also showed that gullies occurring in the rangelands that were dominated by overland flow had the strongest S−.A relationship while land sliding dominated gullies did not have a statistically significant S−.A relationship. In comparison to theoretical and literature based relationships for gully initiation, relatively low values for β were obtained (0.187), possibly influenced by the presence of seepage and subsurface processes in many gullies.
In this research the following equation was obtained:

$$S=3.82\ A^{0.187} \qquad \text{(Eq. 1)}$$

In this region there were direct relation (Eq. 1) between mean slope of gullies drainage-basins (S) and gullies drainage-basins areas (A) (Fig. 8).

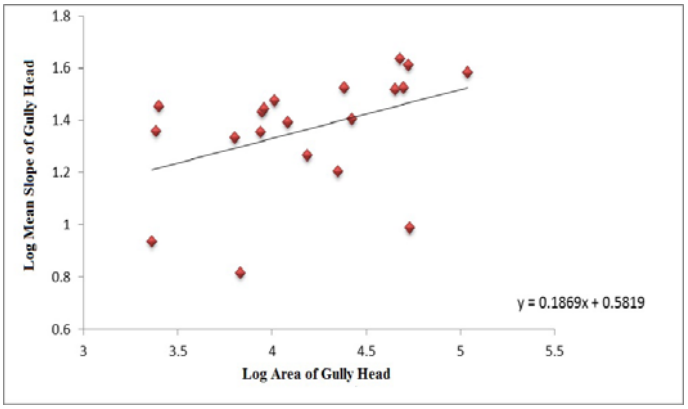


Figure 8: Relationship of mean slop and area of gully head in study region

The values of exponent β are much lower than the value of 0.5 proposed to indicate gully erosion (Montgomery and Dietrich, 1994). Therefore it can be implied that exponent in S-A relation is controlled by subsurface erosion process. Result showed that in Reyhanlou region, seepage and subsurface processes are responsible for gully initiation.

The low β values for the Reyhanlou gullies must either be interpreted as a response to the increasing importance of seepage in the later stages of gully evolution or the inference that they reflect subsurface processes.

Acknowledgment

Author wants to thank the Consultant Engineering Company Ab-Andishan-Azar (Tabriz) for their efforts and cooperation.

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Aggregate stability as an indicator of soil crusting, soil erodibility and erosion

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Abstract

In an attempt to assess soil, we use the most frequent tests such as structural stability or rain simulation. This paper presents a recent method that consists in three tests corresponding to various initial conditions and energy levels: fast wetting, slow wetting and wet stirrings. Particle sizes distribution after breakdown is measured and the Mean Weight Diameter is calculated. The results of the tests, for various Chelifian soils plain region where compared to the indices of instability and to the infiltration measurement under simulated rainfall. The method gives a good ranking of the soil and a good description of the soil behaviors under rainfall.

The particle size distribution allows for predicting the structural deterioration and erosion risks. According to these tests, it has been revealed an example of application of this method to the study of the role of a mineral conditioner on aggregate stability. The result shows that the conditioners reduce both the breakdowns by slaking, micro cracking and by raindrop impact.

Key words: Aggregate stability, crusting, erosion, conditioner and methodology.

1 – Introduction

There are numerous internationally methods for measuring soil structural stability. In fact, it is a fundamental property of the soil for many aspects of their behaviour particularly regarding hydrodynamics and erosion (Al-Durrah and Bradford, 1982 ; Boiffin, 1984 ; Le Souder, 1990 ; Hairsine and Rose, 1991 ; Fies and Panini, 1995 ; Saidi, 1992). However, the complexity of the mechanisms and the number of parameters show that there is some confusion regarding the process of structural degradation and its relationship to soil erosion. The purpose of this study is to analyze the relationship between the degradation, the crusting and sensitivity to soil erosion, after a theoretical review on the mechanisms of desegregation and the parameters that influence it. It then examines the various tests of the existing method which is used for all examples of the use and the developments of this method will be then presented.

2 - The mechanisms of desegregation and interactions with crusting, infiltration and erosion

The breakdown by water resulting from different physical mechanisms and physico-chemical and can affect different levels of soil structure from the interactions between clay particles to the clods. We can identify four main mechanisms (The Bissonnais, 1988): (1) the slaking, ie the breakdown by compression of the air trapped during wetting (2) the mechanical disintegration under the impact of the raindrops, (3) microcracking by differential swelling, (4) physicochemical dispersion.

Soil characteristics that affect soil stability, most often mentioned are texture, organic matter content, clay mineralogy, cations, particularly sodium, iron oxides and aluminum carbonates calcium (Boiffin, 1984 ; Le Bissonnais, 1988 ; Le Souder, 1990 ; Saidi, 1992 ; Saidi *et al*., 2004), with many possible interactions between parameters that should be considered in interpreting the results. The crusts are the result of structural reorganization in situ fragments and particles produced by slaking and mechanical breakdown by raindrops, without significant displacement ore size granulometric. Sedimentary crusts or deposits crusts resulting from a shift and a segregation of particles in the presence of excess water (runoff and water standing).

The mechanisms involved are essentially the dispersion and mechanical breakdown. The important role of the fragments and particles of size <100 microns in reducing infiltrability has been shown (Loch, 1989; The Bissonnais, 1990). In addition, the particle size resulting from the disintegration also determines their ability to be transported by runoff (Le Souder, 1990).

3 - Description of the method

The aim of the method is to give a realistic description of the behavior of soils subjected to the action of rain, and allow a relative ranking of materials vis-à-vis the behavior.

The methodology is largely inspired by the classic test of Henin *et al.*, (1958). The three proposed tests are intended to account for this behavior in the different climatic conditions, structural and water that may be encountered at the soil surface. The method is the one proposed by Le Bissonnais (1995). We recall the main lines:
The sample is air dried and sieved aggregates 3 to 5 mm are selected for testing.
Treatment 1 (fast wetting by immersion) permits to test the behavior of dry materials subject to wetting brutal type of flood irrigation, or heavy rain (storm of spring and summer). **Treatment 2** (slow wetting by capillarity) permits to test the behavior of low humidity or dry materials subjected to moderate rains. It is less destructive than wetness faster and therefore allows discriminating soils very unstable. **Treatment 3** (mechanical disintegration by agitation after rewetting) permits to test the behavior of wet material (wet winter periods). We measured for each treatment, the size distribution of resulting particles (DTPR) (> 2 mm, 1 mm, 0.6 mm, 0.2 mm, 0.1mm and <0.1mm). Then we calculated the mean weight diameter after breakdown (MWD) for each tests (value between 0.05 mm and 4 mm). We can also make the average of three MWD tests, to have a synthetic value. For this method, we can also calculate indices of structural instability (Is) which is the ratio between the fine fraction and coarse fraction and the geometric mean Diameter (GMD) to control the existence of values that are not well estimated of the distribution.

4 - Examples of application of the method

4.1 - We applied this method to a series of soils Cheliff plain (13 soil samples) differing from each other by the organic carbon content (Saidi, 1992). The results show, first, a good relationship between the stability and organic matter content (Figure 1), and secondly, a very good relationship between the test results, soil structure and hydrodynamic behavior (Figure 2).

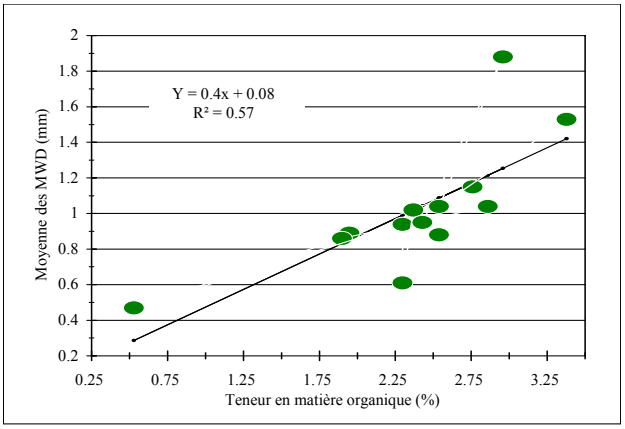


Figure 1: Effect of organic matter on the structural stability

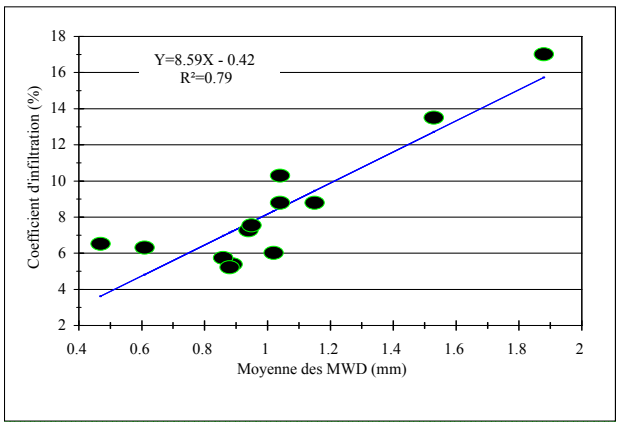


Figure 2: Relation between the structural stability and the infiltration

The method was applied to a range of Chelifian soil plain, for which we have to measure the infiltration under simulated rainfall and the results of the standard test. The correlation coefficients between the various stability tests give values higher than the theoretical correlation

coefficients with the exception of the rate of lime stone (Table 1). The characteristics of the soil variables most related to the stability and infiltration are organic matter, salinity and the rate of clay.

Table 1: The influence of soil characteristics on the structural stability. (1)

Parameters	MWD (mm)	INF (mm/h)
M. O. (%)	0.75 **	0.68 **
Arg. (%)	-0.60 *	-0.65 *
CE (dS/m)	-0.66**	-0.68**
$CaCO_3$ (%)	0.38 ns	0.46 ns

Table 2 : Relation between infiltration and the various structural stability tests. (1)

Parameters	MWD1	MWD2	MWD3	MWD
	(mm)			
INF (mm/h)	0.89 ***	0.83 ***	0.63 *	0.89 ***

The good correlation obtained between the infiltration and the weight average diameter (Table 2) that this method can provide a good estimate of the structural stability. In addition, measures of structural stability of the three tests are all correlated with measures of infiltration under simulated rain with a better relationship in the first phase of disintegration.

4. 2 - The effect of a soil conditioner on the structural stability

The soil conditioners are substances of organic or mineral origin (often large synthetic polymers) acting at low doses on the soils physical properties. These products can work on the structural stability (De Boot, 1972, Le Souder, 1990; Saidi, 1992). The proposed structural stability tests were carried out on a soil conditioner called (WAC), this product, a polymer of polyvinyl basic aluminum sulfate, was effective on the ground to delay the formation of crusts formation (Le Souder, 1990). Its action is mostly visible on maintaining a cloddy structure.

The conditioner (liquid miscible with water) was sprayed, using a micro pulverizer on a bed of graded aggregates of 3-5 mm air-dried. The sample of the surface layer represents the interface soil atmosphere, from a cultivated soil of the Cheliff plain. It belongs to the class with some salines and sodics soil, electrical conductivity of 23.6 dS / m and texture silty clay can form a slaking crust. The product used is diluted in the same amount of water (ratio 1/1) or at a dose of 250 l / ha. The analytical characteristics are presented in Table 3

Table 3: Physical and chemical characteristics of the soil sample

Distribution of particle size (%)									
0-2	**2-20**	**20-50**	**50-200**	**200-2000**	**pH**	**MO**	**$CaCO_3$**	**ESP**	**CE**
µm						**%**			**dS/m**
27.3	15.3	32.4	14	11	7.9	1.3	23.8	21.3	23.6

4. 2. 1 – Breakdown by slaking

In Figure 3, we first note that the size distribution obtained for the indicator is characterized by a high proportion of finer particles, with 45% of the distribution of less than 0.1 mm. It is indeed a very unstable soil. When the aggregates have been previously treated with conditioner at the recommended dose, the size distribution is shifted. The rate of fine particles (particles) of less than 0.1 mm increased to 10%, while the rate of coarse elements (aggregates) greater than 2 mm from 8 to 14%. A significant increase in all classes is stored in the upper classes to 0.1mm.

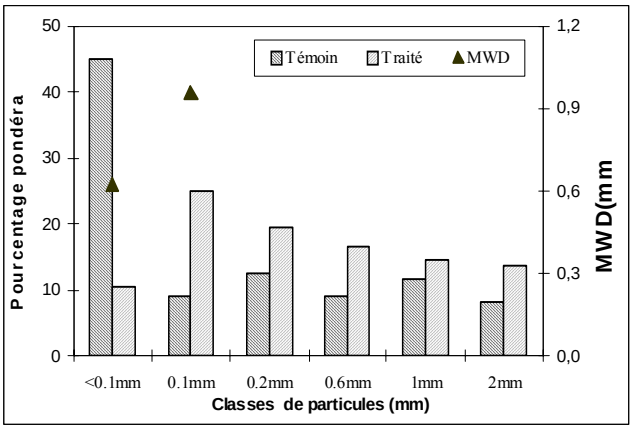


Figure 3: Influence of soil conditioner on disaggregation for the fast wetting by immersion test.

4. 2. 2 - Breakdown by mechanical energy

The histogram of the control sample which is characterized by two dominant fractions: the fraction less less than 0.1mm, with 40% and the fraction more than 2 mm at 19 %. Small fractions are poorly represented (Figure 4). After pretreatment with a conditioner, the resulting aggregate rate greater than 2 mm is strongly increased to 29% of the distribution at the expense of the finer classes.

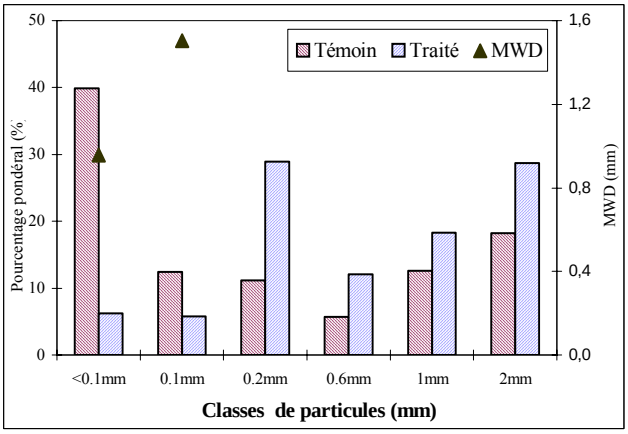


Figure 4: Influence of soil conditioner on desegregation for the test of Breakdown by mechanical energy

4. 2. 3 - Effect of soil conditioner on the test of slow wetting by capillarity

The resulting size distribution (Figure 5) of the control is characterized first by the importance of the more extreme classes: 41% of the resulting particles are in the class below 0.1mm and 22% of the aggregate is in the residual class greater than 2 mm. As for the samples that received treatment with WAC. The coarse fractions are highly elevated: The rates above 2 mm aggregates resulting from 22% for the control over 66% of the treated sample.

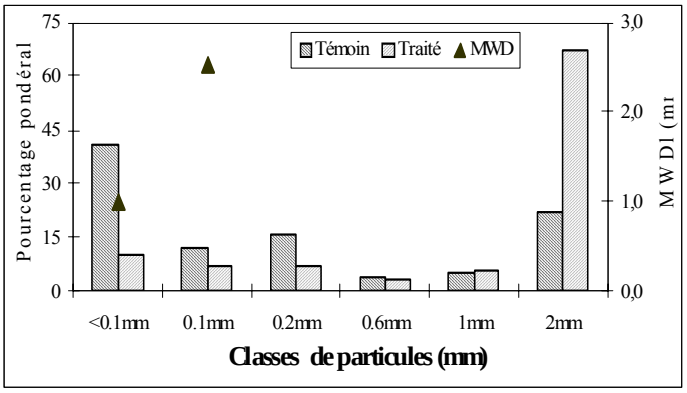


Figure 5: Influence of soil conditioner on desegregation for the test of slow wetting by capillarity

5 - Discussion

1 - Organic matter is the most critical parameter in the structural stability. Indeed, the higher organic matter increases, the structural instability decreases. This influence is explained by its role in the connection between the mineral particles of soil on the one hand (Tisdall and Oades, 1982; Chenu, 1989) and the hydrophobicity of the pore wall surfaces of mineral particles of soil in the other, and this slows down the speed of wetting of the aggregates and thus reduce the break (Jouany *et al.,* 1992).

2 - The results show that the conditioner can increase the resistance of aggregates against disintegration tests, without discrimination. This effect is mainly due to the protection of the periphery of aggregates having received treatment during the spraying. The conditioner works by increasing the cohesion of the aggregates and thus limiting the wear exerted when testing mechanical agitation (Saidi, 1992 &1996). It slows the breakdown by bursting. This action is due to the hydrophobicity of the pore walls of access. The effect of the conditioner was presented by WAC (Le Souder *et al.,* 1991 & 1995) in order to demonstrate its effectiveness in maintaining soil structure clodly both on dry during heavy rains (case of storms) on moist soil (winter rains). The application example of this method in this particular case illustrates the value of the use of tests and the description of the size distribution of the resulting particles.

6 - Conclusion

Because of the role of the phenomena of disintegration in the formation of crusts capping the soil and triggering erosion, it is reasonable to assume that the measurement of structural stability with a suitable method can provide a good estimate of the sensitivity to crusting and soil erodibility. The proposed method takes into account different mechanisms of desegregation and different physical parameters and physico-chemical weathering and the sensitivity to erosion that may result. The results presented illustrate the value of the method used and shows its validity for predicting the behavior of soils under rain vis-à-vis the degradation and erosion.

The purpose of a test is only to provide a basic reference on the behavior of soil under the specific conditions and allow comparisons between soils and the study of the effect of a particular parameter such as conditioners that enhance physical properties. Test results with the application of treatment showed that conditioning contributes to the improvement of structural stability by limiting the break. A test can be interpreted when compared to other measurements or observations and it is the convergence of results that allows us to judge its value. We preferred the test with the greatest possible extent of their results and rapid tests such as the indices of instability for more measures.

Finally, the structural stability of Chelifian soils plain Algeria is dependent mainly on organic matter, electrical conductivity and secondarily of the clay content.

(1) Statistical significance at the 5, 1 and 0.1% respectively indicated by *, ** and***.

7- Références

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Soil Erosion Prediction to Prioritize Areas for Sustainable Land Management Using RUSLE Model in the Gerado Catchment, South Wello, North Eastern Ethiopia

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Abstract
Soil erosion is one of the severe forms of land degradation over the wider parts of highland Ethiopia. It has wide-range on-site and off-site affects such as soil nutrient loss, sedimentation of irrigation canals and hydropower dams, and flooding of properties. It is therefore essential to devise mechanisms of tackling soil erosion through site-specific and problem-oriented management measures. The main objective of this study is to identify hotspot areas of soil erosion to prioritize for land management intervention in the highlands of Ethiopia using the Revised Universal Soil Loss Equation (RUSLE) model. The required inputs for the RUSLE were acquired from different sources and integrated in a GIS environment to estimate soil loss. The mean annual soil loss rates range from less than 5 tons on the flatter to over 100 tons ha^{-1} y^{-1} on steeper slopes. In over 75% of the total catchment, the rate of soil loss is higher than the tolerable soil loss rate of 18 tons ha^{-1} y^{-1} estimated for the country. To identify hotspots of concern, the catchment was classified into severe, very high, high, medium, low and very low soil loss categories. Based on this, the study concludes that areas with severe, very high and high erosion hazard of over 25 tons ha^{-1} y^{-1} should be prioritized for land management intervention. As a result, out of 6700 ha of the total catchment, more than 75 % (5064 ha) requires immediate management interventions to prevent further degradation and rehabilitate degraded lands. The result shows the severity of soil erosion in the Gerado catchment attributed the main controlling factors to be too steep terrain, cultivation of steep slopes and absence of effective conservation measures.
Keywords: Soil loss rate, RUSLE, tolerable soil loss, land management prioritization.

Introduction
At the contemporary time much of the earth is degraded, being degraded or at a risk of degradation (Barrow, 1991). Soil erosion has been a serious problem of many countries (Morgan, 1977, 1996). In Ethiopia, soil erosion is as old as the history of agriculture (Hurni, 1993) and soil loss rate by water ranges from 16 to over 300 tons ha^{-1} $year^{-1}$ mainly depending on the degree of slope, rainfall intensity and type of land use/cover (Hurni, 1988; Tamirie, 1995).
Overgrazing, deforestation, poor farming systems and inappropriate soil management induced soil erosion in many parts of Ethiopia (Tamirie, 1997) considerably reduce the productive capacity of land (Hurni, 1993), results huge reservoirs sediment accumulation, lowering soil water holding capacity, shortages of water supply and hydroelectric power generation (Haregeweyn *et al*., 2005; Tamene *et al*., 2011).
Thus, a thorough understanding of erosion processes is essential in reducing rate of soil loss by planning, designing and implementing appropriate conservation strategies (Tamene and Vlek, 2007). This study, therefore, is aimed to estimate and quantify the average annual soil loss rate and identify soil erosion prone hotspot areas to prioritize for land management intervention using the Revised Universal Soil Loss Equation (RUSLE) model (Renard, *et al*., 1996).

Materials and Methods
Description of the study area
The study is conducted in Gerado catchment of South Wello (Ethiopia), which is one of the most soil erosion prone areas of the country. It is located between 11^0 3' 00" -11^0 8' 30" N and 39^0 32' 20"- 39^0 39'10" E (Fig.1) and covering 6700 ha of land. The study area, characterized by steep mountains at the periphery and flat plain at the center, has elevation ranging from 2, 174 to 3, 032 meters above mean sea level (amsl).

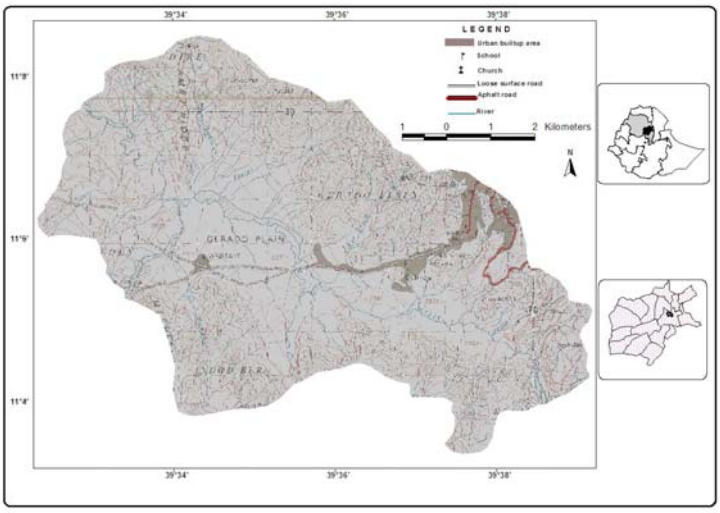


Fig.1. Location of Gerado catchment, South Wello, Northeastern Ethiopia

The gradient varies from flat slope (0-2%) at the center to very steep slopes (>70%) on the mountain ranges. It has *moist dega* (temperate) *and moist weyna dega* (subtropical) agro-climates (Hurni, 1995) with high inter seasonal and annual rainfall variability (Fig 2). The rainfall is used for rainfed cultivation of a variety of cereals, pulses, oil seeds, vegetables and root crops.

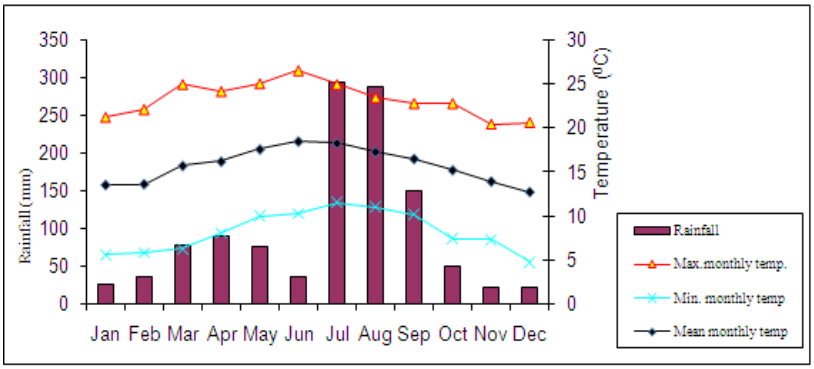


Fig.2. Mean, maximum and minimum monthly temperature (2008) and mean annual rainfall records (1976-2008) of Dessie meteorological station (2540masl; 11^0 05' N and 39^0 40' E), South Wello, Northeastern Ethiopia (NMSA, 2008, unpublished document)

Data acquisition and modeling soil loss rates

The Revised Universal Soil Loss Equation (RUSLE)

The GIS compatible RUSLE model is employed to estimate the soil loss rate, identify hotspots of soil erosion and prioritize areas of land management over a wider area (Shi *et al*., 2004). The model has been used to calculate the average annual soil loss rate (A) of catchments based on the product of six different data sets: rainfall erosivity (R), soil erodibility (K), slope length and angle (LS), land cover (C) and land management (P) factors (Hudson, 1995; Renard *et al*., 1996):

$$A = R * K * LS * C * P \quad (1)$$

Where A is the mean annual soil loss (t $ha^{-1}yr^{-1}$); R is the rainfall erosivity factor (MJmm ha^{-1} h^{-1} yr^{-1}); K is the soil erodibility index (t ha h ha^{-1} MJ^{-1} mm^{-1}); LS is the combination of slope length (L) and slope steepness (S) factor; C is the land use/cover factor; and P is the management practice factor (Fig, 3).

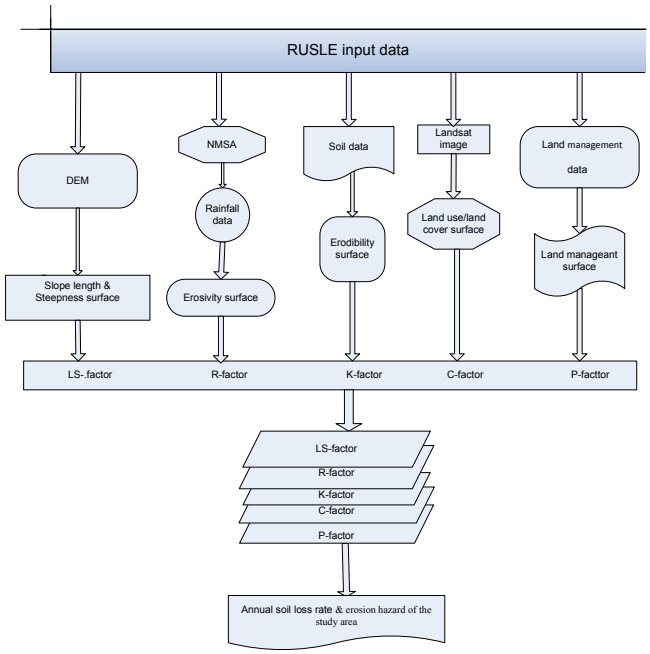


Fig.3. Required inputs and geoprocessing of RUSLE model factors to produce soil loss rate and erosion hazards of Gerado catchment, South Wello, Northeastern Ethiopia

Rainfall Erosivity (R) Factor

For the Ethiopian condition, Hurni (1985b) has developed relationship between annual rainfall and R-factor as follows:

$$R = -8.12 + 0.562P \text{ (Hurni, 1985b)} \quad (2)$$

Where R is the calculated rainfall erosivity factor and P is the mean annual rainfall (mm).

The thirty three years (1976-2008) meteorological data of Dessie town was employed to calculated rainfall erosivity (R-value) and found to be 649.98 for all pixels of Gerado catchment. R- value ≤ 800 mm describes the low erosivity of rainfall to erode soil resources (Batjes, 1996).

Soil Erodibility (K) Factor

According to Randolph (2004: 354), the K value of Gerado catchment (Table 2) was determined from soil texture class and organic matter content of the topsoil (Table 1).

Table 1. Soil erodibility (K) factor values of different textures and organic matter content

Textural class	Organic Matter (%)		
	≤ 2	2 - 4	≥ 4
Fine sand	0.16	0.14	0.10
Very fine sand	0.42	0.36	0.28
Loamy sand	0.12	0.10	0.08
Loamy very fine sand	0.44	0.38	0.30
Sandy loam	0.27	0.24	0.19
Very fine sandy loam	0.47	0.41	0.33
Silt loam	0.48	0.42	0.33
Clay loam	0.28	0.25	0.21
Silty clay loam	0.37	0.32	0.26
Silty clay	0.25	0.23	0.19

Source: Randolph (2004: 354)

Table 2. Soil texture, organic matter content and estimated values of soil erodibility (K) factor of Gerado catchment, South Wello, Northeastern Ethiopia

Point data	UTM reading		Top soil texture class	Organic matter (%)	K Value
	Easting	Northing			
T_1P_1	565319	1227159	Clay	2.31	0.23
T_2P_1	564054	1226935	Clay	8.95	0.19
T_2P_2	564127	1225935	Clay	2.33	0.23
T_2P_3	564303	1227545	Sandy clay loam	1.37	0.28
T_2P_4	563151	1229520	Clay	1.64	0.25
T_2P_5	563820	1227535	Clay	3.14	0.23
T_3P_1	567344	1224851	Loam	3.84	0.42
T_3P_3	567950	1226447	Loam	4.96	0.33
T_3P_4	567116	1224927	Clay loam	2.23	0.25
T_4P_1	566005	1225386	Loam	2.41	0.24
T_4P_2	565904	1225845	Silty clay	2.33	0.23

The K values of Gerado catchment that range from 0.19 to 0.42 are highly erodible to soil erosion (Fig 4). However, the flat grasslands had the lowest erodibility factor (0.19) due to their high topsoil organic matter while the steep mountains shrubland soils have the highest erodibility partly resulting from low organic matter and high gradient (Fig 4).

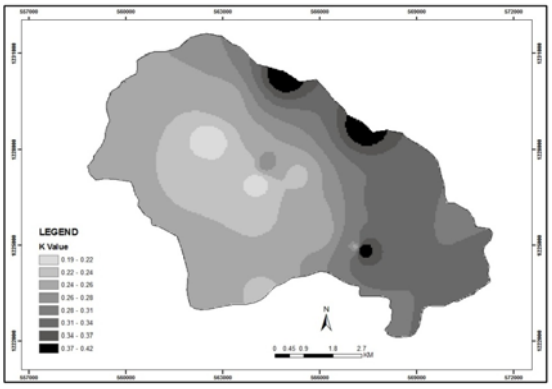


Fig.4. Soil erodibility (K) factor of Gerado catchment, South Wello, Northeastern Ethiopia

Topographic (LS) Factor

The Digital Terrain Model (DTM) of ASTER satellite image at a resolution of 30 by 30 meter pixel size has been used to calculate the slope length and steepness (LS) (Fig 5). The LS factor was calculated based on the principle of stream transport capacity index (equation 3):

$$LS = (m+1)\left[\frac{A_s}{22.13}\right]^{m}\left[\frac{\sin\beta}{0.0896}\right] \quad (3)$$

Where m and n = empirical constants (slope length and angle coefficients), where m = 0.4 and n = 1.3 (Moore and Wilson, 1992); A_s= specific upslope contributing area per unit length of contour; β = local slope gradient in degrees.

Large values of LS are associated with increasing catchment area/concentrated flow and slope gradient. Hence, the amount of erosion would normally be expected to increase with increases in slope length and slope steepness as a respective increase in the volume and velocity of surface runoff (Hudson, 1995; Morgan, 1996).

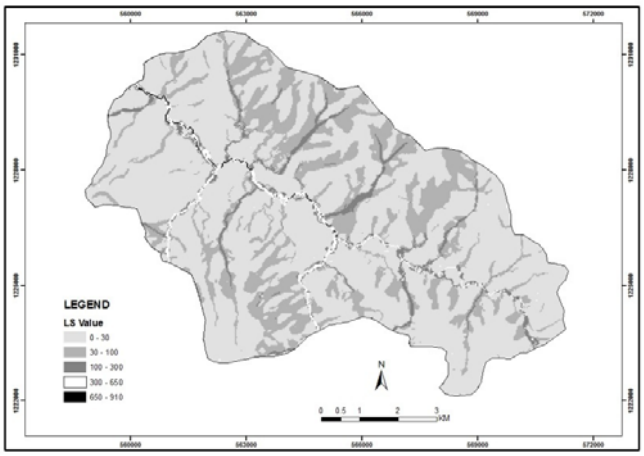


Fig.5. Slope length and angle (LS) factors in Gerado catchment, South Wello, Northeastern Ethiopia

Land use/land covers (C) Factor

Land use/cover patterns influence the degree of soil protection against erosion (Morgan, 1977). Land use/cover pattern with better vegetation cover has lower C value and low degree of soil erosion hazard and vice versa. Thus, soil loss rates rapidly accelerate to high levels whenever land cover is depleted and land is misused (Morgan, 1996). Furthermore, cultivation breaks soil aggregate particles, reduces the amount of soil organic matter and raises degree of soil erodibility (Elwell, 1986). The C factor the study area that reflects the extent of soil protection given by vegetation cover (Hudson, 1995) was derived from a supervised land cover classification of 2006 SPOT 5 satellite image and verified with data gathered from different sample training sites (Table 3; Fig. 6).

Table 3. Land use/land(C) value of Gerado catchment (Hurni, 1985a), South Wello, Northeastern Ethiopia

Land use/cover	C- value
Cultivated	0.15
Shrubland	0.01
Woodland	0.01
Bare land (hard)	0.05
Grassland	0.01
Urban built up area	0.05
Plantation forest	0.01

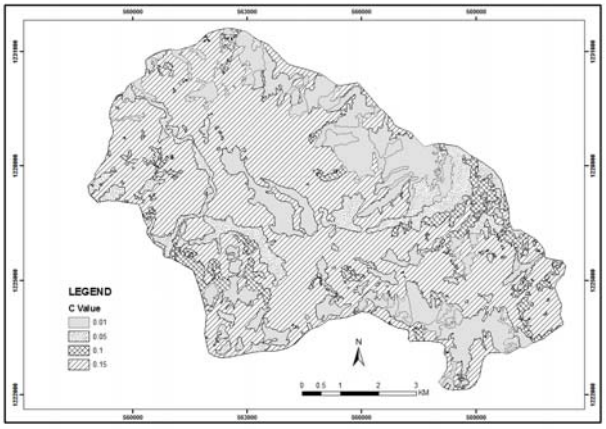


Fig. 6. Land use/cover (C) factor of Gerado catchment, South Wello, Northeastern Ethiopia

Conservation Practices (P) Factor

Within the study catchment, conservation measures such as terracing, traditional ditch, check dams and tree planting are practiced at a limited scale (Bahir, 2010). To determine the conservation

practice (P) factor, the seven land use/covers of the study area were reclassified as agricultural lands and non arable lands (Table 4). All the non-arable land use/covers were merged using GIS technology. The agricultural and non-arable lands were again overlapped with slope classes to determine the respective P factors (Table 4). Finally, the corresponding P value of agricultural and non-arable lands of different slopes has been determined (Table 4; Fig. 7).

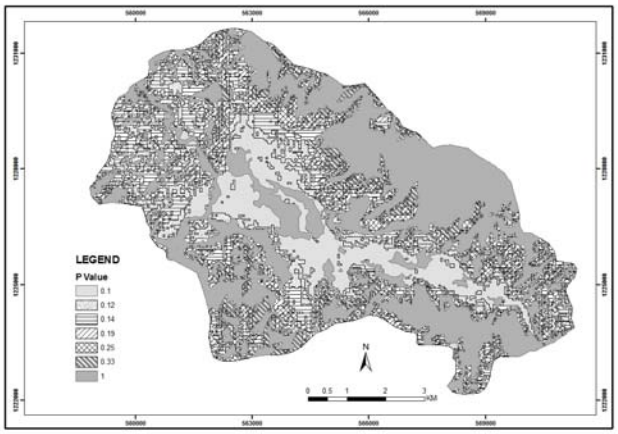


Fig.7. Conservation practice (P) factor of Gerado catchment, South Wello, Northeastern Ethiopia

The P-values gradually increase with rising of agricultural slopes. However, on the non-arable lands with no conservation measures, the P value is 1.0 (Morgan, 1980).

Table 4. The p-values of agricultural and non arable lands of Gerado catchment, South Wello, Northeastern Ethiopia

LULC	Slope (%)	P-Value
Agricultural land	0 – 5	0.10
	5 – 10	0.12
	10 – 20	0.14
	20 – 30	0.19
	30 – 50	0.25
	50 -100	0.33
Non arable lands	All	1

Results and Discussion

Estimated annual soil loss rate

The average annual soil loss of Gerado catchment varies from less than 5 tons to over 100 t ha^{-1} y^{-1} (Fig. 8). Much of estimated soil loss rate is greater than the tolerable soil loss rate (18 t ha^{-1} $y^{-1)}$ of Ethiopia (Hurni, 1983a, 1983b). The high soil loss rates (> 25 t ha^{-1} y^{-1}) covers over 75% of the total Gerado catchment and excels the average soil formation rate of 2 to 22 tons ha^{-1} y^{-1} for Ethiopian highlands (Hurni, 1983a, 1983b). Thus, such high menace of soil erosion requires appropriate implementation of soil management.

Soil erosion that excels rate of soil formation degrades agricultural lands (Elwell, 1986) and threatens existing agricultural production system as it lowers land productivity (Morgan, 1980; Hurni, 1983b; Hellden, 1987). The priority of appropriate land management intervention, therefore, has to be planned according to severity of soil loss, extent of erosion hazard and availability of required labour and resources inputs.

Spatial pattern of soil loss

For effective management interventions, information on the spatial variability of soil loss is more useful than gross annual soil loss rate. It is therefore essential to focus on the relative erosion hazard variability of the different of topographic/slope positions (Fig. 8). The study depicted that the back and upper foot slopes of the catchment experience high amount of soil loss rate compared to the other parts. This is mainly due to the high water velocity/ flow energy and large volume of

runoff from upslope contributing areas. The east-west central toe slope position shows low soil erosion risk. The long, deep, and wide gullies observed during the field work in 2010 and 2011 witnessed the worst form of erosion occurring especially in the northern, northeastern and southwestern parts. Most of these gullies extended from the steep mountain head to the toe slopes of Gerado catchment and damaged large cultivated lands.

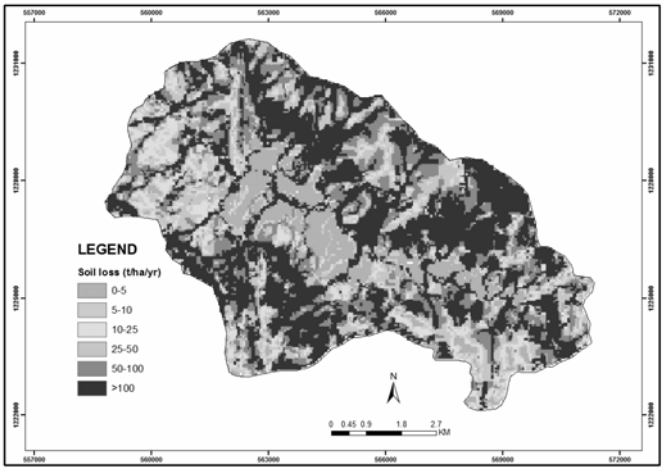


Fig.8. The potential mean annual soil loss rate and distribution of hotspot erosion hazard areas Gerado catchment, South Wello, Northeastern Ethiopia

Topographic factors (slope gradient), the volume of runoff and land use/land cover changes are the major governing factors for the observed variability of soil loss and erosion hazard in the catchment.

About 5064 ha of Gerado catchment are characterized by soil loss rate of over 25 t ha^{-1} y^{-1}. The steep cultivated areas and/or poorly vegetated shrublands covering 2659 ha (40 %) of the total catchment suffers severe erosion and high soil loss rate exceeding 100 tons ha^{-1} y^{-1} (Table 5; Fig. 8). The mean annual soil loss rate ranges from less than 5 tons on the flat toe slopes to over 100 t ha^{-1} y^{-1} on upper foot and back slopes of the catchment. However, all steep areas do not have high soil loss rate as some steep slopes are characterized by resistant lithology and relatively dense vegetation cover. The dense wood/shrub lands of the steep slopes experience moderate soil erosion and rate of soil loss ranging from 10 to 25 t ha^{-1} y^{-1} or 25 to 50 t ha^{-1} y^{-1}. Thus, these relatively inaccessible areas are under less stress of cultivation and over grazing which thereby contribute in reducing soil erosion risk. These areas do not require immediate intervention measures. However, care should be taken to inhibit cultivation or grazing as these areas are sensitive to severe degradation.

Table 5. Annual soil loss rate, severity of soil erosion and priority of land management in Gerado catchment, South Wello, Northeastern Ethiopia

Soil loss (t $ha^{-1}y^{-1}$)	Severity Classes	Priority classes	Area	
			hectare	Percent
0- 5	Very low	VI	736	11
5-10	Low	V	245	4
10-25	Moderate	IV	665	10
25-50	High	III	1054	16
50-100	Very high	II	1351	20
>100	Severe	I	2659	40

Areas with higher soil loss rate (≥ 25 t ha^{-1} y) than the tolerable limit (18 t ha^{-1} y) are erosion hotspot areas and need prior management intervention. However, based on our field experiences, it

has to be noted that gullies should be the first to be conserved due to 1) their widespread occurrence and 2) the direct and severe impact of gullies on agricultural lands and crop production.
Based on the RUSLE model, only in one-fourth (25%) of the total catchment, soil erosion was very low, low and moderate and account for 736 ha (11%), 254 ha (4%) and 665 ha (10 %) in that order. These portions of the landscape may be recognized as requiring low management priority (Table 5). However, such low soil erosion prone areas would not be totally neglected rather they have to be managed after the treatment of hotspot areas.
Areas with slope of < 5% have the lowest soil erosion hazard mainly due to its lower gradient (Fig. 8). These areas are generally depositional zones where eroded materials from up slopes are accumulated and enrich the soil fertility. Due to summer water logging, these low erosion prone lands are left uncultivated. However, they are beneficial for root crops and vegetable cultivation in autumn and cereals production mainly teff, wheat, barley and maize in spring through supplementary irrigation and spring rainfall.
After identifying hotspot areas, the second step will be to subscribe appropriate management interventions. The measures should be intended to tackle soil erosion and accelerated transportation processes. By implementing various land management practices, it would be possible to modify the impacts of LS, R and K and reduce soil erosion hazard. The type of management intervention also should consider the landscape position, land use/cover characteristic, land availability as well as people willingness to adopt sustainable measure. Erosion prone steep slopes could be used for perennial plantation or agroforestry coupled with terracing, restriction of cultivation and grazing. Since those areas are not currently under extensive cultivation, the management measures will not compete with farmers needs and therefore will be acceptable. The regional and national agricultural policy enforcement has to be strong to inhibit cultivation of erosion prone steep areas. The shrub and woodlands have to be protected from animal and human interference so as to rehabilitate plant biodiversity and keep balance of ecology. In this case, it is necessary to plan alternatives, especially grazing lands for the livestock of the local farmers. To avoid resource demand conflict, local farmers have to be allowed to use the steep mountain grasses through cut and carry pasture system. The construction of hillside terraces is important to reduce slope length and gradient and the consequent high soil loss rate. The implementation of all these conservation strategies and farmer's awareness, community participation and policy support contribute in rehabilitating degraded lands and sustainably managing environmental resources to improve the livelihoods of the present and future generation.

Conclusion

Soil erosion is a severe problem in the Gerado catchment of northeastern Ethiopia. In over 75% of the total catchment, soil loss rate is ≥ 25 t ha^{-1} y^{-1} and beyond tolerable limit (18 t ha^{-1} y^{-1}). The soil loss rate and erosion hazard was very high over the steep cultivated and/or poorly vegetated areas. The erosion severity of the catchment is governed by the combined interaction of environmental factors and anthropogenic activities. The spatial variability of soil loss indicates the erosion hotspots and management priority. Accordingly, more than 75 % of the catchment that experience soil loss over the tolerable limit of 18 t ha^{-1} y^{-1} need immediate conservation.
Implemented land management strategies should match the suitability of topography, land use/cover and interest of the local community. Agroforestry, terracing, cut and carry pasture use, for instance, can be integrated in managing erosion of steep mountains. The regional and national agricultural policy enforcement has to be strong to inhibit crop cultivation and grazing on shallow mountain soils. In addition, uncontrolled grazing practiced over some fragile environment should be banned through awareness creation and community participation. Depending on the problem, environmental management has to be implemented as pivotal component of land resource rehabilitating. For such measures to be effective the government should provide incentives or alternatives for farmers who are prohibited to graze and/or cultivate marginal and sloppy lands.
In addition, the side way and upward expansions of destructive and dynamic gullies have to be managed through cemented check damming. Furthermore, the gully sides have to be managed with *sesbania sesban* and leguminous shrubs planting. The soil erosion hazard of sloping and/or strongly sloping cultivated lands should be minimized through bunding, terracing and strip cultivation. The water logging of toe slopes (< 2% gradient) can be tackled through the cultivation of suitable crops

like rice that match with the potential of the area. Moreover, the accumulated water should get enough time to infiltrate and/or evaporate for the cultivation of fast maturing cereals like chickpea and lentils. All these strategies in a long run can restore degraded lands and prevent and/or manage soil erosion hazard and rehabilitate the ecological balance of the catchment and improve the livelihood of the community.

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An Investigation on the Effect of Aquifer Management on the Quality and Quantity of Range (Product, Density, Soil Conservation, Soil Cover and Plants Canopy Cover) In Kuhdasht Aquifer

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Abstract
Water is one of the important vital gifts that if it was utilized irregular and irrational, it would be changed to catastrophic flood. Water floods cause to destroy foundation of ecosystem which is soil as well as to contaminate around of deposition environment which could be a threat for men and environment; so both accurate management practices and inattention to water could change it as a gift or a calamity. Aquifer management is one of the most important management methods which utilize and manage water sources. Due to being new subject, there is need for research, monitoring and assessment. The study was conducted in aquifer of Kohdasht and adjacent rangelands by using of quadrates 1 m^2 and systematic method by measurement of canopy cover factors of rangelands, Product forage, litter, stone and gravel, soil cover and fresh and multiplying of plants in level of quadrates. To measure production and utilization, clipping and weighting method was used up concerning each species and palatability classes. Besides, field survey method for providing floristic list and species diversity was used. At last, repetition of these activities was done out of aquifer so that to compare and investigate the effect of these function on plants cover. Most of these factors show the difference at the level of 1 and 5% inside and outside of aquifer level. For example, there are significant difference at canopy cover percentage between inside (82.75%) and outside (29.95 %) of aquifer. Also, there are difference of 1 % related to pasture production which are 1347 kg/ha and 212 kg/ha for inside and outside of aquifer, respectively. In addition, we can see these differences in soil cover, density and per cent of stone and gravel. However, results didn't show significant difference at litter contents. From diversity point of view, genome was richer in aquifer compared to outside of aquifer. Predominance of desirable species was one of the mentioned aquifer characteristics.
Key word: vegetation, quality, quantity, range, aquifer

Introduction
Essential and vital human demand of water led to make great concern in their mind on supplying of water issues so that they had to dig Qanats or academically use aquifer management with increasing permeability of the soil and aquifer levels. Moreover, the vast areas of Iran are located at arid latitudes. On the other hand, the large majority of Lorestan province is located in Iran-Turan climate and arid forests sub-region on critical climate classification (Mobarakiyan, 1994). Therefore, optimum utilizing of water is very special concern in this region. Consequently, Kuhdasht aquifer, with 3000 ha effective area in east of Kuhdasht (45600 ha) and mean annual precipitation of 440 mm, considered as an examination station for underground substrates supplying functions. Although, the impact of this function on various critical factors like vegetation cover of rangelands as an effective source of changes was markedly mentioned so as to investigate quantitative and qualitative affects on rangelands indices in this paper.

Material and methods
The study was undertaken in the delineated station of aquifer and adjacent regions by using of random- systematic method and an area of 1 m^2 for each plot with sampling of canopy cover, pasture production, litter, stone and gravel, bare soil and fresh and multiplying of plants factors in level of plots. Then, clipping and weighting method was used up concerning each species and palatability classes. After that, the samples were put in autoclave at 70 ° C takes 24 hours. To estimate production, dry matter was calculated, and field survey method was used for floristic list and species diversity along five transects (100 m) and four plots in each transect as well as

repetition of these activities out of mentioned aquifer. In order to compare and investigate on the effects of activities on plants cover, Analysis of variance (ANOVA) by *Mstatc* software was carried out. Range condition and range condition trend were determined by using of inventive method of American Forestry Association and rating approach to vegetation cover and soil as called form No.2 respectively (Moghadam, 1999). Also, regarding to taken coefficient of classes of palatability and multiplying at production in each class, herbage mass was computed.

Results

Investigation on effects of aquifer on canopy cover:

The results of analysis of variance of canopy cover (table 1) showed that there is a significant difference at the level of 1 % at canopy cover percentages between inside and outside of aquifer basin. In addition, comparison of means with Duncan test indicated that the average of canopy cover with 82.75 and 29.95 percent for inside and outside of aquifer basin showed significant difference at the level of 1 and 5 % respectively. Results of analysis of variance of this factor are given at following table.

Table (1): analysis of variance of canopy cover in and out of aquifer

Sources	df	MS	F
repetition	19	9.95	2.5
Canopy cover	1	27878.4	727.99**
error	19	38.29	
total	39		

Investigation on the effect of aquifer on pasture production inside and outside of aquifer basin:

Assessment of results of ANOVA of production showed that there is a significant difference between total productions inside and out of aquifer at the level of 1 and 5 %. Also, means comparing with Duncan test indicted that the average of production with 137.42 and 21.17 g/ m^2 for inside and out of aquifer basin showed a significant difference at the level of 1%. Results of analysis of variance of this factor are given at table2.

Table (2): analysis of variance of production inside and outside of aquifer

Sources	df	MS	F
Repetition	4	251.16	585.0
Production	1	33782.83	78.63**
Error	4	429.63	
Total	9		

Investigation on the effect of aquifer on species density inside and outside of aquifer basin:

To investigate density of species, palatable species *Viciea villosa* and *Astragalus spp.* were selected as key species, and were counted at the level of plot (1 m^2) inside and outside of aquifer basin. The results of ANOVA of density data showed that there is a significant difference at the level of 1 % inside and outside of basin. Moreover, comparison of means of density with number of 27.75 and 1.85 showed a significant difference at the level of 1 and 5 % between inside and outside of basin. Table 3

Table (3): analysis of variance of key species density inside and outside of aquifer basin

Sources	df	MS	F
Repetition	19	30.65	1.04
Density	1	6708.1	228.45**
Error	19	29.36	
Total	39		

Investigation on the litter condition inside and outside of aquifer basin:
There isn't a significant difference between litter contents with mean of 5.25 and 5.65 inside and outside of aquifer basin respectively. Table 4

Table (4): analysis of variance of litter in and out of aquifer basin

Sources	df	MS	F
Repetition	19	11.94	1.25 ns
Litter	1	1.6	0.16 ns
Error	19	9.55	
Total	39		

Investigation on the stone and gravel condition inside and outside of aquifer basin:
The results showed that stone and gravel significantly were affected at the level of 1 %. The average of stone and gravel were 22.05 and 5.35% inside and outside of basin, respectively. Duncan results illustrated that content of stone and gravel was higher out of aquifer basin about 16.7%. Table 5

Table (5): analysis of variance of stone and gravel inside and outside of aquifer basin

Sources	df	MS	F
Repetition	19	72.86	1.76 ns
Stone and gravel	1	2788.9	67.49 **
error	19	41.32	
total	39		

Investigation on bare soil content inside and outside of aquifer rangelands:
The ANOVA results showed that bare soil significantly was affected at the level of 1 %. In addition, comparison of means implied that bare soil percentage out of basin was higher (42.35 %) compare to inside of basin with 6.65 % at the level of 1 %. The results are given at table 6.

Table (6): analysis of variance of bare soil inside and outside of aquifer rangelands

Sources	df	MS	F
repetition	19	107.89	1.388 ns
Stone and gravel	1	12744.9	163.94 **
error	19	77.74	
total	39		

Discussion

With superficial regard to aquifer and outside of aquifer can be estimated that the aquifer management has had significant and positive impacts on rangelands. It converted *Astragalus spinosa-Euphorbia* type (with very poor condition and negative trend) to collection of palatable legumes like *Astragalus spp-Vicieae villosa-Medicago spp- As.dictyophysus-Astragalus homosus-Lensse orvensis- Lathyrus-Onobrychys spp- Trifilium* (with good condition and positive trend).Also, It minimized the presence of spurge. Besides, soil color was changed from grayish white to brownish gray which indicates increase of organic matter in aquifer. On the contrary, there are significant changes respect to statistical results and analysis. For example, canopy cover percentage of class 1 species in aquifer (38.5%) compared to out of aquifer (3%) indicated that aquifer management is an opportunity for revealing capacity of basin. With attention to production in aquifer (1374 kg/ha) compare to out of aquifer (211.7 kg/ha) implied that not only did aquifer management improve soil and plant condition but also it impacted livelihood of rural people and livestock. However, biomass differences got less due to involving annual growth (desirable samples). But, plants biomass was involved, so undesirable samples were considered. Exclosure

made increase production with significant differences. Due to the fact that herbage mass and livestock were calculated for pasture production, good production is related to quality and rehabilitation rangelands in aquifer.

From erosion and soil conservation point of view, means differences were at the level of 1 % and bare soil and stone and gravel percentage were less inside of aquifer. In aquifer, suitable Vegetation covers resulting in increasing soil permeability as well as considering of underground substrate.

But what is remarkable is the lack of significant difference between litter percentages in two basins. The reason is that it seemed litter were higher in aquifer, although litter contents were high out of the basin due to the dead biomass, presence of invaluable plants from soil conservation point of view and grass production like *Acanthus* and *Acanaceous* family. Because *Acanthus* wither on June and in summer by monsoons were harvested and transported to other places, and rangeland soil related to out of aquifer due to loss of vegetation is exposure to precipitation and splash erosion (ghadiri, 1994). Moreover, sequential droughts cause withers vegetation out of aquifer. Anyway, with investigation on differences in two basins inferred aquifer is effective on rangelands rehabilitation and improvement. Also it minimized water problems and enhanced condition, trend and production of rangelands. On the other hand, aquifer management introduced compilation of mechanical and biological functions as an effective mechanism for improving rangelands condition as well as quantity and quality factors of rangelands.

In conclusion, regarding to mentioned differences in this paper and positive trend and good condition of aquifer, poor condition and negative trend outside of aquifer, density that was higher about 15 times and others factors considering, it could be inferred that aquifer with supplying of underground substrates significantly impacted on rangeland condition. Therefore, it suggested improving storage functions consist of mechanical practice in aquifer up to capture precipitation and reduce plants water problems resulted in improving rangeland condition.

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Effect of Different Densities of Pigweed on Soybean Water Requirements

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Abstract
In order to determine effect of different densities of pigweed on soybean water requirement a field experiments were performed at ORDCs research field (Oil Research and Development Company) in the summer of 2009 in Gorgan - Golestan province of Iran. Crop evapotranspiration (ETcrop) was measured using a drainage lysimeter during the crop growth season. The lysimeters were constructed using a iron container, and were 60 cm × 60 cm × 100 cm in size and had filters at the bottom and provision for collecting drainage water. Experiment was done based on the complete block design of the lysimeters was replicated three times. Treatments were included control (lysimeter without weed) and lysimeter with 4, 8 and 12 weeds/m^2. Soybean seeds were sown in soil of lysimeter in rate of 30 plants /m^2. Moisture levels of all lysimeters were kept to field capacity during the experiment because of the preventing the plants from water stress. To do this, lysimeters were irrigated two to three days, regularly. Analysis of variance showed that the treatments (density of pigweeds) until beginning of the third period have no significant effect on soybean water need. At the agronomic point, this period almost coincides with the critical period of weed control and weed should be removed in during this period because it can largely prevent agricultural water waste. But after the third period (35 DAP), there are difference between treatments in the term of water use until end of growth period. In the weed free treatments, water consumption until the end of the growth period is 398.74 mm but by adding 4, 8 and 12 weeds/m^2, water consumption rate reached to 436.84, 447.69 and 466.68 mm, respectively.
Keywords: water requirement, soybean, pigweed, lysimeter

Introduction
Water is one of the most important inputs essential for the production of crops. Plants need it continuously during their life and in huge quantities. Proper amount and correct application of water, guarantees crop yields. Population growth and the need for more food on one hand and water sources contamination on the other hand, have faced researchers with the fact that the misuse of water especially in agriculture leads to some problems such as drought and soil salinity in the future thus rendering agricultural lands unproductive. Therefore the water is the first and most important limiting factor in agricultural production. One of the factors that significantly wasted water is weeds. It is said that the amount is approximately two fold more than the main cultivated plants consume. Weeds that are more effective competitors for soil water could cause more yield loss when soil water is limiting, but this is not always the case when potential crop yield is also lowered due to water stress. It is unknown yet how much water is wasted by the weeds. Therefore, having information about this can help a lot in increasing water use efficiency and saving the limited and valuable source. Considerable of amount water that should be consumed by crops is consumed by weeds. In a country like Iran that the value of water for agriculture more than any other factors, especially in dry lands which is every drop of water is worth, vital importance of this issue would be more sensible. Because weeds due to being stronger, absorb water and consume faster than crops (Rastgari, 1996).
Crop yields in semi-arid areas and in a country like Iran, are impacted by highly variable precipitation, low soil water availability, and high evapotranspiration (Yazdani et al., 1386). Uncontrolled weeds not only reduce soybean yields through their competition for light, nutrients, and moisture, but they can also severely reduce yield and harvest efficiency. Weed-crop competition depending on species, density, time of emergence, geographic location, soil type, fertility and spatial distribution of weeds or crop. Weeds have adapted to water stress by possessing one or more mechanisms which include: 1) avoidance of stress, 2) conservation and efficient use of water, or 3) tolerance to water stress (Dwain, 2007).
In contrast with crops, weeds particularly strong competitors specially to absorb the water. Therefore, competitive mechanisms for crops and weeds need to be better understood and quantified to develop effective crop management solutions to minimize yield loss in water limited environments. Improved understanding of the crop growth, development, and yield potential in

association with sensitivity to seasonal water stress in water limited environments would aid farmers in making profitable decisions for weed control (Dwain, 2007). Most competitive weeds possessed the C4 pathway. Crops (i.e. soybean) typically grown in temperate zone have dangerous weeds. For example, most of the troublesome summer annual weeds are C4 specious. Furthermore sever competition could be expected for water, soil nutrients, light and space and thus reduce crop yields. Increased knowledge of farmers regarding the potential growth and crop yield in relation to seasonal water stress sensitivity, particularly in environments where water is a limiting factor, they can to assist in weed control, make better decisions.

Methods and Materials

Properties of experiment location

This study was conducted in ORDCs research field (Oil Research and Development Company) in the summer of 2009 in Gorgan - Golestan province of Iran. Gorgan city in terms of weather and climate shows temperate and Mediterranean characteristics. Average rainfall is 550 mm, but the amounts in other parts of the province is lesser than 550 mm. There are large agricultural lands or summer planting (second crop) in the province which is almost all of them rely on the numerous water wells. Second crop consist more products such as rice, soybean, cotton, corn, sunflower and tobacco is done mainly after the products such as wheat, barley, potatoes, and canola.

Field experiment

At the time of soybean planting no fertilizer application was done because it seems that the soil humus is high due to there has been soybean cultivation history and highly contaminated with weeds which had been cultivated or ploughed under ground year after year. Due to soybean cultivation history, rhizobial bacteria were not used for seed inoculation for possibility that there are much rhizobial bacteria in soil. Soybean and pigweed seedlings were emergence simultaneously.

Crop evapotranspiration (ETcrop) was measured using a drainage lysimeter during the crop growth season. The lysimeters were constructed using a iron container, with 60 cm × 60 cm × 100 cm in size and filters at the bottom for collecting drainage water. All of the lysimeters were filled with the soil of experiment site. This soil was infected to weed seeds. Table 1 show the soil texture and soil moisture constant at 0-60 cm depth of soil in site experiment. Experiment was done based on the complete block design with three replicates. Treatments were includes control (lysimeter without weed), lysimeter with 4 (W1), 8 (W2) and 12 (W3) weeds/m^2. Soybean seeds were sown in soil of lysimeter in rate of 30 plants /m^2. All lysimeters moisture level was kept to field capacity during the experiment because plant does not suffer from stress. To do these, two to three days lysimeters were irrigated regularly.

Actual evapotranspiration (ETcrop) was calculated for each lysimeter via a water balance method, as in Eq. (1).

$$ETcrop = I + P - D - R \pm \Delta S \quad (1)$$

Where I denotes irrigation depth (mm); P, rainfall (mm); D, drainage (mm); R, runoff (mm); ΔS, the change in soil moisture (mm). In this study, the R-value is considered as zero because the system is closed and ΔS changes are fixed because lysimeter moisture content is held in field capacity.

Table 1. Soil texture and soil physical characteristics at the experimental station.

Parameter	Soil depth from 0-60 cm
Soil texture	Clay loam
Saturation content (% of dry weight)	32
Field capacity (% of dry weight)	21.7
Wilting point (% of dry weight)	7.1
Bulk density (g/m^2)	1.62

Results and Discussion

Amount of soybean consumed water in various densities of pigweed in different periods of growth

From planting to harvest time we had in total nine courses time frame varies from 8 to 22 days had been collecting the drainage water during each treatment period. Variance analysis results for consuming cumulative soybean water are presented in Table 2. As seen in the Table 2, statistically all periods between repeats do not shown significantly different. This means that surely great care be taken in the lysimeter's soil preparation and can achieve acceptable results. Table 2 also shows that different treatments (density of pigweed) to start of the third period of the water consuming, statistically have not significant different. At the agronomic point, this period almost coincides with the critical period of weed control and weed should be removed before the onset of the period because it can largely prevent agricultural water waste. Also this time is very close to the soybean flowering stage. In this study, in July 28, 37 day after planting(DAP) the first flowers beginning open and 42 DAP it reached full flowering. Analysis of variance showed (Table 2) that the treatments (density of pigweeds) until beginning of the third period have no significant effect on soybean water need. But after the third period (35 DAP), there is difference between treatments in the term of water use until end of period.

Table 2. Variance analysis results for cumulative soybean water in various densities of pigweed in different periods of growth.

Source of variable	df	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9
Repeat	2	2.54 ns	2.57 ns	2.70 ns	3.66 ns	7.96 ns	10.42 ns	18.66 ns	20.07 ns	30.92 ns
Treatments (Weeds/m^2)	3	1.12 ns	12.49 ns	125.21 **	376.51 **	791.56 **	1128.61 **	1509.54 **	1844.73 **	2457.12 **
Error	6	2.70	6.18	9.00	13.95	17.96	23.11	27.51	33.62	40.63
CV (%)	--	12.70	7.98	5.80	3.12	2.66	2.47	1.36	1.41	1.45

ns, * and ** non significant and significant at 5 and 1 percent probability levels, respectively.

Means comparison of consuming cumulative soybeans water (mm) in various densities of pigweed is given in Table 3. As mentioned earlier, consuming cumulative soybeans water in the early of third period in different weed densities have not significantly different (Table 2). Because soybean plants and weeds sizes are small that is still in this period crop and weed root was inadequate to pose a threat to start competition for water absorption. Brent (1998) studies also indicated that no difference between soybean water needs when irrigated on 3.5 day schedule compared to 14 days after planting.

William et al. (2005) have expressed that Soybeans can be stressed early in the season without greatly affecting yield thus highly irrigation or rainfall in vegetative stage to increasing soybean yield is not really necessary unless the field moisture is much stress. Diana et al. (1993) have expressed in soybean in normal conditions until flowering stage only once irrigation is sufficient.

But the third period, (i.e. 35 DAP) (approximately early bud forming stage), competition for water absorption started, and water requirement also significantly increases by increasing weed density due to increase in crop and weed size and spread of roots. Comparison of water consumption of soybean with different weed densities in the third period is presented in table 3. As can be seen in the weed-free treatments, water consumption until the end of the third period is 43.4 mm but by adding four pigweed (W1) per square meter, water consumption rate reaches to 50.49 mm this means water consumption rate of W1 about 14% more than control, namely this amount is equivalent to approximately 60 cubic meters of water per hectare. 60 cubic meters of water per hectare is equivalent to 6 mm precipitation. Therefore it can be realized that weeds how can become disastrous or enforce extra costs to farmers. 6 mm of rainfall is a very valuable and ideal rainfall and if occur softly for a day will added 6 liter water to per square meter of soil. It can be seen that with increasing weed densities per unit area in soybean field, the amount of water consumed per unit area will increase. So the density 12 weeds (W3) per square meter, water consumed until the end of third period has reached to 58.74 mm compared to control about 26 percent more water is consumed. This amount of water is equivalent to about 113 cubic meters of water per hectare.

According to the Hezarjeribi and Raeisi (2008) findings, the required amount of water to soybean depends on weather conditions, growth period and farm management but from planting to harvesting, soybeans total water requirements is approximately 4500 to 7000 cubic meter or normally 3 to 4 times irrigation. This report is consistent with Asadi (2006), which says: The rate of water consumption of soybean during the growing season can be varied between 450 to 825 mm (Asadi, 2006). With time and age crops and weeds can be seen that the need for water also increases, as if the cumulative water to the end of the third period to be deducted from the fourth period, the net water consumption of the fourth period (except the seventh period coincided with the pod filling) is higher in contrast with others. For example, in the control treatment, net water in this period - which is lasted about two weeks - is 61 mm while 67.85, 69.86 and 72.11 mm in the treatments of W1, W2 and W3 respectively. In fact the daily water intake in control treatment in this period, approximately 4.35 mm while for the W3 treatment (12 pigweed/m^2) is 5.15 mm but for the rest period, amount of daily water vary from (except the seventh period) approximately 1.5 mm to 2.5 mm for the control and W3 treatment respectively. This shows importance of irrigation in this period. Based on the results of researchers, critical period of irrigation start from flowering to pod-filling stage, especially pod-filling stage is the most critical period for adequate moisture to obtain maximum soybean yield. If adequate moisture do not applied in good time during the critical pod-filling period, yields would be greatly affected. (Asadi, 2006; Rastgar, 2009; Brent, 1998; Reicoscky, 1997; Doss, 1974).

According to Table 3 at seventh period (the length of this period is 22 days) again, we saw an increase in net water consuming. So when cumulative water until sixth period (167.29 mm) deducted from the cumulative water until the end of the seventh period in the control treatment (353.77 mm), pure water consumption for this period can be obtained as 186.48 mm. If that comes to the division to this period, for every day 8.5 mm of water is obtained which seems the water level is high enough for every day, but since this period coincided with the period of pod filling, the need for water in this period is higher than other growth stages and on the other hand this period coincided with hot days in the second week of September. Thus such a calculation can be did for other treatments so cleared that the peak water use period for soybeans occurs during reproductive growth (flowering, pod filling and full seed stages). This is in agreement with other researcher findings (Asadi, 1996., Rastegar, 2008., Brent, 1998). So as mentioned above in during growth period, anyone with a simple account can also calculate (from planting to harvest), how much water consumed by weeds. Pigweed is a C_4 weed that is particularly problematic on soybean fields. C_4 plants have a competitive advantage over plants possessing the more common C_3 carbon fixation pathway under condition of high temperatures especially in summer crops that could cause more yield loss. They consume more water and have more water efficiency.

As discussed in previous, according to environmental conditions, cultivar type and soil type from planting to harvesting, soybeans need 4500 to 7000 cubic meters of water. How much of water can be wasted by weeds? If weeds in the critical period of weed control of soybean fields are removed, how much would be saved in irrigation course and cost? These are the cases that they have been answered in this study. There are research evidences demonstrated that weeds damage are not limited to water, however, the competition between weeds and crops is largely for water but in irrigated tracts, the competition is severe for nutrients and weeds generate a formidable competition with crop for light. Totally, weeds grow in the fields where they compete with crops for water, soil nutrients, light and space and thus reduce crop yields. They also harbor insect's pests, micro-organism.

Certain weeds release into the soil the inhibitors or poisonous substances (allelopathy) which are harmful to the plants, human beings and live-stocks. They increase the expenditure on labor and equipment, render harvesting difficult, and reduce the quality and marketability of agricultural produce (Ahmadi et al., 2007).

In this study was observed that pigweeds (12 weeds/m^2) reduced yield soybean strictly (% 50 approximately, data was not shown).

The competitive ability of crops and weeds can be significantly influenced by the weed densities. In other words, yield loss increased with weed density. Therefore, the understanding of the influence of the weed densities on crop yield is an area that warrants further investigation (Mirshekari et al., 2007). They germinate with the crop and may begin to compete almost

immediately but may appear have not an extreme competition at early crop growth stages. But afterwards, they utilize all of suitable sources intensively.

Additive experiments were performed to determine optimum densities to extend satisfactory yield by also using them for weed suppression. Light plays a significant role in plant growth and is crucial to crop–weed competition. Shading causes decrease in amount of available PAR and adversely affects the weeds growth beneath of the crop canopy. Weeds respond to shading by decreasing biomass and leaf appearance rates and by increasing specific leaf area, stem elongation, lowering their net photosynthetic rates and light compensation points. Understanding shade response of weeds may also aid selection of crop planting densities and row spacing for reducing weed interference, especially from those cohorts that emerge after crop emergence. Thus this strategy could be used to control those weeds that emerge after crop emergence (Mousavi et al., 2009). In fact weeds are the choice of nature. On other words it is highly oriented to various environmental conditions. They can overcome all the obstacles and problems and transfer their experience to their progeny as a genetic package. In many cases and stress, they can do much better than any other creations and thus reduce crop yields. Interesting point here is that in this research soybean has been never in terms of water stress but located under ideal moisture conditions and on average every two days once irrigation was performed. Imagine a time when the soybeans farm to do so contaminated by pigweed and water is the limiting factor. The information gained from this experiment has provided an improved understanding of soybean yield loss risks associated with water management and red root amaranth competition. Perhaps if the irrigation is not applied as the plan, (as farm conditions) a very severe problem than mentioned ago may be occurred. Here's a little part of the competition phenomenon mentioned and still further research is needed to evaluate how much the weed seeds may be entered into the seed bank, how much allelopathic material releases to the soil and weed set shadow to what extent the damage function are brought there. This future knowledge will improve crop-weed competition models and ultimately, optimize soybean water use and weed management decisions in diverse environments.

Table 3. Mean comparisons of consuming cumulative water of soybean (mm) in various densities of pigweed.

Treatments	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9
Control	43.41	104.43 c	136.52 c	167.29 c	353.77 c	376.42 c	398.74 c
W1	50.49 b	118.34 b	158.58 b	194.30 b	384.20 b	409.44 b	436.84 b
W2	54.03 ab	123.89 ab	165.77 b	202.09 b	393.52 b	419.47 b	447.69 b
W3	58.74 a	130.85 a	174.50 a	212.70 a	406.49 a	435.04 a	466.68 a

Means with the same letters have no significant difference at 5 percent probability level.
W1, W2 and W3 are 4, 8 and 12 weeds/m^2 respectively.

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Wind Soil Erosion in Ukraine: Prediction and Control

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Abstract
Approximately 70 % of Ukraine occupied by agricultural lands, most of them involved in extensive technologies of agriculture production systems. Climate changes provoke dust storms even in regions with "low" soil erosion risk status before. In both cases appears vivid need to control erosion or prevent it in the beginning, optimize agricultural activity and improve conditions for the preservation and renewal of soil. This studying gives general view on wind erosion damage done to environment and ways of decision according to experimental data obtained from comparison between two different geographical zones of Ukraine. There are south-eastern region - "Steppe" with annual, wide-spread dynamic and north-west part of region "Polissya"- with some local centres appeared once per 2-3 years. Aim we planned to achieve - complex of conceptual-functional data with criteria of deflated soils estimation and diagnostic due to methodologies of assessment on the international scale. Database of the main parameters determining wind erosion appearance were developed. Investigations included influence of climatic factors, identification of main soil indices, technological particularities, attempts of WEPS model. The results and methods of researches are verified in laboratory conditions (modeling, chemical and physical tests) and during the field experiments. Received information would be useful support as for scientific institutions so for land-owners and soil protecting governmental or public organizations.
Land restoration is common task of humankind and we would be grateful for any source of collaboration in search of new experience, comments and proposals on such outstanding event in soil science.
Keywords: Soil, erosion, prediction, methods, wind-resistance.

Introduction

Ukraine is located in South-Eastern Europe and borders with Hungary, Slovakia and Poland in the West, Belarus in the North, Russia in the North and East, Romania and Moldova in the South, Black and Azov Seas in Southern Part. The total area of the country is 603,700 km^3. The territory of the Ukraine is mostly flat: near 90 % of the whole area is plain; the average elevation of the flat area is 170 m. Carpathian Mountains in the West and Crimean in the South occupy near 5% of the country. During spring-autumn in the Southeast and Southern parts of Ukraine droughts, dry winds (25-30 days per year), and dust storms (3-8 days per year) sometimes occur. The duration of dust storms varies from a few minutes to a few days. Even in Polissya (Forest Area), the most part of which covered by forests and shrubbery and where portion of cultivated lands is relatively small, raising dust from dry turfs take place even with such wind velocity as 2-3 m/s (Truskavetsky, 2010). Dust emission by wind erosion is the largest source of aerosols, which directly or indirectly influences the atmospheric radiation balance and hence global climatic variations (Shao, 2000).

Materials and Methods

The main purpose of the works is to determine quantitative indices reflecting potential soil loss in Ukraine and develop a territory database for zoning according to the levels of wind erosion resistance. The investigations included morphological description of soil profiles, determination of mechanical strenght values, main physical and chemical properties of topsoil vulnerable to erosion process. The following parameters were determined: toughness, mean diameter of soil particles, pH of saline extract, hydrolytic acidity, total humus content, number of primary soil particles, cation exchange, density and other. The investigations were conducted by route method using the data from permanent experiments of regional research institutions (Lutsk Research Station in Polissya and Donetsk Research Station in Steppe). The climatic index has been calculated for the descriptions of the area ability to cause erosion process (Chepil *et al.,* 1963). This main climatic ratio is:

$Ic=V^3/(P-E)^2$, where

V- average wind velocity (m/s),

P-average precipitation amount (mm),

E – evaporation (mm).

Evaporation value should be determined for every month separately. The following data on long term observation were taken into consideration: average monthly wind velocity, average monthly air humidity, precipitation amount and air temperature (Mozheiko *et al.,* 1980).
The average annual duration of dust storms, average and maximum wind velocities during dust storms and their frequency were calculated. Relief of the area, degree of soil cultivation and the ratio of the crops have been also taken into consideration.

Table 1. The main parameters of soils according to their geo-zonal location

Soil type	pH	Cation exchange, Mgeq*100g $^{-1}$	Hydrolytic acidity, Mgeq*100g $^{-1}$	Base-saturated degree, %	Humus, %	Toughnes g*sm^{-3}	Density, g*sm^{-3}
Forest (Polissya)							
Turf-podzol soil	6.3	4.4	2.3	75	1.3	1.5	2.6
Turf soil	5.7	3.3	2.0	62	2.2	1.5	2.6
Forest Steppe							
Light grey soil	5.1	16.5	3.2	81	4.2	1.3	2.6
Grey soil	4.5	20.0	3.5	85	2.0	1.4	2.7
Dark grey soil	7.0	31.5	3.9	89	7.3	1.1	2.6
Podzol chernozem	7.0	22.3	3.3	88	5.2	1.2	2.6
Typical chernozem	7.0	36.3	0.7	98	5.5	1.2	2.6
Steppe							
Common chernozem	7.2	37.1	1.1	97	5.0	1.2	2.7
South chernozem	6.9	36.4	1.6	96	3.6	1.0	2.6
Chestnut soil	7.4	26.5	1.8	95	3.4	1.2	2.6

Results and discussion
Received material shows that the main part of Polissya belongs to the regions with an average potential wind hazard in which the values of combined climatic index varies from 0.1 to 0.5. Whole information about physico-geografical areas of Ukraine shown below (Figure 1). Some areas of Kyiv, Chernigiv, Zhytomyr regions have higher climatic indices and in Lviv and Rivne this index even reaches 2.5. At the same time, southern part of Polissya can be characterized by moderate potential hazard. Thus, Polissya has rather high climatic potential that provides very widespread and intensive manifestations of the wind erosion processes. But wind erosion in Western and Central Polissya has distinctive feature. It is determined by north-western and western winds and takes place on the soils which are not covered by vegetation. Mentioned earlier Polissian soil feature causes sharp decrease of critical wind speed values in the region down to 6-7 m/s (compare to 9-11 m/s at Forest-Steppe zone and 10-12 m/s at Steppe zone). Hence, we still have relatively

high potential for the wind erosion in the region. The soils belonging to Forest-Steppe zone stay apart from others. Their aggregates much less destructive then ones of zonal forest soils types. Even if light grey and grey soils are more destructive than the aggregates of Steppe zonal soils, summary conditions of main agricultural indices from greater amount of dark grey and chernozem soils make this zone more resistent to wind erosion.



Figure 1. Physico-geografical areas of Ukraine. Zones, subzones, regions and provinces (after Polupan, 1988)

The annual wind erosion manifestations take place in south-eastern and eastern districts of Ukraine and cover the territory up to 5 millions ha, which are the main districts of grain crops production (Dolgilevich, 1967). According to average annual data, wind erosionprocesses appears once per 1.5-2.0 years period as dust storms, local processes appears annually (Figure 2).
Wind velocity during dust storms reaches 21-26 meters per second or more. Potential soilloss caused by wind erosion ranges from 64 t/ha in the Crimea up to 890 t/ha in the near-Azov Lowland while wind velocity has 20% probability of its maximum value exceed. Such regions as Lugansk, Donetsk, Zaporizhzhia, Mykolaiv and Kherson are most vulnerable to wind erosion (Figure 3).
The basic soils of the Steppe foothills are chernozem lying on the eluvium of various dense carbonate parent material, sod carbonate and chestnut soil.

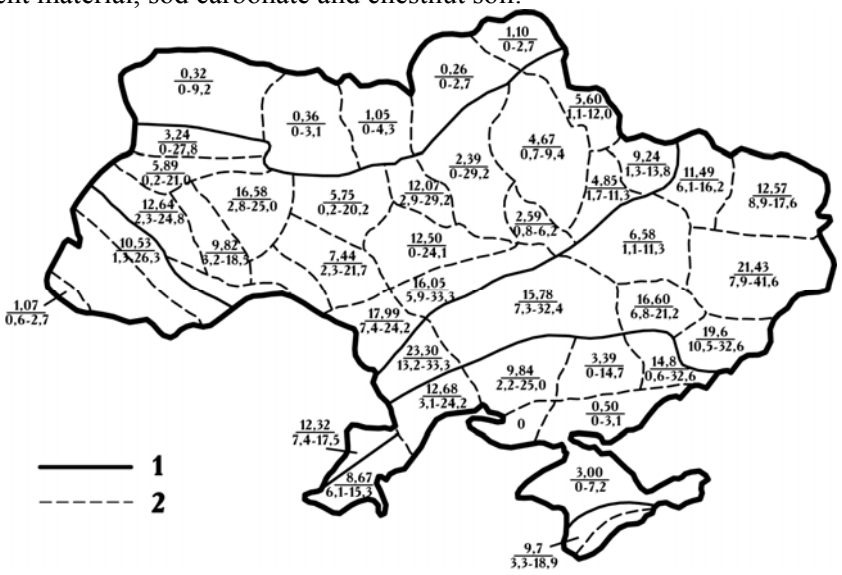


Figure 2. Percentage of medium and high eroded soils in Ukraine with borders of 1.- physico-geographycal zones and 2.- local regions and provinces (above - average area index, below – ratio between min and max local indices).

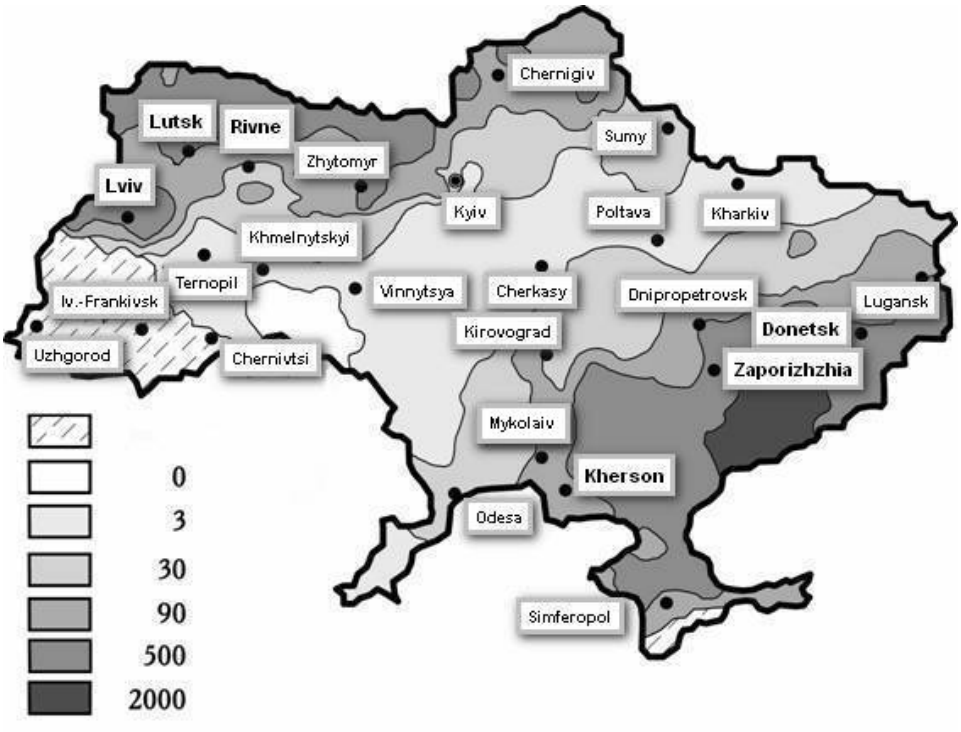


Figure 3. Possible soil loss from wind erosion on plain lands of Ukraine, (t /ha per year)

Acknowledgments

Existing of forest shelter-belts in Steppe and Forest-Steppe and high heterogeneity of Polissyan topsoils decrease possibility of WEPS or WEELS model use for development of erosion control measures in Ukraine but common positions can be taken into consideration.

Degradation processes of wind erosion are in process as for Steppe, so for Forest regions in spite of vivid interest of scientists and landowners. The soil protecting technics such as No-Till farming or GIS-based technologies have trivial results by the reason of local or rare character, therefore their positive effect is only expected in future with proper investments and scientific approaches.

If the prevention of erosion is based on an actual soil erosion data, the main efforts will be in regions with hihgly eroded soil surface (Steppe Area). In regions with moderate erosion (Forest Area) further intensification of agriculture works is planned, even if the farmer uses 5-10 years old data. In such an approach, actual erosion frequently does not coincide with the potential danger of the wind erosion spreading dynamic.

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Evaluation and Modification of Chemical Approach for Determination of Dispersion Potential of Soils

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Abstract

Soil dispersion is a phenomenon in which soil particles become afloat when they are exposed to water, and are carried away by the force of seepage. Various chemical and physical based approaches are used for determination of dispersion potential of soils. Generally the results obtained from the chemical methods do not match with the results of well-known Pinhole test. This study tries to evaluate the reliability of chemical methods for determination of dispersion potential of clayey soils. For this purpose, several natural soil samples were collected from different regions of Iran and some artificial soil samples were made by adding different percentages of four chemical agents, including sodium chloride, sodium carbonate, sodium sulfate, and sodium polyphosphate to a natural soil. The physical, chemical and index properties of all samples were determined. Determination of dispersion potential was employed by the commonly used chemical test (Sherard Method) and Pinhole test. The results obtained from the tests showed that the Sherard chemical method is not able to determine soil dispersion correctly because of the neglected chloride. It was also found that among the existing anions in the soil, the chloride on the contrary to sodium acts as a flocculating factor. A new approach was suggested by converting the vertical axis of the Sherard chart from sodium percentage to sodium-chloride percentage, its conformity to the results of Pinhole tests increases considerably.

Keywords: Soil dispersion, pinhole, Sherard Chemical Method, anion and cation

Introduction

Dispersive soils are one of the most common problematic soils in several countries around the world which can cause severe damages to hydraulic structures such as earth dams and irrigation structures. Due to a specific chemical nature of dispersive clays, the interparticle force of repulsion (Electrical surface forces) exceeds those of attraction (Van der Waals attraction). Soil particles would disperse when comes in contact with water and are carried away by flowing water resulted in leakage or surface runoff (Bhuvaneshwari et al., 2007). Shanmuganathan and Oades (1983) presented dispersions of clay were stable when most of the counter ions existed in the diffuse double layer and the thickness of this layer was of the same order of magnitude based on the diameter of the individual colloidal particles. Repulsive forces created by overlapping double layers which are increased by increasing the surface charge density prevent the close approach and coalescence of individual particles. In other words, dispersion will lead to severe internal and external erosion of the soil and would eventually lead to destruction of the neighboring structures.

The identification and diagnosis of dispersion phenomenon is the fundamental measure for preventing early destruction of hydraulic structures. Although a number of methods have been suggested for identification of dispersive soils, careless tests and/or inappropriate interpretation of their results may lead to incorrect assessment of the problem. Pinhole, Double Hydrometer and Sherard chemical methods are the most commonly used laboratory methods for determining the dispersion potential of soils; each having their own advantages and disadvantages (Paul, 1991). In Pinhole test which the dispersion potential of the soil is evaluated directly, water is allowed to flow through a small hole created in the soil sample. The discharge and transparency of the out flow and the diameter of the hole at the end of the test are three main criteria for evaluation of soil dispersion potential. On the basis of this test, the clayey soils are classified in six different categories named as: D1, D2, ND4, ND3, ND2, and ND1 with respect to the intensity of dispersion, where; D1 is most dispersive and ND1 is the most resistance to dispersion. In Double Hydrometer test, gradation curve of the soil is drawn in two cases; using standard hydrometer test and hydrometer test without employing dispersing agent and mechanical mixer. The percentage of particles are smaller than 5 μm in both cases. Determined and dispersion ratio is calculated as the ratio of the percentage of

particles smaller than 5µm in the method without using dispersing agent and mixer to the percentage of particles smaller than 5µm in the standard method. If the dispersion ratio is more than 50%, the soil has dispersion potential, and if the result is between 30-50%, it shows intermediate dispersion potential and less than 30% shows non-dispersive nature of the soil (Paul, 1991). According to Sherard Chemical Method, the dispersion potential of the soil is evaluated with respect to the type and quantity of cations present in pore water of the soil sample. For this purpose, saturation extract is prepared from the soil sample, then its four main cations namely; Ca, Mg, Na, and K are determined in terms of meq/l and the amount of Total Dissolved Salts (*TDS*) and the Percentage of Sodium (PS) are calculated. The dispersion potential of the soil sample is evaluated from the Sherard diagram as shown in Fig. 1. The diagram is divided into three zones: Dispersive (zone A), Non-dispersive (zone B), and the Intermediate (zone C) based on PS and TDS of the soil extract (Paul, 1991).

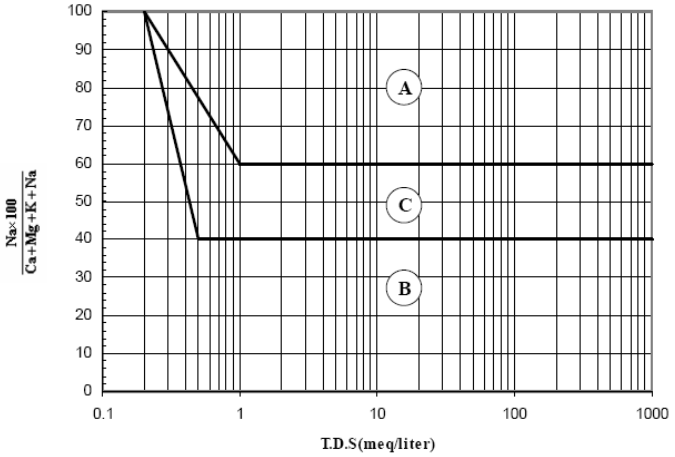


Figure 1. Sherard Diagram for evaluation of dispersion potential of soils (Paul, 1991).

As presented in the literature Double Hydrometer test and sherard diagram are not reliable for evaluation of soil dispersion, however Pinhole test is the reliable method as determine dispersion potential of soils directly (Craft and Acciardi, 1984; Didiek, 2007). But considering the fact that the nature of clay dispersion phenomenon is chemical and that tendency to erosion depends on chemical properties of dissolved salts in pore water therefore accurate and proper interpretation of the chemical tests results would lead to reliable assessment of soil dispersivity (Sherard et al., 1977). Ouhadi and Goudarzi (2006) shown that the dispersivity potential of low electrolyte concentration increases due to repulsive forces overcoming attractive forces. With a further increase in sodium sulfate salt concentration, the dispersivity potential decreases. Lashkaripour et al., (2006) reported that the results of Pinhole and chemical tests do not match while the results of double hydrometer and Pinhole have a good overlap. Based on the findings of different researchers, it is concluded that there is still a great unreliability in chemical methods, especially the most commonly used Sherard method, for evaluation of soil dispersion. In the present study, the limitations of Sherard method is evaluated and an attempt has also been made to modify the Sherard method for a more accurate evaluation of soil dispersion.

Materials and Methods

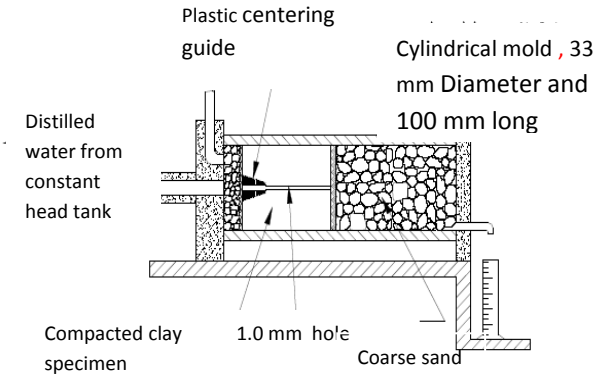
Collection of soil samples and preparation of specimens

To investigate the validity of chemical methods for the identification of dispersion phenomenon, 26 natural soil samples with a wide range of physical and chemical properties were collected from different regions of Iran. Firstly, the index properties of samples including particle size distribution, Atterberg limits, compaction characteristics and their classification were determined. Then the chemical characteristic of the soil pore water including cations, anions, electrical conductivity, and acidity were determined using the standard methods (Anon, 2000). Some artificial soil specimens were also made by adding four different chemical agents including; sodium chloride, sodium carbonate, sodium sulfate and sodium polyphosphate which all have sodium cation but different

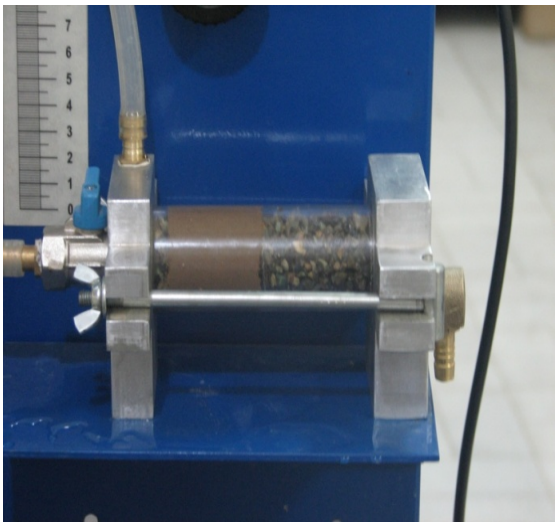
anions, to the natural clayey soil. In order to prepare the artificial specimens, the required quantity of the chemical agents was dissolved in warm water and the dry soil was added to the solution, to form homogeneous slurry. The prepared mixture was kept in the open air to be dried. The dried soil was then crushed and passed through sieve No:10 (2 mm opening). Two extra artificial specimens were also made by adding 5 and 10 percent of sodium chloride (NaCl) to one of the natural dispersive soil. Then, chemical tests were performed on the soil pore water to find the exact concentration of different ions in the artificial samples.

Determination of dispersion potential of samples

In order to determine the dispersion potential of the samples, the test of dissolved salts (Sherard method) and Pinhole were performed on all natural and artificial soil samples. Fig. 2-shows different parts of the Pinhole test device in a schematic form. Fig. 2-b shows the photo of Pinhole test device used in this study. In the present study, sample preparation and testing procedure were all based on the ASTM standards (Anon, 2000).



a. Schematic drawing of the Pinhole test device



b. The the photo of Pinhole device

Figure 2. The Pinhole test device used in this study.

Results

Since the Pinhole method presents a more realistic physical model simulating the dispersion phenomenon, it is accepted as the most accurate and reliable method for determining soil dispersion potential (Paul, 1991). Therefore, in the present study, the results of Pinhole test are taken as the control measure and the results of other method are compared with them. Table 1 shows the results of different dispersion tests carried out on natural soil samples. As it can be seen from the table, in most of the samples (17 samples out of 26) the results of the three testing methods do not match one another, to the extent that in some cases, samples were categorized as dispersive by Sherard chemical method, while they were categorized as ND_1 (completely non-dispersive) by Pinhole method.

Table 1. Results of dispersion tests on natural samples.

Sample No.	Dispersion potential	
	Sherard Chemical Method	Pinhole Method
1	Non-Dispersive	ND2 (Non-Dispersive)
2	Intermediate	ND1 (completely Non-Dispersive)
3	Non-Dispersive	ND2 (Non-Dispersive)
4	Dispersive	ND4 (moderately Dispersive)
5	Non-Dispersive	ND3 (slightly Dispersive)
6	Intermediate	ND1 (completely Non-Dispersive)
7	Dispersive	ND1 (completely Non-Dispersive)
8	Dispersive	ND4 (moderately Dispersive)
9	Dispersive	ND2 (Non-Dispersive)
10	Intermediate	ND1 (completely Non-Dispersive)
11	Dispersive	D2 (Dispersive)
12	Dispersive	D2 (Dispersive)
13	Dispersive	ND1 (completely Non-Dispersive)
14	Non-Dispersive	ND1 (completely Non-Dispersive)
15	Dispersive	ND2 (Non-Dispersive)
16	Dispersive	ND1 (completely Non-Dispersive)
17	Dispersive	ND1 (completely Non-Dispersive)
18	Dispersive	ND1 (completely Non-Dispersive)
19	Dispersive	ND1 (completely Non-Dispersive)
20	Intermediate	ND1 (completely Non-Dispersive)
21	Intermediate	ND1 (completely Non-Dispersive)
22	Dispersive	ND4 (moderately Dispersive)
23	Dispersive	ND1 (completely Non-Dispersive)
24	Dispersive	ND1 (completely Non-Dispersive)
25	Intermediate	ND1 (completely Non-Dispersive)
26	Dispersive	ND1 (completely Non-Dispersive)

According to the Table 1 there are many contradictions (for over 70 percent of the samples) between the results of Pinhole and Sherard chemical methods. The samples with a large percentage of sodium were classified as dispersive by Sherard chemical method, whereas some of the same samples were categorized as non-dispersive in Pinhole test. After detailed assessment of the chemical characteristics of the samples which were classified dispersive in the Sherard method, but non-dispersive in the Pinhole test. It was found that although the sodium percentage is high in these samples, the type and quantity of their anions are different. It was therefore concluded that the dispersion of the soil does not only depend on the type and quantity of cations (especially sodium percentage which plays the main role in the Sherard chemical method) but also depends on the type and quantity of the anions present in the soil. With respect to the aforementioned points, it can be realized that the results of Sherard chemical methods, apart from being inefficient, can also be confusing in some cases.

In order to investigate the effects of different anions on dispersion of the soils, the dispersion potential of artificial samples were analyzed. According to Table 2 all artificial samples which have the salts with the same major cation (sodium), are categorized as dispersive on the basis of Sherard chemical method. However, based on the results of Pinhole tests, some of the samples were classified as non dispersive depending on the type and quantity of their anions.

Table 2. Results of dispersion tests on artificial samples.

Samples characteristics			Dispersion potential		Samples characteristics			Dispersion potential	
Sample No.	Agent type	agent per.(%)	Sherard Method	Pinhole Method	Sample No.	Agent type	agent per.(%)	Sherard Method	Pinhole Method
A0	-	-	Dispersive	ND1	A10	Na_2So_4	12	Dispersive	ND3
A1	NaCl	8	Dispersive	ND1	A11	Na_2So_4	8	Dispersive	ND3
A2	NaCl	4	Dispersive	ND1	A12	Na_2So_4	4	Dispersive	ND3
A3	NaCl	1	Dispersive	ND1	A13	Na_2So_4	1	Dispersive	ND1
A4	Na_2Co_3	15	Dispersive	ND4	A14	$(NaPo_3)_33$	12	Dispersive	D1
A5	Na_2Co_3	8	Dispersive	D1	A15	$(NaPo_3)_33$	8	Dispersive	D2
A6	Na_2Co_3	4	Dispersive	D2	A16	$(NaPo_3)_33$	4	Dispersive	D2
A7	Na_2Co_3	1	Dispersive	ND4	A17	$(NaPo_3)_33$	1	Dispersive	ND3
A8	Na_2Co_3	0.5	Dispersive	ND1	A18	NaCl	5	Dispersive	ND2
A9	Na_2So_4	20	Dispersive	ND4	A19	NaCl	10	Dispersive	ND3

ND1: completely Non-Dispersive, **ND2**:Non-Dispersive, **ND3**: slightly Dispersive, **ND4**: intermediately Dispersive
D1: very Dispersive, **D2**: Dispersive

Discussion

Samples A1, A2, and A3 which were made by adding 8, 4, and 1 percent by weight of NaCl, in spite of having high sodium content, are all classified as completely non-dispersive according to the Pinhole test, while based on Sherard diagram, they should be dispersive. That is to say that chloride ion neutralizes dispersive effect of sodium, and prevents soil from dispersion. In order to confirm this finding, 5 and 10 percent of NaCl salt was added to a naturally dispersive soil (Sample No. 11), and tested afterwards (Samples A18 and A19). Results showed that by increasing the amount of chloride anion in the pore water, the soil tends to flocculate, so that the artificial sample A19 having 5 percent of salt is categorized as ND_3 (closer to non-dispersive) and sample A18, having 10 percent of salt was classified as completely non-dispersive. Therefore, it can be concluded that although NaCl salt provides a large amount of sodium cation to the soil, it leads to reduction of soil dispersion. In the case of sodium carbonate, Na_2Co_3, it was found that samples A6, A5, and A4 which were made by adding 4, 8, and 15 percent of sodium carbonate are evaluated as dispersive (D_2), very dispersive (D_1) and dispersion-prone (ND_4), respectively. Thus, it can be concluded that sodium carbonate causes dispersion, though its effect differs according to the salt percentage. The effect of sodium sulfate, Na_2SO_4, on soil dispersion was also studied in the same manner and it can be concluded that the sulfate tends to act as a dispersing agent.

In general, based on the results of the present study, only chloride anion leads to formation of a flocculated structure in the soil and elimination of dispersion potential, while other anions more or less lead to soil dispersion. In other words, presence of chloride anion in the soil acts like an obstacle against the dispersing nature of sodium cation. In the case of sodium chloride, the produced salt after cation exchange would be calcium chloride which is a high soluble salt and led to increase the concentration and decrease the sodium absorption ratio, SAR, of the electrolyte and so that decrease the dispersion potential of the soil. Unlike in the case of the other salts (sodium carbonate and sodium sulfate, the produced salts will be calcium carbonate and calcium sulfate which are less soluble material and may settle and go out of the electrolyte and subsequently decrease the concentration and increase the sodium absorption ratio, SAR, of the electrolyte where both of them led to increase the dispersion potential of the soils.

As it was mentioned earlier, among all anions present in the soil, only chloride anion acts as a flocculating agent which makes the soil non-dispersive. Therefore, a part from the total sodium ion existing in the soil employs for neutralization of chloride anion and the surplus amount of chloride anion acts as dispersion factor of soil. This fact was considered in order to modify the Sherard diagram and a new index named as “percentage difference of sodium and chloride” (PSC), is introduced to replace “sodium percentage” (PS), on the vertical axis of the Sherard diagram. In order to evaluate the accuracy of the modified method, the dispersion potential of some of the natural soil samples, which mainly showed contradictory results in Sherard and Pinhole methods, were determined according to the proposed method. The results of the new experiments in comparison with the results of Sherard and Pinhole methods are presented in Table 3. As the table 3 shows, the results obtained by the modified method are in a very good agreement with the results of Pinhole test.

Table 3. Comparison of the results of the modified with other methods

Sample No.	Dispersion potential		
	Modified Chemical Method	Sherard Chemical Method	Pinhole Method
1	Non-Dispersive	Non-Dispersive	ND2 (Non-Dispersive)
2	Non-Dispersive	Intermediate	ND1 (completely Non-Dispersive)
3	Non-Dispersive	Non-Dispersive	ND2 (Non-Dispersive)
6	Non-Dispersive	Dispersive	ND4 (moderately Dispersive)
7	Non-Dispersive	Non-Dispersive	ND3 (slightly Dispersive)
10	Non-Dispersive	Intermediate	ND1 (completely Non-Dispersive)
16	Non-Dispersive	Dispersive	ND1 (completely Non-Dispersive)
17	Non-Dispersive	Dispersive	ND4 (moderately Dispersive)

Conclusion

Based on the overall results of the experiments carried out in this study, the following conclusions are made:

- Sherard chemical method is not able to determine soil dispersion potential reliably as it does not consider the role of anions, especially chloride. The results obtained by this method are mostly conflict with the results of Pinhole test.
- It was shown that among different anions present in the soil, the chloride anion, as opposed to the sodium cation, is a factor that makes the soil non-dispersive.
- Sodium chloride leads to reduction of dispersion potential of the soil, while sodium carbonate leads to its dispersion.
- A modification was made for Sherard diagram by introducing a new index named as the "percentage difference of sodium and chloride", (PSC), to replace "sodium percentage" on the vertical axis of the Sherard diagram.

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Infiltration Capacity Enhancement in Recharge Basins through Gypsum Application

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Abstract

The artificial recharge of groundwater has been judged an appropriate technology in mitigating an impending water crisis in the I.R. of Iran. Clogging is an inevitable outcome of spreading turbid floodwater in recharge basins. Although our soils are calcareous and our floodwater contains some calcium sulfate, we hypothesized that an abundance of free Ca^{2+} may cause coagulation of clay minerals and prevention of their translocation in the unsaturated zone. Therefore, effects of raw gypsum (<500 μm) on infiltration capacity enhancement were investigated. The treatments were arranged in a completely randomized design. The experimental plots consisted of 150 cm long polyethylene cylinder with 30 cm inside diameter. Ten cm of coarse sand was used as a filter at the bottom of each cylinder. Then 40 cm of sieved soil (<4 mm) from a recharge basin was placed on the filter and 95 cm of recharge water was added to the cylinder. The treatments were: 1. Control (without gypsum application); 2. Gypsum mixed with 15 cm of the top soil at 0.5 kg/m^2 (of the cylinder area) before the addition of recharge water; 3. Gypsum mixed with 15 cm top soil at 1 kg/m^2 before adding recharge water; 4. Gypsum suspended at 0.5 kg/m^2 after the addition of recharge water; 5. Gypsum suspended at 1 kg/m^2 in water after the addition of recharge water. Infiltration rate was determined by daily measurement of the water level recession in each cylinder. These data were later converted into infiltration rate. The data were analyzed using the MSTAT-C software; the means comparisons were carried out by the Duncan's Multiple Range Test. The results showed that an addition of 0.5 kg/m^2 gypsum to recharge water significantly increased infiltration rate ($P<0.05$) in comparison with the control and other treatments on the first and second day after application (28.5 and 23.4%, respectively). Therefore, we recommend the addition of 0.5 kg of gypsum per m^2 of the recharge basin area to recharge water to enhance the infiltration rate.

Keywords: Recharge basin, Gypsum application, Infiltration rate

Introduction

The Land of Iran, as many other dry lands of the world, is suffering from water scarcity. This shall be further intensified as the population growth exceeds the limited resources. The annual per capita water allocation of Iranians, which was 2200 m^3 in 1990, will be reduced to 726-860 m^3 in 2025. It is predicted that Iran will be amongst water-short countries even before 2025 (Vakili, 1996). Deficient rainfall during the latter part of the growing season is one of the outstanding features of arid and semi arid areas with the Mediterranean precipitation regime. The scant precipitation usually occurs in the cold part of the growing season when the water demand of crops is the lowest. Therefore, supplemental irrigation is necessary for obtaining a fairly respectable yield. It is ironic that the same limited rainfall sometimes occurs as intense showers producing highly turbid floods on degraded watersheds. Collection of this precious resource in underground reservoirs is called the artificial recharge of groundwater (ARG). This water may later be extracted and used for the timely supplemental irrigation of crops. A major hindrance of the ARG is a sharp decline in the infiltration capacity of the recharge basins. Translocation of minute particles, particularly clay minerals of the nanometer size, clogs the pores and impedes the flow in the unsaturated zone. Clogging takes place through 3 distinct processes: 1) mechanical (settlement of suspended material in water, transportation of air by water and release of dissolved gases); 2) chemical (dispersion and swelling of clays due to cation exchange, sedimentation of alkaline or alkaline earth element salts); and 3) biological (bacterial and algal proliferation, production of chemicals) (Biz et al., 1990). Decreasing infiltration rate from 4 m/day to 2 m/day in 3 months in Varamin, and from 3 m/day to 2 m/day in Garmsar has been reported (Mousavi et al., 1998). Also, it is found that sedimentation in recharge basins in Ramshae had reduced infiltration rate from 2 m/day to 0.5 m/day during the first period of operation in Ramshae and reported that infiltration rate in the Kahrouyah project was reduced from 1.5 m/day to 0.6 m/day (Mousavi et al., 1998). It is observed that sedimentation

had decreased infiltration rate by 80 % in a recharge pond (Mousavi and Rezai, 1999). Removal of the crust to a depth of 15 cm, increased the infiltration rate only to 70-80 % that of the initial rate. However, plowing or removing the heavy crusts formed at the bottom of recharge basins to increase infiltration rate is not recommended, as clogging is not limited to the plow depth (Biz et al., 1990; Esmaeili and Mousavi, 1988). Clay accumulation at a depth of 7.5 m in a sedimentation basin has been reported (Mohammadnia and Kowsar, 2003). It is reported that covering the bottom of a recharge basin with well graded filter of sand and cotton husks increased infiltration rate; covering with compost gave the best results after crust removal (Tabesh and Javaheri, 2003). Addition of coagulants such as potash alum, ferrous sulfate, iron chloride and planting inundation tolerant grasses at the bottom of sedimentation basins to increase infiltration rate have been successfully tried (Kowsar, 1985). Application of gypsum phosphate in a sandy loam soil with an exchange sodium percentage (ESP) of 10; increased the infiltration rate from 7.5 to 12 mm/hr and in another soil with an ESP of 11.6, infiltration rate increased from 6 to 10 mm/hr (Shainberg and Singer, 1985; Shainberg, 1986; Southard et al., 1988). Whit subject to structural crusts, the same authors have reported that application of gypsum phosphate at higher electrolyte concentration significantly increased infiltration rate. They further reported that application of gypsum, gypsum phosphate and waste material of phosphorus fertilizer manufacturing increased electrical conductivity of water, caused flocculation of clays, and increased porosity of sediments. The results of an experiment showed that the initial irrigation with 12 me/l gypsum in comparison with freshwater, increased the infiltration rate of clay soils (Scotter and Loveday, 1966). This improvement was mainly due to an increase in total porosity and void ratio ranging from saturation to oven dry conditions. Dispersion of clays and clogging of soil pores are the main reasons of destroying soil structure and slowing down the infiltration rate (Felhendler et al., 1974). Application of phosphate gypsum to soils containing high smectite with low ESP increased the infiltration rate (Afuni et.al; Kazman et al., 1983). As outcrops of the gypsiferous Gachsaran and Razak Formations cover a vast area in southwestern Iran, their runoff contains dissolved calcium sulfate, and they are usually side-by-side of the calcareous basins, it is logical to benefit from this readily available resource in precipitating some suspended load from the turbid recharge water. This required a small-scale laboratory experiment prior to implementing the larger-scaled field work. The main objective of our study was to find a simple and economical method for increasing clogged recharge basins' infiltration rate.

Materials and Methods

Research Site: About 0.5 m^3 of the dried crust was collected from the bottom of a representative recharge basin in the Sarvestan Plain, 80 km southeast of Shiraz, I. R. Iran. A critical groundwater shortage, the outcropping of the gypsum-containing Razak Formation in the eastern area of this plain, the availability of X-ray diffraction (XRD) analysis of the clay minerals of the plain (Abtahi, 1980), and the proximity to our laboratory were the main reason for our sampling site selection. The crusts were ground and passed through a 4 mm sieve.

Selection of Raw Gypsum: As the bulk gypsum from the Fasa mine had shown the highest purity (88.9%), we secure the needed amount and passed it through a 500 micrometer sieve.

Treatments and Experimental Design: Effects of application this mineral on water infiltration of a recharge basin was studied using a completely randomized design with 5 treatments and 3 replications. Polyethylene cylinders of 30 cm inside diameter and 150 centimeter in height were used in this study. Ten cm of coarse sand filter was placed at the bottom of each cylinder then 40 cm of crusted soil from the bottom of a recharge basin, which had been passed through a 4 mm sieve, was placed on the filter. Subsequently, 95 cm of floodwater was slowly poured into each cylinder. Treatments were: 1.control without raw gypsum; 2. mixture of 0.5 Kg/m^2 gypsum in 15 cm of top soil of the recharge basin before watering: 3. mixture of 1 Kg/m^2 gypsum in water of recharge basin; 4. adding 0.5 Kg/m^2 gypsum to water of recharge basin; and 5. adding 1 Kg/m^2 gypsum to water of recharge basin. For adding gypsum in cylinders of treatments 4 and 5, first gypsum was mixed with some water of cylinders then the suspension was added to the cylinders. Infiltration rate was determined by daily measurement of the water level recession in each cylinder. These data were later converted into infiltration rate. Each cylinder was capped to reduce evaporation. Although Abtahi (1980) has given a detailed report of the clay minerals in the

Sarvestan Basin, where our study was performed, we decided to characterize them in the recharge basin sediment. These minerals were characterized by the powder X-ray diffraction method. The identified minerals were: quartz, calcite, dolomite, plagioclase, feldspar, albite, chlorite, mica (illite), kaolinite, hematite and amphibole.

Data Analysis: Infiltration data were analyzed using the MSTAT-C software and the means comparisons at statistical level of 0.05 were carried out by the Duncan's Multiple Range Test and using the EXCEL software for drawing the graphs.

Results and Discussion

Tables 1and 2 present the results of physical and chemical analysis of the crust of the recharge basin and chemical analysis of water from the basin, respectively. Table 1 indicates that the soil is of heavy texture (clay loam) and high density (apparent specific gravity is 1.54 g/cm^2). Since the reaction of the soil is alkaline, the surplus amount of calcium carbonate in the soil (Table 1) is not soluble enough to flocculate the clay particles. Effect of experimental treatments on water infiltration rate is shown in figures 1 through 6.

Table1: Physical and chemical analysis of soil

Characteristics	Quantity	Characteristics	Quantity
Dissolved Ca^{+2}	9.19 meq/lit	Sand	35.68 %
Dissolved Mg^{+2}	6.16 meq/lit	Silt	34.00 %
Dissolved Na^{+}	0.42 meq/lit	Clay	30.32 %
Dissolved K^{+}	0.51 meq/lit	Texture	Clay loam
Equivalent Calcium Carbonate	36.12 %	Initial soil water content	30.72 %
Sodium Adsorption Ratio	0.152	Bulk density	1.54 g/cm^3
CO_3^{-2}	0.00 meq/lit	Electrical Conductivity	1.50 dS/m
HCO_3^{-}	3.94 meq/lit	pH	7.49
Cl^{-}	2.57 meq/lit	Organic matter	1.63 %
$SO4^{-2}$	4.69 meq/lit	Total nitrogen	0.0815 %

Table 2: Chemical analysis of water from the recharge basin

Characteristics	pH	EC (dS/m)	me/L								SAR
			Na^{+}	K^{+}	Ca^{2+}	Mg^{2+}	SO_4^{2-}	Cl-	HCO_3^{-}	CO_3^{2-}	
Quantity	7.50	0.14	0.04	0.09	1.20	0.014	0.23	0.25	1.28	0.00	0.049

Figures 1and 2 indicate that gypsum treatment significantly increased IR on the 1st and 2nd day the experiment, of which application of 0.5 Kg/m^2 of gypsum after watering was statistically greater ($P<0.05$) than the rest. This increase in the IR rate was still significant relative to control in the 3rd and 4th day, too (Figures 3 and 4). Infiltration rate in the 5th day was the same for all treatments. IR in the 0.5 Kg/m^2 mineral gypsum after watering treatments for the 1st, 2nd ,3rd, and 4th day were 10.22, 5.59, 3.89, 3.13 mm/hr, respectively. Therefore, there were 28.5, 23.4, 15.8, 9.8 percent increase in IR (Figure 6). Application of 0.5 Kg/m^2 gypsum before watering increased the IR 10.6, 13, 14.9 and 4.9 percent for the 1st, 2nd, 3rd, and 4th day. However, application of 1 Kg/m^2 gypsum after water addition reduced the IR by 26.7, 6.4, 11 and 12.3 percent. Average

increases in the IR for the first two days, for the first three days, and for the four days after application of 0.5 Kg/m^2 gypsum after watering in comparison with control were 26, 22.6, and 19.6 %, respectively. Rangasamy (1982) reported that the presence of free electrolyte can improve soil characteristics in respect to dispersion. Rousta (2001) reported that application of 9 metric ton of gypsum per hectare caused an increase in IR as compared with the control. McKenzi (1982) and McKenzi and So (1989) have shown that application of 7.5 t/ha gypsum to a Vertisols (clay=72%; ESP = 7.0) increased the IR 2.5 times that of the control. Davidson and Quirk (1961) reported that application of gypsum during irrigation increases IR of arduous soils.

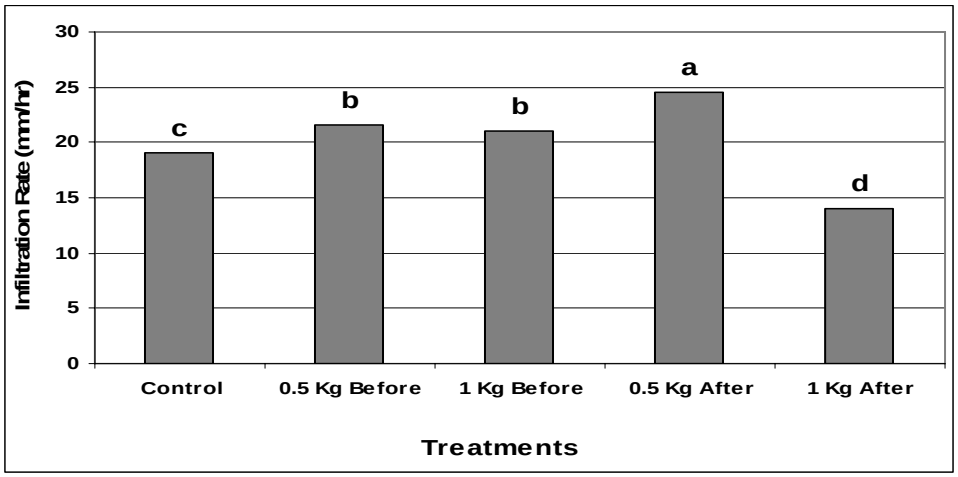


Fig. 1: Effect of mineral gypsum on infiltration rate in soil of recharge basin (1st day).

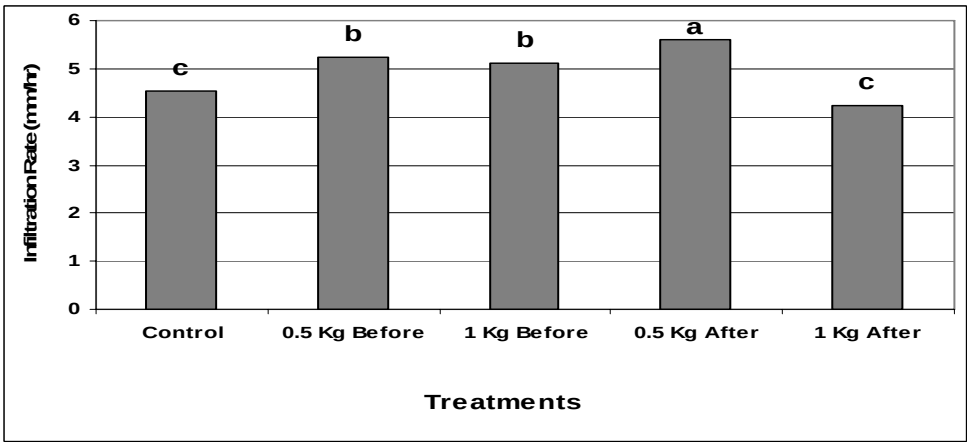


Fig 2: Effect of mineral gypsum on infiltration rate in soil of recharge basin (2nd day).

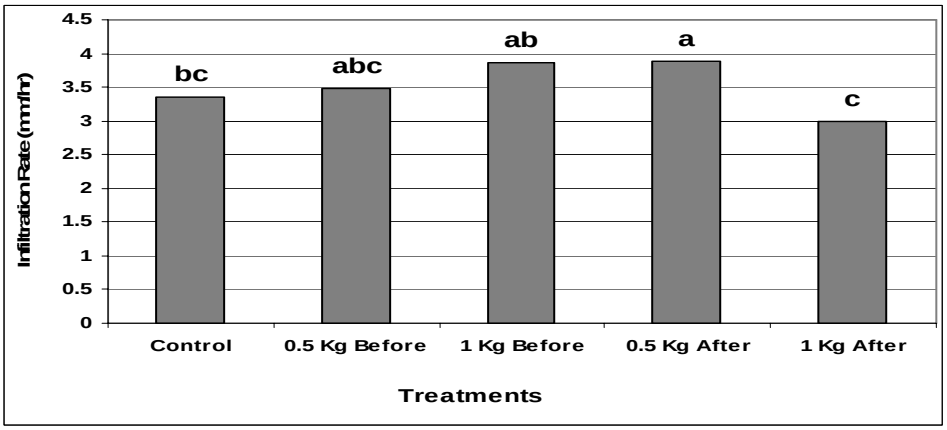


Fig. 3: Effect of mineral gypsum on infiltration rate in soil of recharge basin (3rd day).

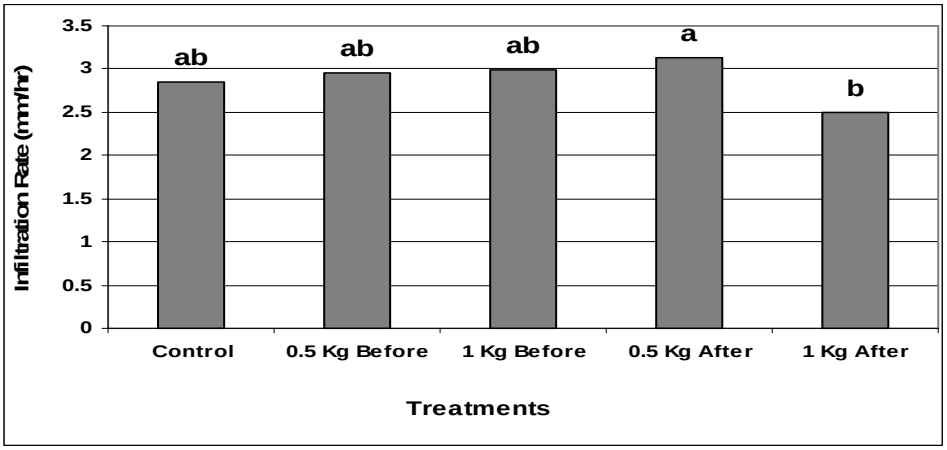


Fig. 4: Effect of mineral gypsum on infiltration rate in soil of recharge basin (4th day).

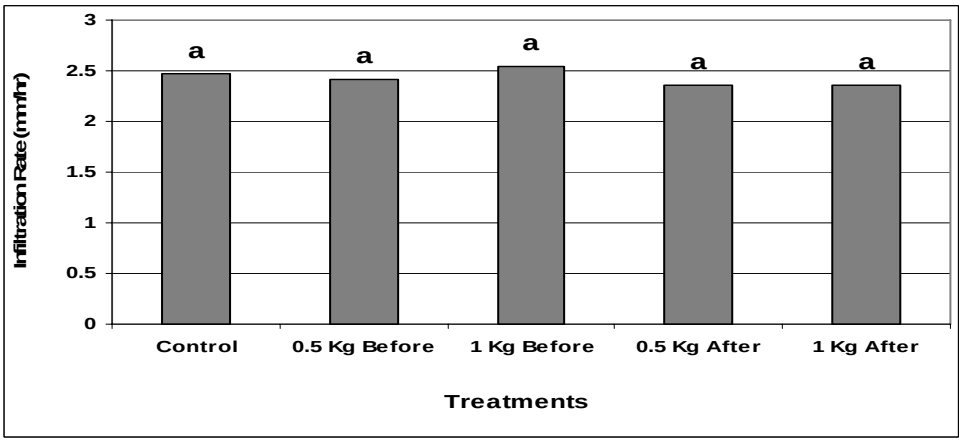


Fig. 5: Effect of mineral gypsum on infiltration rate in soil of recharge basin (5th day).

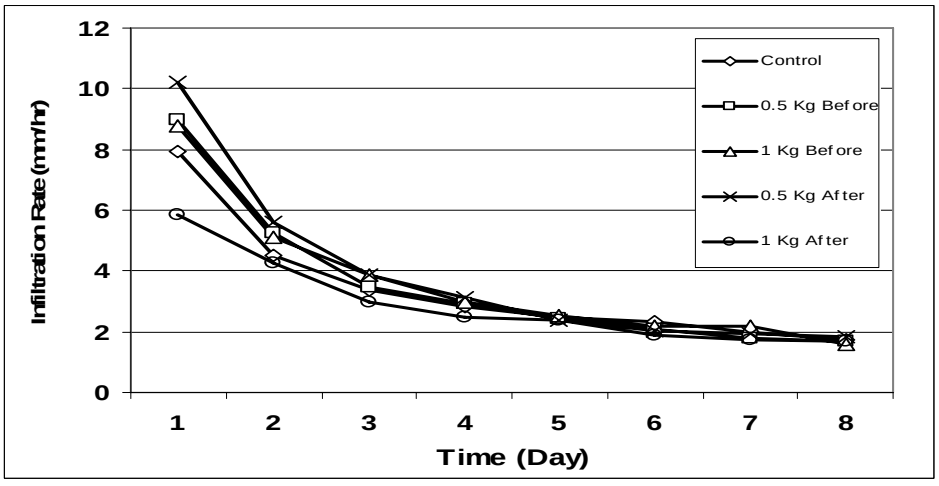


Fig. 6: Effects of different treatments on infiltration rates in soil of recharge basin.

Mixing 1 Kg/m^2 of <500 micrometer gypsum with the crust of recharge basins in the Sarvestan area before the recharge activities, or addition of 0.5 Kg/m^2 of the same material to the recharge water, significantly increases the IR. This is probably due to cation exchange, i.e., sodium replacement by calcium ions that abound in the solution. Flocculation of suspended clay particles decreases their entrance into soil pores. Therefore, extended application of this technology is recommended. This is economically justified as well. It is postulated that the addition of 1Kg/m^2 of gypsum after watering causes clogging of some pores. Therefore, crust removal is effective only after the gypsum treatment of the basin bottom or the recharge water. Thus, the large scale

application of this financially viable technology is recommended. Economics of the scale decides the applicability of one of the two methods.

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Wind Erosion Control of Soils Using Polymeric Materials

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Abstract:

Wind erosion of soils is one of the most important problems in environment and agriculture which could affects several fields. Agricultural lands, water reservoires, irrigation canals, drains and etc. may be affected by wind erosion and suspended particles. As a result wind erosion control needs attention in arid and semi-arid regions. In recent years, some polymeric materials have been used for improvement of structural stability, increasing aggregate stability and soil stabilization, though kind of polymer, quantity of polymer, field efficiency and durability and environmental impacts are some important parameters which should be taken into consideration. In this study, a Polyvinil Acetate-based polymer was used to treat different soils. Then polymer-added soil samples were investigated experimentally in a wind tunnel to verify the effecte of polymer on wind erosion control of the soils and the results were compared with water treated soil samples. The results of wind tunnel experiments with a maximum 26 m/s wind velocity showed that there was a significat difference between the erosion of polymer treated and water treated soil samples. Application of 25g/m^2 polymer to Aeolian sands reduced the erosion of Aeolian sands samples to zero related to water treated samples. For silty and calyey soils treated by polymer, the wind erosion reduced minimum 90% in relation to water treated samples.

Keywords: Polymer, Wind erosion, Wind tunnel, Aolian sand

Introduction

Wind erosion is one of the main factors in soil and environment degradations, air pollution, suspended particles transports, etc. So there must be many studies to get a better understanding of the process of this phenomenon (Refahi, 2004). On the other hand, with regard to climate changes, wind erosion is one of the important issues in arid and semiarid areas. Wind erosion damages depend on wind characteristics such as velocity and duration of the wind as well as the amounts and types of transported particles and also surface layer properties. Wind erosion causes many damages to agricultural productions, buildings and structures (Lian-You et al., 2003). There are different methods to control wind erosion; biological methods (using plants as windbreak), mechanical methods (trench excavation and building windbreak), and surface layer reinforcement using soil stabilizers such as petroleum mulches and polymeric materials. Applications of mechanical and biological combinations are better especially to reduce the execution time and costs of the surface stabilization.

One of the common methods in dust control is water sprinkling on soil surface which prevents dust production and wind erosion and it can be also very expensive depending on climate condition, site position and labor wage (Hoover, 1987). Some methods as petroleum mulch and artificial polymers application have been considered to increase soil and aggregates stability in order to control of wind erosion and soil stabilization. Many factors such as defining effective polymer in wind erosion control, resistance to erosive factors, effeciency in water erosion control, optimum concentration, durability in natural condition (low and high temperatures, UV rays, chemical solutions and etc.) must be considered in selection of a polymer as soil stabilizer. Application of these types of materials is under development due to its numerous advantages.

Many attempts in laboratories and fields have been done to find the simple index of soil erosivity against wind and water. Investigation of wind erosion by wind tunnel showed that soil erosion depends on dry aggregates size distribution (Chepil and Milne, 1941). Other studies also revealed that aggregates' stability is one of the main factors in erosion control. Bryan (1968) represented the aggregate's stability in water as the best index. However, soil resistance to erosion depends on dry aggregates' stability. Soil moisture percentage also is one of the effective factors to wind erosion, so wet soils are more resistant than dry ones. Chepil and Woodruff (1963) by investigating different soils, listed their mechanical consistency from the high to the low: water stable

aggregates, secondary aggregates, surface layer and small particles between secondary aggregates. As water stable aggregates are smaller than 1 mm in diameter, only the other particles can provide a stable surface layer. However, the stability of aggregate with diameter less than 1 mm is also important as they could be eroded and source of suspended soil (Hagen and Lyles, 1985). Estimations of region soil losses are assessed by experimental methods such as I.R.I.F.R or similar methods (based on effective factors in wind erosion) or indirect measuring by Wind Erosion Meter with analyzing of regional analysis of wind duration and velocity (Ekhtesasi and Ahmadi, 1996).
Application of chemical polymers to control of wind erosion and to increase water holding capacity of soil is one of the other methods in dust and erosion control which depends on polymer characteristics. Moore and Siddiqi (1981) investigated water and wind erosion of sandy soils which revealed that Butadiene-Styrene has good performance in wind and water erosion control and treated soil permeability is not significantly different. Wellace et al. (1986) showed that contrary to anionic polymer, cationic polymer has better aggregation in calcic soil rather than acidic one. These results show that salts make the clay particle close to each other, so some of them can adhere together by one poly anion. Telyscheva and Shulga (1995) revealed that application of water solution polymer (Si-Ad) which contains 0.5-0.8 % silicone with application doses of 375 gr/m^2, causes the sand particle adheres and makes one 4-14 mm layer with 0.49-2.9 MPa penetration resistance. So polymeric materials reduced the evaporation from soil surface and wind erosion (wind erosion is less than 0.09-0.11 kg/m^2) and it didn't affect the germination and seed growth. Kennth and Nwankwo (2001) represented that polymer effects on soil appears with large aggregates formations by adhering the smaller ones. The study about application of 30-50 gr Acetate polymers on fly ash showed that it makes a protective layer to 20m/s wind velocity and it stays stable for 6-8 months (Hadjiv and Hadjiv, 2003). Research about poly Acryl Amid also revealed that 4 gr/m^2 application of this material increases the soil resistance to wind erosion (He et al. 2008). Therefore, application of polymers for increasing of soil particles diameter and agregates is one of the control methode to prevent surface layer erosion. But in polymers applications in wind erosion control some factors must be considered. The aim of this study is experimentally investigation of the efficiency of Poly Vinyl Acetate (PVA) in wind erosion control of different soils.

2. Materials and Methods

First, the appropriate soil samples were provided. To this end and define polymer efficiency in wind erosion control, three types of soil textures including wind-blown sand, silty and heavy clay soils were selected. Clayey and silty soils were provided from Alborz province and wind-blown sand was supplied from Aran and Bidgol and were transported to laboratory. Physical properties of the soils including natural soil moisture, sieve analysis and hydrometery test, Atterberg limits and soil density were determined by standard tests. In this study applied chemical material for soil stabilizing was a chemical co-polymer based on Poly Vinyl Acetate ((C4 H6 O2) n) which used as a water emulsion. The emulsion was white in color and had 1.05 g/cm3 specific gravity and concentration of 25 g/lit. The type and rate of applied polymer for wind erosion experiments were defined based on last researches results. Therefore, D_{25} or 25 gr polymeric material in 1 liter of water was used for treatment of the soils. The rate of 25 gr/m^2 of added polymer and water without polymer in 25 gr/m^2 were considered as treatments. To investigate the wind erosion rate, an open-circuit wind tunnel was designed, fabricated and applied (Figure 1). This tunnel was similar to low-speed wind tunnel (Pope and Harper, 1966) designed and constructed by Ekhtesasi (1991). Wind tunnel was fabricated by 2 mm galvanized iron sheets with dimensions of 0.3×0.3×2.25 m and it has four windows. These windows were designed to install anemometer, samples and observation of the wind erosion process (Figure 1). Samples were prepared in 0.02×0.3×0.4 m trays and inatalled in the tunnel's floor in centre of tunnel. Also central part of tunnel had a 4 cm metallic frame to allow the installation of the samples. Wind was produced by a fan with 56 cm propeller diameter and 16000 m3/hr air capacity. Fan was set on a platform; tunnel and fan were concentric. A white iron diffuser in 1.8 m length was applied to connect the fan and tunnel.

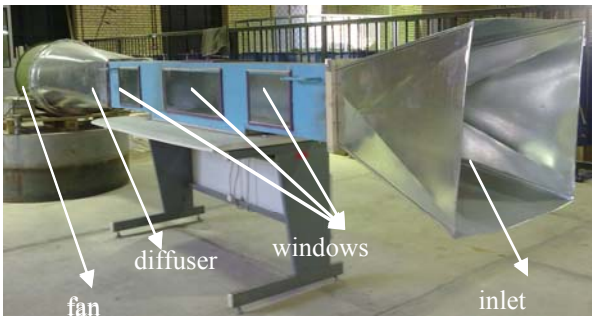


Fig. 1- Fabricated wind tunnel including, inlet, tunnel and windows, diffuser and fan

To facilitate air entrance in the tunnel an inlet was applied by the proportion of inlet to outlet as 4 to 1 (Rathakrishnan, 2007). Wind velocity was measured by two anemometers; propeller velocimeter and hot film anemometer. Logarithmic wind velocity in the center of tunnel was investigated and confirmed. Experimental samples were preapared in 0.3×0.4×0.02 m metallic trays. After filling sieved soil, water or polymer emulsion (25 gr/m^2) was sprayed on the samples by weighted method. So the samples were put on an automatic balance, then the emulsion or water was added up to the defined weight. The samples were put in an air conditioned place to make dry naturally. Then the samples were set in specified place in wind tunnel to investigate the wind erosion. To study the polymeric treatments in wind erosion the maximum velocity in tunnel center (26 m/s) was considered which was more than wind erosion threshold in the region and it was appropriate for investigating polymeric samples. Experiment duration was determined considering maximium wind velocity and size of the samples and was fixed to 5 minutes. After this time, the samples were weighted again and compared with its primary weights to find out wind erosion rate. Treatments comprising three soil different soils (wind-blown, silty and clayey soils), two types of materials; water (D_0) and polymer emulsion with 25 gr concentration (D_{25}) were selected. So, three types of soils with two materials in three replications or 18 samples were considered. Table 1 shows the treatment's characteristics.

Fig. 1- Treatment properties

Soil type	Experiment	Tretment	
Sand	Wind (26 m/s)	by water	D_0
	Wind (26 m/s)	Polymeric	D_{25}
Silty	Wind (26 m/s)	by water	D_0
	Wind (26 m/s)	Polymeric	D_{25}
Clayey	Wind (26 m/s)	by water	D_0
	Wind (26 m/s)	Polymeric	D_{25}

D_0: 1 lit/m^2 water added to soil
D_{25}: 1 lit/m^2 polymeric emulsion added to soil

3. Results and Discussion

Soil texture, compaction characteristics and Atterberg limits were presented in Table 2. Wind-Blown sand, silty and clayey soils were classified based on USDA as sand, silty loam and clay silty loam, respectively (Table 2).

Table 2: Physical properties of soils

Sample	Soil texture (%)			Compaction (Standard Proctor test)		Atterberg limits		Unified Classidication
	Caly	Silt	sand	Optimum water content (%)	Maximum dry density (g/cm^3)	LL (%)	PL (%)	
Sand-blown	0	0.4	99.6	12.5	1.73	NP[1]	NP[1]	SP[2]
Silty loam	15	75	10	19.5	1.58	38	28	ML[3]
Silty Clay Loam	30	65	5	21	1.60	42	28	CL[4]

1: Non-Plastic; 2: Poorly graded Sand; 3: Low plasticity Silt; 4: Low plasticity Clay

The volumetric water content of wind-blown sand, silty and clayey soils were 0.65, 3.38 and 4.06% respectively which shows that soil moistures are very low. Atterberg limits; i.e. Liquid Limit (LL), Plastic Limit (PL) and Shrinkage Limit (SL) of samples were determined based on Unified System. Based on Table 2 the sand sample (wind-blown) is completely non-plastic (NP) with uniform particle size and two other soils are a little plastic (liquid limit is less than 50). To identify the soils compaction characteristics (optimum water content and maximum dry density) were determined by Proctor method. Investigation of the samples before putting in tunnel showed that surface layers in both water and polymer treatment samples of silty loam and silty clay loam soils, included multiple cracks. Meanwhile in sandy soil, an integrated surface layer whitout any cracks was atablished. Studying wind velocity profile in wind tunnel center shows the maximum velocity (26 m/s) in tunnel center (Fig. 2). In addition, Fig. 2 represents the high-speed velocity gradient in tunnel bed. The wind velocity difference between the beginning and the end of tunnel was less than 5%.

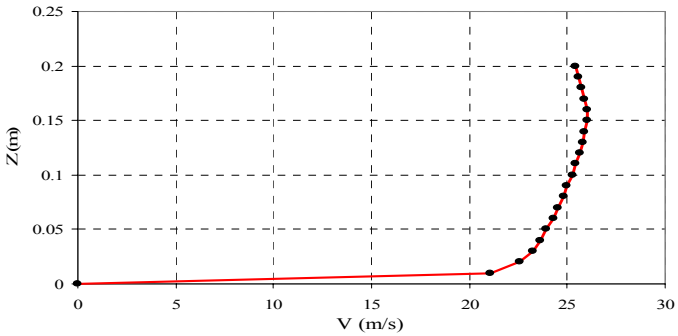


Fig. 2- Wind velocity distribution in centre line of wind tunnel (Z and V are distance from the bed and wind velocity, respectively)

Table 3 represents the results of wind erosion of different soils.

Table 3- Soil losses of samples by wind velocity of 26 m/s

Test No.	Soil	Treatment	Mean erosion[1] (gr)	Mean erosion (kg/m^2/hr)	Mean erosion (kg/m^2/hr)		
					Soils	D_0	D_{25}
1	Sand-blown	D_0	2126	212.6	106.3	55.2	0.2
2		D_{25}	0	0			
3	Silty loam	D_0	35	3.5	1.95		
4		D_{25}	4	0.4			
5	Silty clay loam	D_0	23	2.3	1.25		
6		D_{25}	2	0.2			

1: Mean of three replications

The effect of polymer on wind erosion was statistically analyzed by completely randomized block as factorial experiment design using SPSS ver. 16 (table 4).

Table 4- Results of variance analysis of effects of soil and stabilizer on wind erosion

Sources of variation	Degree of Freedom	Mean square of soil erosion
Replication	2	220.5^{ns}
Soil	2	21924.8**
Stabilizer	1	23718.4**
Soil X Stabilizer	2	22050.4**
Total error	10	196.4
Total mean (kg/m^2/hr)	17	36.5
Coefficient of Variation (%)		38.4

**: significant at a significance level of 1 % (0.01)
ns: Non-significance

Considered factors were stabilizer (in two levels; D_0 and D_{25}), types of soil (in three levels; wind-blown sand, silty loam, and silty clayey loam) and in three replications (Table 4). The statistical analysis (Table 4) reveals that there is no significant difference betweenot replications at a significance level of 0.01 or with a probability level of 99%. But there is significant difference between soil erosion of treatments containing different levels of polymer and soil types. Also, the table shows that various parameters; i.e. soil type and kind of stabilizer, affect the erosion, significantly, meanwhile there exist interactions between these parameters. Assessment of the effect of polymer application on soil erosion control of soils by mean values comparison using Duncan method showed that there is no significant difference betweenot wind erosion of silty loam and silty clayey loam (with 1.95 and 1.25 kg/m^2/hr soil losses, respectively; Table 3). But there is significant difference between these soils and sand-blown sand (with 103.6 kg/m^2/hr soil loss; Table 3). Table 3 shows also that the erosivity of polymer treated samples is less than water treated samples (0.2 and 55.2 kg/m^2/hr, respectively). On the other hand, wind erosion averages in different soils (using Duncan method) are different significantly. Based on Table 3, clayey soil with 1.25 kg/m^2/hr and wind-blown sand with 106.3 kg/m^2/hr are the lowest and highest erosion respectively. Silty soil erosion is limited to 1.95 kg/m^2/hr. As in Table 3, wind erosion of wind-blown sand treated by polymer is zero. In addition, wind erosion of polymer treated silty soil is 90% less than water treatment silty soil and in clayey soil this reduction is 91%. Therefore, wind erosion rates in polymer treatment soil is reduced more than 90% which proves the polymer efficiency in wind erosion control.

In fact, added polymer chains produce a layer on the soil surface that contains the aggregates and particles. Although the surface layer's nature is different in soils but polymer material increases the soil resistance to wind, by producing this thin layer. The surface layer of polymeric samples of sandy soil, is completely homogenous, relatively hard and without any crack after drying. Surface layer in silty loam and silty clayey loam treated by polymer, includes also a layer but with cracks. The crack patterns in water and polymer treated samples are not different. However, polymer emulsion is efficient in erosion reduction of these soils (Table 3). Therefore, the surface layer in wind-blown sand treated by polymer is sufficently resistant against wind erosion and is different from water treated samples. The surface layer of polymeric samples in silty and clayey soils icludes random cracks with lower efficiency against wind erosion.

4. Conclusion

In order to study of the effect of Poly Vinyl Acetate based polymer emulsion on resistance to wind erosion, three types of soils were treated by polymer emulsion in three replications. Wind-tunnel was designed and fabricated for experiments. The results showed that 25 gr/m^2 of this polymer (added as water emulsion of 25 gr/lit) by forming a resistant layer on soil surface, which is completely different from water layer formation, controls the wind erosion against 26 m/s wind velocity. Based on results, polymer erosion rate in 26 m/s velocity is very low. Polymer treatment erosion is reduced at least 90% in comparison to water treatment and it represents the polymer emulsion efficiency in wind erosion control. In fact the mechanisms of erosion control by polymer are increasing dry aggregates stability and their connections and creating a surface layer which is resistant to erosion. To optimize performance condition it is recommended to determine the optimum polymer in natural condition, considering important parameters such as temperature, humidity, durability, wind velocity, vegetation and etc.

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Effect of Polymer Application on Temporal Variation of Dry Aggregates Stability

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Abstract
Increasing soil resistance against erosive factors such as wind and water erosions has been under consideration and in this way different methods have been used. In the previous studies, a great emphasis has been done on the role of dry aggregates stability in erosion control. This paper aims to investigate the impact of a Polyvinyl Acetate-based polymeric emulsion on dry aggregate stability, MWD temporal variation and optimum amount of polymer in different soils. To do this, at first 3 different soil textures were prepared and were investigated. Then 12 treatments were prepared using four levels of 0, 25, 40 and 50 g/m^2 of polymeric material of different concentrations and three different soils. Finally in one day, one, three and six month's intervals after preparation, the dry mean weight diameter (MWD) of treatments were measured with 3 replications. Statistical analysis showed that in all time intervals, application of polymeric material has significantly increased the MWD related to water treated samples. For Aeolian sand, the effects of all polymers on MWD are considerable in all time intervals. Amount of 1-day MWD in polymeric silty samples increased significantly related to water treated samples. MWD of polymer treated of these samples shows an increase for 50 and 40 gr/m^2 treatments followed by a decrease which relates to amount of polymeric material. For clayey soil, only the MWD of 50 g/m2 polymeric sample is greater than water treated sample and variation of aggregate diameter in clayey soil depend not only the amount of added polymer but also to dilution rate of polymer.
Keywords: MWD, PVA polymer, Dry aggregate stability

Introduction
Water and wind erosion have been under consideration due to their impacts on the environment and agriculture. Soil and wind erosion are main factors in the damage to natural resources, air and water pollutions and with regard to climate changes, are still important issues in arid and semi-arid regions. Although global-scale risk of wind erosion is less than water erosion (Refahi, 2003), but wind erosion in some areas is more important (Ghadiri, 1993). Wind erosion, transports particles which destroy agricultural soils and transported particles make problems and could cover the lands (Alizadeh, 1989). This is more serious especially in arid areas due to poor vegetation, lack of humus, dry and fine-grained soil surface. Different methods and tools have been used for improving the characteristics of soil and increasing soil resistance against corrosive factors. Depending on the type and purpose of the projects, various solutions such as biological methods (use of plants and vegetation as protective layer), mechanical methods (digging ditches, construction of wind breaks) and enhanced surface layer by soil stabilizers and mulches and polymeric materials have been used for water and wind erosion control. Investigation of wind erosion by wind tunnel showed that soil erosion depends on dry aggregates size distribution (Chepil and Milne, 1941). Other studies also proved that aggregates' stability is one of the main factors in erosion control. Bryan (1968) represented the aggregate's stability in water as the best index. However, soil resistance to erosion depends on dry aggregates' stability or Mean Weight Diameter (MWD). Soil moisture percentage also is one of the effective factors to wind erosion, so wet soils are more resistant than dry ones. Chepil and Woodruff (1963) by investigating different soils, listed the mechanical consistency of soils from the high to the low: water stable aggregates, secondary aggregates, surface layer and small particles between secondary aggregates. As water stable aggregates are smaller than 1 mm in diameter, only the other particles can provide a stable surface layer. However, the stability of aggregate with diameter less than 1 mm is also important as it could be eroded and source of suspended soil (Hagen and Lyles, 1985).
One of the common methods in dust control is water sprinkling on soil surface which prevents dust production and wind erosion and it can be also very expensive depending on climate condition, site position and labour wage (Hoover, 1987). Some methods as petroleum mulch and artificial polymers application have been considered to increase soil surface resistance and aggregates

stability in order to control of wind erosion and soil stabilization. Many factors such as defining effective polymer in wind erosion control, resistance to erosive factors, efficiency in water erosion control, optimum concentration, durability in natural condition (low and high temperatures, UV rays, chemical solutions and etc.) must be considered in selection of a polymer as soil stabilizer. Application of these types of materials is under development due to its numerous advantages.
Application of chemical polymers to control of wind erosion and to increase water content capacity of soil is one of the other methods in dust and erosion control which depends on polymer characteristics. Siddiqi and Moore (1981) investigated water and wind erosion of sandy soils which revealed that Butadiene-Styrene has good performance in wind and water erosion control and treated soil permeability is not significantly different. Wallace et al. (1986) showed that contrary to anionic polymer, cationic polymer has better aggregation in calcareous soil rather than acidic one. These results show that salts make the clay particle close to each other, so some of them can adhere together by one poly anion. Levy et al. (1995) found that application of low values of anionic Poly Acrylamide (PAM) to irrigation water, could reduce runoff and erosion of saline soils but the performance of this material depends basically on water quality and polymer concentration. Telysheva and Shulga (1995) revealed that application of water solution polymer (Si-Ad) which contains 0.5-0.8 % silicone with application doses of 375 gr/m^2, causes adherence of sand particles and makes a 4-14 mm layer with 0.49-2.9 MPa penetration resistance. As a result, polymeric materials reduced the evaporation from soil surface and wind erosion (wind erosion is less than 0.09-0.11 kg/m^2) and it did not affect the germination and seed growth. Kenneth and Nwankwo (2001) represented that polymer effects on soil appears with large aggregates formations by adhering the smaller ones. Research about Poly Acryl Amid also revealed that 4 gr/m^2 application of this material increases the soil resistance to wind erosion (He et al. 2008). Liu et al (2009) investigated water-stability of clay aggregates admixed with aqueous polymer and reported that application of polymer, increased water-stable aggregates size. Therefore, application of polymers for increasing of soil particles diameter and aggregates is one of the control methods to prevent surface layer erosion. But in polymers applications some factors must be considered in wind erosion control. Since understanding the erosion mechanisms are important for design of erosion control, investigation of efficient factors in this phenomenon is an essential tool for any soil conservation success. Considering the importance of dry aggregate stability, the aim of this research is investigation of the efficiency of Poly Vinyl Acetate (PVA) in dry aggregate stability (MWD) of different soils. MWD of dry aggregates will also study in different time interval to find the durability of polymer application.

2. Materials and Methods

First, the appropriate soil samples were provided. In order to find the polymer efficiency in dry aggregate stability, three types of soil including wind-blown sand, silty and clayey soils were selected. Clayey and silty soils were provided from Alborz province and wind-blown sand was supplied from Aran and Bidgol region and was transported to laboratory. Physical properties of these soils, including natural soil moisture, sieve analysis and hydrometery test, Atterberg limits and soil density were determined by standard tests. In this study applied chemical material for soil stabilizing was a chemical co-polymer based on Poly Vinyl Acetate ((C4 H6 O2) n) which used as a water emulsion. The emulsion was white in colour and had specific gravity of 1.05 g/cm^3. Three levels of polymer concentration (25, 40, 50 g/m^2 named as P_{25}, P_{40} and P_{50} respectively) were used to find the optimum amount. Water without any polymer also used as a treatment. Table 1 presents characteristics of different treatments in this study.

Table 1- Characteristics if considered treatments

Treatments	Emulsion concentration (g/lit)	Volume of emulsion added to soil (lit)	Application level (g/m^2)
P_0	0	2	0
P_{25}	25	1	25
P_{40}	40	1	40
P_{50}	25	1	50

To verify the natural conditions on such as UV rays, temperature, rainfall and time on aggregate stability, a suitable site was considered. Considering three types of soil and four levels of polymer, this site included 12 plots of 1m x1.5m and each plat considered as one treatment. Sieved soils (< 2 mm) were used to fill the plats and the plats were filled till height of 0.02 m and the soil surfaces were smoothed (Fig. 1).



Fig. 1- Site preparation for treatments

Then, the samples were treated by different amount of polymer. Water or polymer emulsions were hand-sprayed on the soil surface by weighted method. To do this, the considered amounts of water or polymeric emulsions were weighted and sprayed to soils. The treated soils, dried naturally. Mean Weight Diameter (MWD) of dry aggregates were determined in 1-day, 1, 3 and 6 months time periods. MWD was calculated using Equation 1 (Klute, 1986; Le Bissonnais, 1996).

$$MWD = \sum_{i=1}^{n} \overline{x}_i W_i \qquad (1)$$

In this equation, W_i and x_i are the percent of soil weight on sieve and sieve mesh diameter respectively. First, for each time period, the treated soils were sieved by 4.76 mm mesh size. Then 70 g of soils, were put on top of a sieve set with 2, 1, 0.425, 0.250, 0.106, 0.075 and 0.045 mm mesh size (10, 18, 40, 60, 140, 200 and 325 sieve numbers respectively; ASTM standard). A rotary shaker was used to sieve the treated soils. Each sample was shaken for 5 minutes with 60 rpm. For each soil, three replications were measured. The same sample was shaken for second time to determine the effect of mechanical vibration of shaking on MWD value. As the difference between the two MWD values was very small, mechanical vibration impact on MWD was considered negligible. Treatments comprising three different soils (wind-blown, silty and clayey soils) and four levels of polymer emulsion (0, 25, 40 and g/m^2. So, three types of soil with four level of polymer in three replications or 36 samples were considered in each time period. Considering four time periods (1 day, 1, 3 and 6 months), a total of 144 samples were investigated. The effect of polymer on MWD of soils analyzed as a factorial experiment design using SPSS ver. 16. The MWD results, analyzed by a 3x4 factoriel test (with soil as main factor in three levels of sandy, silty and clayey soil and polymer as lateral factor in four levels of 0, 25, 40 and 50 g/m^2 polymer) as a completely random design with three replications.

3. Results and Discussion

Wind-Blown sand, silty and clayey soils were classified based on USDA as sand, silty loam and silty clay loam and the amounts of MWD of natural soils were 0.196, 0.760 and 1.017 mm respectively. It should be noted that for sandy soil, no clay or silt particles were find so MWD of this soil is in fact the mean diameter of particles and in reality there is no aggregate in the sandy soil. But this value could easily compare with treated soils. Mean Weight Diameter of aggregates (MWD) for all treatments determined. For each time period, 12 treatments with 3 replications were investigated. The results of MWD for all periods are shown in Fig. 2.

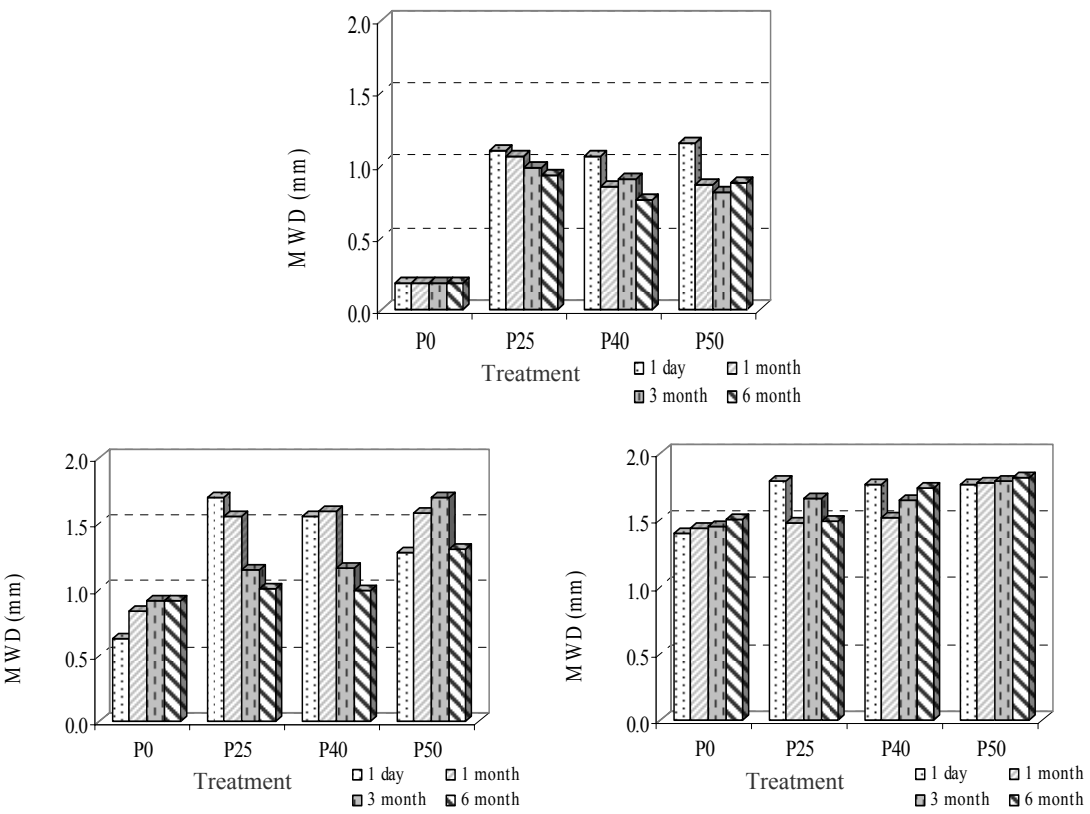


Fig. 2- Variation of MWD for sandy, silty and clayey soils in different time intervals

The effect of polymer on MWD of soils analyzed by a 3x4 factoriel test (with soil as main factor in three levels of sandy, silty and clayey soil and polymer as lateral factor in four levels of 0, 25, 40 and 50 g/m^2) as a completely random design with three replications. The means comparison was done by Duncan test in a level of 1 % significant. Table 2, shows the result of the analysis for 1-day MWD.

Table 2- Results of variance analysis of effects of soil and amount of polymer on MWD (1 day)

Sources of variation	Degree of Freedom	Mean square of MWD
Replication	2	0.069^{ns}
Soil	2	1.943**
Amount of polymer	3	1.191**
Soil X Amount of polymer	6	0.103**
Total error	22	0.023
Total mean (mm)	35	1.280
Coefficient of Variation (%)		11.8

**: Significant at a significance level of 1 % (0.01)
ns: Non-significance

The statistical analysis (Table 2) shows that in 1-day MWD, there are no significant difference between replications at a significance level of 0.01 or with a probability level of 99%. But there is significant difference between MWD of treatments containing different levels of polymer and soil types. Also, the table shows that various parameters; i.e. soil type and amount of polymer, affect significantly the MWD, meanwhile there exist interactions between these parameters. As Table 2 and Fig. 2 show, the effect of polymeric emulsion on 1-day MWD of sandy soil is considerable in comparison with water treated sample (0.189, 1.014, 0.894 and 0.923mm for P_0, P_{25}, P_{40} and P_{50} respectively). But for silty and clayey soils, the differences between 1-day MWD of polymeric treatments (P_{25}, P_{40} and P_{50}) and the water treated samples (P_0) treated by water are not so high.

Nevertheless in these soils also, polymer application has increased dry aggregates. The values of 1-day MWD of P_0, P_{25}, P_{40} and P_{50} treatments of silty soil are 0.825, 1.354, 1.327 and 1.464 mm respectively and for clayey soil are 1.449, 1.601, 1.667 and 1.785 mm respectively.
In the same manner, MWD values in 1, 3 and 6 months also were analyzed. There are no significant difference betweenot replications at a significance level of 0.01 or with a probability level of 99%. But the mean comparison analysis showed that there is significant difference between MWD of treatments containing different levels of polymer and soil types. The results showed that also, as 1-day results, the sandy soil has lowest value of MWD (0.740 mm) and clayey soil has highest MWD (1.549 mm) and silty soil is between these values (1.391 mm). These results are also valid for 3-month MWD. As Fig. 2 shows, 3-monthes MWD of soils are significantly different (0.718, 1.231 and 1.637 mm for sandy, silty and clayey soils). The 3-month MWD of polymeric treatment also are significantly different with water treated samples. These results are also valid for 6-month MWD. But For clayey soil, only the MWD of 50 g/m^2 polymeric sample is greater than water treated sample and variation of aggregate diameter in clayey soil depend not only the amount of added polymer but also to dilution rate of polymer. Finally, statistical analysis of MWD of different soils in four time intervals (all 144 samples), showed that, MWD of soils are different (0.755, 1.242 and 1.625 mm for sand, silty and clayey soil respectively). In addition, there is significant difference between MWD of polymeric emulsion and water treated samples (0.820, 1.391, 1.291 and 1.323 mm for P_0, P_{25}, P_{40} and P_{50} respectively). It should be noted that between P_{25} and P_{50} which produced highest values of MWD, there is no significant difference (Fig. 2). Therefore, considering economical and operational aspects of polymer, application of P_{25} (using 25 g/m^2 emulsion with concentration of 25g/lit) chooses as optimum value of polymer.

4. Conclusion

In order to study of the effect of Poly Vinyl Acetate based polymer emulsion on dry aggregate diameter; sandy, silty and clayey soils were treated by four levels of 0, 25, 40 and 50 gr/m^2 of polymeric emulsions and MWD were determined at 1-day, 1, 3 and 6 months intervals. The results showed that polymeric treatments had higher MWD in all time intervals, and the difference between polymeric samples and water-treated samples were significant. Aggregates diameter of polymeric emulsion, were relatively high, in comparison with water treated samples. Application of polymer, increases aggregate diameter. One day after polymer application, MWD of untreated samples; 0.196, 0.760 and 1.017 mm for sandy, silty and clayey soils were increased and reached to 1.102, 1.507 and 1.771 mm. Meanwhile these values decreased with time, but the values were still bigger than untreated soil aggregates (0.944, 1.382 and 0.682 mm after 6 months for sandy, silty and clayey soils respectively). Therefore, polymer application is efficient on increasing aggregates diameter even after 6 months. In fact the addition of water soluble polymers could create chemical bonds between soil aggregates and polymer molecules. These links vary depending on soil structural properties, concentration and polymer type and therefore aggregate sizes were different in sandy, silty and clayey soils. This mechanism of increasing aggregate size may also connect secondary aggregates and create larger aggregates. Such properties can greatly reduce wind erosion.

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Mean weight aggregate stability; is it soundfull?

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Abstract

Soil aggregate stability, the ability of soil aggregates to resist breakdown by disruptive forces is used as an index for evaluating soil structure, instead of using aggregate size distribution. Only one size aggregate fraction (1-2 mm in diameter) is used to estimate aggregate stability, although it is well-stated that the larger an aggregate when it is dry, the smaller the probability that its disintegrated components will pass through a sieve of given size when it is wet, in other words, stability is highly correlated with aggregate size. The objective of this study was to compare and re-evaluate aggregate stabilities of different-sized aggregate fractions. Soil samples collected from four different great soil groups with different textures were separated into 15 different aggregate size fractions (<0.25, 0.25-0.5, 0.5-1, 1-2, 2-3, 3-4, 4-5, 5-6.4, 6.4-9.5, 9.5-12.7, 12.7-19.1, 19.1-25.4, 25.4-31.8, 31.8-38.1, 38.1-50.8 mm), weighted and aggregate stability of each size fraction was determined using wet sieving analysis. The mean weight aggregate stability (MWAS) was calculated by the sum of products of proportional coefficient of each aggregate size fraction and aggregate stability of each aggregate size fraction. The results indicated that aggregate stability of each aggregate size fraction is different from each other, and showed great variability depending on soil texture. Differences in stability among different size aggregate fractions were less important for the soil with clay content higher than 50%. In overall there was a significant positive correlation between aggregate size and agregat stability ($r = 0.389^{**}$). The MWAS which represents all aggregates in a soil was also statistically different from aggregate stability values of some aggregate size fractions. The highest similarity between the MWAS and fractional aggregate stability was obtained for 5-6.4 mm size fractions in this study. It might be suggested that the MWAS could be a better index for evaluating soil aggregate stability instead of using aggregate stability of a single-size aggregate size fraction.

Key words: Aggregate size, aggregate stability, mean weight aggregate stability

Introduction

Soil structural behaviors influence a wide range of physical, chemical and biological processes. Soil aggregate stability, the ability of soil aggregates to resist breakdown by disruptive forces is used as an index for evaluating soil structure, and a key parameter to provide information about the capacity of soil to function. Many different methods have been proposed to determine soil aggregate stability. Differences in methodology are mainly characterized by the differentiations in the breakdown mechanism of soil aggregates. Slaking, dispersion, differential swelling and raindrop impact are considered as the four main breakdown mechanisms. The suitability of these methods depends on the purpose of the study. Some researchers analyze the breakdown of aggregates due to the wetting actions, but some others consider the mechanical action (Kemper and Koch, 1966; Kemper and Rosenau, 1986; Pierson and Mulla, 1989; Sutherland and Ziegler, 1997; Marquez et al., 2004; Zhu et al., 2009; Nichols and Toro, 2011). The basic method for determining aggregate stability has been employed by Yoder (1936). The most widely used wet-sieving test is the single-sieve method proposed by Kemper and Koch (1966), and later modified by Kemper and Rosenau (1986).

Aggregate stability is often measured on a specific aggregate size class (1-2 mm in diameter) which is not a measurement of whole soil. It is well-stated that the larger an aggregate when it is dry, the smaller the probability that its disintegrated components will pass through a sieve of given size when it is wet, in other words, stability is highly correlated with aggregate size (Kemper and Rosenau, 1986). Therefore, a single size aggregate stability may not correctly represent the whole soil. The objectives of this study were to define the relationship between aggregate size and stability, to compare aggregate stabilities of different-sized aggregate fractions with the aggregate stability of presently used single aggregate size faction and to re-evaluate the results using the mean weight aggregate stability (MWAS) approach.

Materials and Methods

Soil samples collected from four different great soil groups; Pellustert, Argiustoll, Fluvaquent and Ustorthent, with different textures were separated into 15 different aggregate size fractions (<0.25, 0.25-0.5, 0.5-1, 1-2, 2-3, 3-4, 4-5, 5-6.4, 6.4-9.5, 9.5-12.7, 12.7-19.1, 19.1-25.4, 25.4-31.8, 31.8-38.1, 38.1-50.8 mm) by dry-sieving (Figure 1), weighted and aggregate stability of each size fraction was determined using wet sieving analysis.



Figure 1. Aggregate size fractions separated by dry sieving (Pellustert).

The general properties of the experimental soils are given in Table 1. Soil in Pellustert great group is clay textured, Argiustoll soil is clay loam textured, Fluvaquent soil is loam textured and Ustorthent soil is sandy loam textured. Organic matter contents for the study soils were 0.79, 1.73, 2.42 and 1.23% for Pellustert, Argiustoll, Fluvaquent and Ustorthent soils, respectively.

Table 1. General physical and chemical properties of the soils.

Properties	Soil I	Soil II	Soil III	Soil IV
Great soil group	Pellustert	Argiustoll	Fluvaquent	Ustorthent
Clay (%)	61.64	31.48	21.78	17.45
Silt (%)	25.44	47.19	31.01	22.69
Sand (%)	12.92	21.33	47.21	59.86
Textural class	Clay	Clay loam	Loam	Sandy loam
pH (1:2.5 water)	7.04	7.88	7.46	7.22
EC (mS cm^{-1}) $	0.28	0.52	0.36	0.41
CEC (cmol kg^{-1})	33.94	28.57	25.87	19.14
$CaCO_3$ (%)	0.43	1.14	1.03	0.89
Organic matter (%)	0.79	1.73	2.42	1.23

The mean weight aggregate stability (MWAS) was calculated by the sum of products of proportional coefficient of each aggregate size fraction and aggregate stability of each aggregate size fraction.

$$MWAS = \sum_{i=1}^{n} [AS_i . W_i]$$

In where; AS_i = aggregate stability of each aggregate size fraction, %
W_i = proportional coefficient of each aggregate size fraction

The ANOVA was performed by SPSS Statistical Package (SPSS Inc., 2004) using GLM. The Duncan's Multiple Range Test was used for testing mean differences. Correlation analysis was used to define the relationships between aggregate size, aggregate stability and MWAS, and t-tests for determining statistical differences in MWAS and AS for different aggregate size fractions.

Results and Discussion

The experimental soils had different proportions of aggregates in different size fractions (Figure 2). The proportion of micro-aggregates (<0.25 mm) varied from 6.7% and 16.7%. Pellustert soil which has the highest clay content had the lowest proportion for the micro-aggregates. There was a significant negative correlation (r = -0.912**) between clay content and micro-aggregate proportions. The proportion of aggregates with a size of 0.25-4 mm was higher than 50%, on the average.

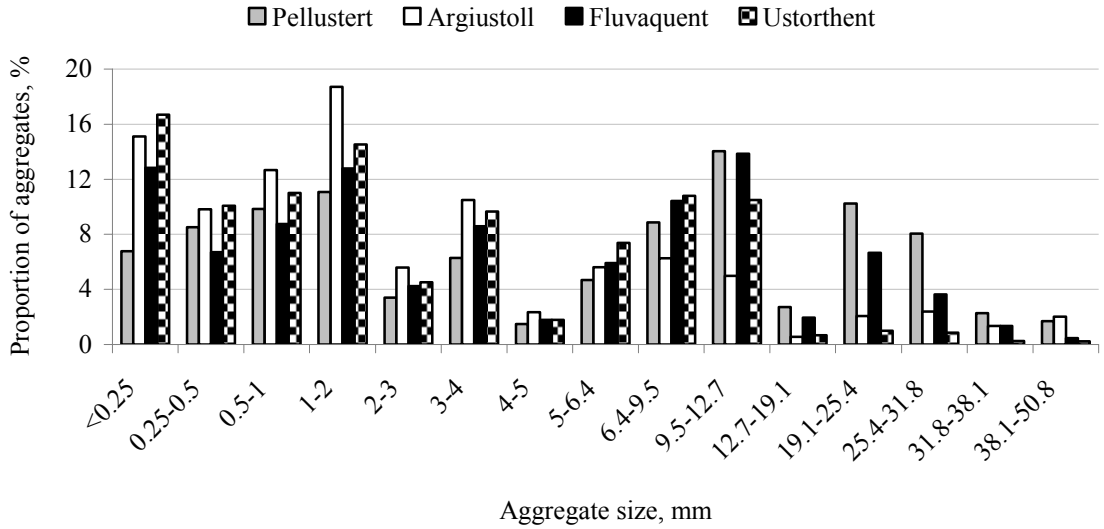


Figure 2. Proportional distribution of aggregates in different aggregate size fractions in soils.

Aggregate stability was significantly affected by aggregate size (Table 2). Unlikely from the other soil great groups, Pellustert soil with higher clay content and low organic matter did not showed clear differences in aggregate stability amoung the aggregate size groups, even though stability of micro-aggregates was generally higher than those of the macro aggregates. However, it was obtained in the rest of the soil great groups of which had relatively higher amounts of organic matter but low clay contents that stability of aggregates greater than 9.5 mm was significantly higher than those of the aggregates smaller than 9.5 mm.

Significant correlations between aggregate stability and clay (r = -0.623**), silt (r = 0.245**), sand (r = 0.442**), organic matter content (r = 0.832**) and $CaCO_3$ content (r = 0.658**) were obtained. In overall, a significant positive correlation was also obtained for aggregate stability and aggregate size (r = 0.389**). It means that aggregate stability increased with increasing aggregate size as shown in Figure 3. The results are agreed with the findings of other researchers. Bresson (1995) reported that with coarse aggregates, slaking due to entrapped air compression is less intensive. Abu-Sharar (1993) emphasized that increasing size of soil aggregates would lead to a reduction of clay dispersion.

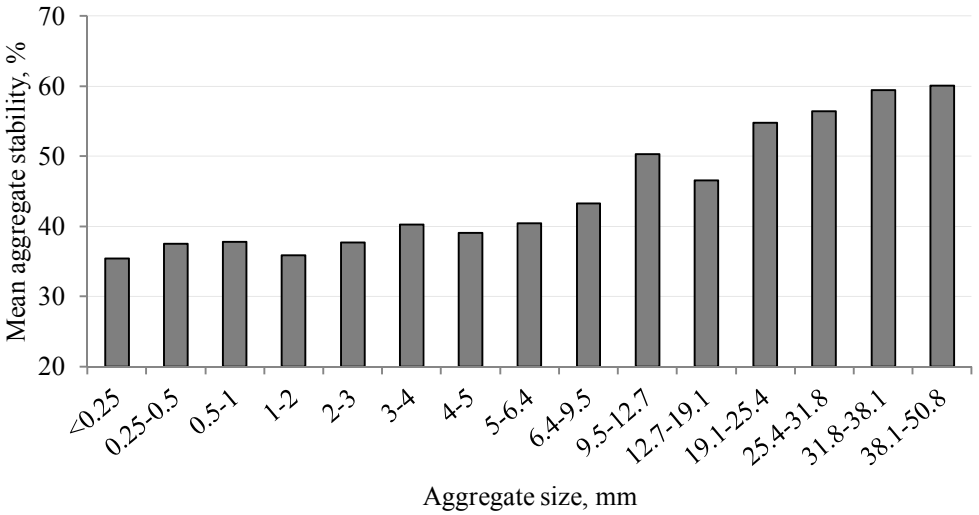


Figure 3. Mean aggregate stability in different aggregate size groups.

Table 2. The MWAS, proportional coefficient of each aggregate size fraction (W_i) and aggregate stability of each aggregate size fraction.

Agg. Size, mm	Pellustert		Argiustoll		Fluvaquent		Ustorthent		Mean	
	AS, %	Wi	AS, %	Wi	AS, %	Wi	AS, %	Wi	AS, %	Wi
<0.25	26.4b	0,0678e	36.4fgh	0,1510b	48.8e	0,1284b	30.1hi	0,1669a	35.4h	0.1285b
0.25-0.5	14.5fg	0,0853d	31.5h	0,0982e	66.8cd	0,0671e	37.6efg	0,1008c	37.6gh	0.0879d
0.5-1	12.4g	0,0984c	33.4h	0,1267c	61.4d	0,0876d	44.0d	0,1102c	37.8gh	0.1056c
1-2	15.8efg	0,1109b	34.2gh	0,1872a	61.6d	0,1278b	32.0h	0,1453b	35.9h	0.1427a
2-3	20.6cde	0,0341g	42.1de	0,0558g	61.8d	0,0423f	26.5i	0,0452f	37.8gh	0.0444f
3-4	21.7bcd	0,0628e	43.0de	0,1049d	63.8d	0,0859d	32.7gh	0,0966d	40.3fg	0.0876d
4-5	24.1bcd	0,0149i	42.6de	0,0235i	60.9d	0,0179g	28.9hi	0,0179g	39.1gh	0.0186h
5-6.4	22.8bcd	0,0467f	40.9ef	0,0562g	64.3d	0,0592e	34.0fgh	0,0737e	40.5fg	0.0590e
6.4-9.5	24.6bc	0,0887d	39.0efg	0,0627f	71.5c	0,1044c	38.1ef	0,1081c	43.3ef	0.0910d
9.5-12.7	24.1bcd	0,1404a	54.2c	0,0498h	80.5b	0,1386a	42.6de	0,1051c	50.3d	0.1085c
12.7-19.1	21.5bcd	0,0272h	46.7d	0,0057j	79.8b	0,0196g	38.2ef	0,0068gh	46.6e	0.0148h
19.1-25.4	35.3a	0,1025bc	60.4b	0,0207i	85.2ab	0,0666e	38.5ef	0,0099gh	54.8c	0.0499f
25.4-31.8	18.8def	0,0805d	66.1a	0,0239i	87.5a	0,0363f	53.5c	0,0085gh	56.5bc	0.0373g
31.8-38.1	21.2bcd	0,0229h	68.3a	0,0134j	84.7ab	0,0136g	63.7b	0,0026h	59.5ab	0.0131h
38.1-50.8	22.0bcd	0,0169i	63.3ab	0,0203i	85.2ab	0,0047h	70.0a	0,0024h	60.1a	0.0111h
MWAS,%	**21.6 D**		**39.8 B**		**67.6 A**		**35.7 C**		**41.2**	

p<0.01

The mean weight aggregate stability (MWAS) values are given in Table 2. A significant positive correlation (r = 0.837**) was obtained between the MWAS and aggregate stability. Significant correlation were also obtained between the MWAS and clay (r = -0.669**), silt (r = 0.210**), sand (r = 0.503**), organic matter (r = 0.974**) and $CaCO_3$ content (r = 0.686**). Among the soils studied, the lowest MWAS (21.6%) was obtained from the Pellustert soil which has the highest clay content and the lowest organic matter. However, the highest MWAS (67.6%) was obtained from the Fluvaquent soil which has the highest among of organic matter content. The t-test comparison test results for the MWAS and aggregate stability of each aggregate size fraction are given in Table 3. There was no significant difference between the MWAS and the aggregate stability of aggregates with a size of 5-6.4 mm in all soils. By considering the integrated effects of all soils, the MWAS was not significantly different from the stability of mid-sized aggregates with the size of 3-4, 4-5 and 5-6.4 mm.

Table 3. The t-test results for the MWAS and aggregate stability of each aggregate size fraction.

Aggregate size mm	Pellustert	Argiustoll	Fluvaquent	Ustorthent	Mean
	p values				
<0.25	**0.025***	**0.017**	**0.002**	**0.036**	**0.022**
0.25-0.5	**0.022**	**0.002**	0.785	0.197	**0.017**
0.5-1	**0.001**	**0.007**	**0.033**	**0.004**	**0.087**
1-2	**0.016**	**0.007**	**0.037**	**0.088**	**0.001**
2-3	0.509	**0.054**	**0.004**	**0.013**	**0.016**
3-4	0.955	**0.078**	**0.065**	**0.046**	0.350
4-5	0.119	0.246	**0.020**	**0.024**	0.160
5-6.4	0.656	0.568	0.242	0.546	0.538
6.4-9.5	0.146	0.584	0.111	0.167	**0.019**
9.5-12.7	0.162	**0.001**	**0.012**	**0.028**	**0.001**
12.7-19.1	0.940	**0.025**	**0.028**	0.149	**0.003**
19.1-25.4	**0.029**	**0.001**	**0.005**	0.419	**0.001**
25.4-31.8	0.103	**0.007**	**0.001**	**0.004**	**0.001**
31.8-38.1	0.728	**0.002**	**0.005**	**0.001**	**0.001**
38.1-50.8	0.857	**0.001**	**0.007**	**0.001**	**0.001**

* The values bolded are significantly different at $p<0.10$

Conclusion

The results of this study indicated that

1. Soils with different texture and organic matter content have different proportions of aggregates into different size groups, and the aggregate stability of each aggregate size groups is significantly different from each other. Aggregates with a size greater than 9.5 mm were more stable than the smaller ones.
2. A significant correlation between aggregate stability and aggregate size implies that aggregate size had great importance for its stability.
3. Using only a specific size of aggregates for determining soil aggregate stability (for instance 1-2 mm as in the standard procedure) does not always perfectly represent the whole soil. Therefore using the MWAS which is calculated by the sum of products of proportional coefficient of each aggregate size fraction and aggregate stability of each aggregate size fraction could be a better estimation of stability of overall soil aggregates.
4. On the average, the highest similarity between the MWAS (41.2%) and the stability of aggregates in different size groups were obtained for 5-6.4 mm (40.5%) aggregate size group followed by 3-4 mm (40.3%) and 4-5 mm (39.1%) aggregate size groups.

In conclusion; soils show great differences in aggregate size distribution that cause differentiation in aggregate stability. It implies that a single size of aggregates may not truly represent an average aggregate stability. Therefore, all aggregates should be considered proportionally in determining aggregate stability. The MWAS is a better explanation of overall aggregate stability for a soil even it is time consuming.

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Chemical Treatment of Contaminated Soils by Using Ozone (Case study: Anthracene Removal)

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Abstract

Polycyclic aromatic hydrocarbons (PAHs) are compounds produced during the burning of coal, oil, gasoline and organic matter. PAHs are an environmental challenge for soils pollution because they are highly recalcitrance, insoluble in water and tend to accumulate in soil surfaces. In situ or on site subsurface soil treatment technologies using chemical oxidants such as ozone may provide effective, low-cost alternatives for removal of these compounds. In the present study, a two-level full factorial design has been investigated the effect of particle size, moisture content, contaminant content, and soil column height on the removal of anthracene by in situ ozonation. The results showed that the removal efficiency decreased with the increasing anthracene concentration, particle size, moisture content and soil column height. According to results of variance analysis, particle size was the most effective factor on removal efficiency of anhtracene from soil. Average removal efficiency range was found between 61% - 82%. Spectrophotometer was employed in this study to determine anthracene as the main ozonation product.

Keywords: In situ, Ozonation, Anthracene, PAHs, contaminated soil.

Introduction

Soil contamination is a challenging problem because of its extent and the difficulty involved in remediation (Shin et al., 2004). Polycyclic aromatic hydrocarbons (PAHs) are a class of organic chemicals that consist of two or more fused-benzene rings (WcisÅ, 1998). PAHs are environmental concern due to their recalcitrant properties, common occurrence in contaminated sites and carcinogenic potential to human health (Glaze, 1987; Choi, 2001). The structure of PAHs differs in the number and placement of aromatic rings, and their physicochemical properties can vary widely (Gustavson and Harkin, 2000). Environmental anthracene contamination originates from a number of sources/practices such as dye factories, production of synthetic fibers, plastics and pesticides, petroleum spills and incomplete combustion of fuel (such as coal, oil, gas) (Saniyo, 2006).

Remediation approaches may be classified as physical, biological or chemical although it should be emphasized that in many cases, a combination of processes may offer the most effective remediation (Castelo-Grande, 2010). Several decontamination technologies, thermal treatment, including soil vapor extraction (SVE), in situ aeration (air sparging/venting), chemical oxidation, bioremediation, soil heating, and surfactant-aided flushing are currently being used for soil cleanup (Hutzier, 1991). Soil extraction and washing are potential and economically feasible technologies for cleaning the contaminated soils on-site (Gustavson, 2000). Thermal treatment of soils for the destruction of organic pollutants involves high-temperature incineration (>1,000°C) or a two-stage process in which pollutants are desorbed at lower (<600°C) temperatures and then combusted (Norris, 1997). Most physical treatment processes remove pollutants from the soil–water complex for further treatment. In some cases, physical treatments can enhance the effectiveness ofbiological degradation of contaminants or indirectly cause their destruction (Scullion, 2006).

Besides the bioavailability, the efficiency of the bioremediation depends also on toxicity, environmental conditions and the presence of suitable microorganisms. Many microorganisms asbacteria, algae and fungi have been shown to be able to degrade PAHs. Bioremediation is one of the most cost-effective technologies, most of the studies have resulted decreased concentrations of PAHs with 2–4-ring in their molecular structure, but no reduction was observed of 5–6-ring PAHs since 5- and 6-ring PAHs are very recalcitrant due to their low water solubility and the resonance energies of their structures (Haapea and Tuhkanen, 2006). Final removals after biological treatment based on the sum of all PAHs are observed to be in the range between 50% and 70% (Sayles, 1999).

Chemical oxidation is an attractive alternative for remediating organic-contaminated soils because the byproducts are usually harmless and the removal efficiency is usually high if the chemicals can

be delivered properly (Shin et al., 2004). A range of chemical processes have been applied to soil to destroy or convert pollutants into less toxic forms, to extract them or to immobilize them (Pollard, 2004). A further oxidation treatment used in aqueous or slurry systems is based on Fenton's (hydrogen peroxide catalysed by iron) reaction, which produces hydroxyl radicals (Scullion, 2006). In this research, a two-level full factorial design has been conducted to investigate the effect of particle size, moisture content, contaminant content, and soil column height on the removal of anthracene by in situ ozonation.

Materials and Methods

Soil preparation

The studied soil was taken from an area in the Sahand University of Tabriz (North West of Iran). Soil was first passed through two sieves (0.5–1.0 and 1.0–2.0 mm) to remove any large sizes such as gravel and rocks. After a more homogeneous material of soil obtained and then was dried during one day at 110 °C in an oven. To contaminate the soil, 0.05 g and 0.25 g of anthracene (MERCK, Germany) was dissolved in 15 ml and 30 ml of acetone, respectively and mixed by hotplate for 20 min to obtain complete dissolution of the solute. A few drops of the PAH solution was added to 50 g of dried soil and shaked. This process was repeated until all of the PAH solution was mixed with soil and a total dry weight of 500 g of soil was combined. The contaminated soil was placed under the hood for 12 hour to evaporate the acetone and stored in an airtight jar in the dark place for one night. Then distilled water was added to the contaminated soil to achieve the selected moisture content (10%). The soil samples were kept one week then ozonation process was started.

Ozonation experiments

Ozone was generated from dried oxygen by electric discharge using an ozone generator (Ozomatic Lab 802 with high capacity 4g/lit). The gas flow rate was fixed at 150 ml/min. The inlet ozone gas concentration was fixed at 60 mg/l and was monitored automatically by ozone detector. For all experiments ozonaton time was 60 min. The experiments were conducted in a column reactor (plexy glass) with an inner diameter of 3 cm and 25 cm long. Column reactor was packed with the soil samples in height of 5 cm and 15 cm. During soil column experiment, the soil-packed column was ozonated for 60 h. Samples were taken from the column and then 10 ml acetone was added in 2 g sample and shaked for 12 h. After the sample was centrifuged at 4000 rpm for 15 min, the obtained sample consist of anthracene dissolved in acetone was analyzed with a fluorescence spectrophotometer (Pharo 300, Germany).

Results and discussion

Influence of parameters: experimental design

A two-level full factorial design with two replications has been conducted to investigate the effect of particle size (0.5-1mm and 1-2mm), moisture content (0% and 10%), anthracene content (300 ppm, 500 ppm), and soil column height (5cm, 15cm) on the removal of anthracene by in situ ozonation. The result of experimental design is represented in table 1. These experiments were designed at the 95% confidence interval. Contaminated soil with antracene was ozonated at 25 °C and soil pH was 8. Analysis of Variance was represented at table 2 in order to indicate effect of investigated factors and also their interactions.

Table 1. 4^2 full factorial design for PAH contaminated soil ozonation.

Anthracene (ppm)	Height (cm)	particle size (mm)	moisture (%)	Remove (%)
100	15	0.5-1	10	71.8041
100	15	0.5-1	0	76.7115
500	5	1-2	0	66.55222
500	5	0.5-1	10	72.4411
100	15	1.5	0	72.622
100	5	0.5-1	0	82.4368
100	15	1-2	10	61.9893
500	5	1-2	0	65.8979
500	5	0.5-1	0	77.3485
500	15	0.5-1	10	73.74974
100	15	0.5-1	0	75.8936
500	5	0.5-1	0	78.49356
500	15	1-2	10	61.64482
100	15	1-2	10	67.7146
500	5	1-2	10	62.78988
100	5	0.5-1	0	81.6189
500	15	0.5-1	0	75.05838
100	5	0.5-1	10	74.2578
500	15	1-2	0	67.5337
100	15	1-2	0	69.3504
100	15	0.5-1	10	73.4399
100	5	0.5-1	10	73.4399
500	15	0.5-1	10	72.4411
500	5	1-2	10	62.13556
100	5	1-2	10	64.443
500	15	1-2	10	61.15408
500	5	0.5-1	10	73.42258
100	5	1-2	0	67.7146
100	5	1-2	0	66.0788
500	15	0.5-1	0	73.09542
100	5	1-2	10	62.8072
500	15	1-2	0	65.8979

The results of Analysis of Variance for anhtracene removal from soil show that particle size (s), moisture content (m) and anthracene content (an) are effective factors as observed in table, based on importance, the more effective factors are s>m>An. Only soil column height (h) factor doesn't have significant effect in removal efficiency of anthracene. In addition, it is observed that some of interactions are affecting and this is an important point that can be obtained only by using full factorial experimental design.

Table 2. Analysis of Variance

Source	DF	SS	MS	F	P-Value
an	1	33.346	33.346	16.38	0.001
h	1	4.335	4.335	2.13	0.164
s	1	793.283	793.283	389.76	0.000
m	1	164.845	164.845	80.99	0.000
an*h	1	0.856	0.856	0.42	0.526
an*s	1	0.967	0.967	0.47	0.501
an*m	1	4.83	4.83	2.37	0.143
h*s	1	29.555	29.555	14.52	0.002
h*m	1	2.091	2.091	1.03	0.326
s*m	1	0.054	0.054	0.03	0.873
an*h*s	1	10.489	10.489	5.15	0.037
an*h*m	1	0.084	0.084	0.04	0.842
an*s*m	1	3.867	3.867	1.9	0.187
h*s*m	1	20.875	20.875	10.26	0.006
an*h*s*m	1	0.405	0.405	0.2	0.662
Error	16	32.565	2.035		
Total	31	1102.445			

Reported at 95% C.I.

Fig. 1 represents main effects plot for removal values. It is observed all four factors that were investigated in this study; have decreasing effect in anthracene removal. Namely the removal efficiency increases with the decrease of these factors.

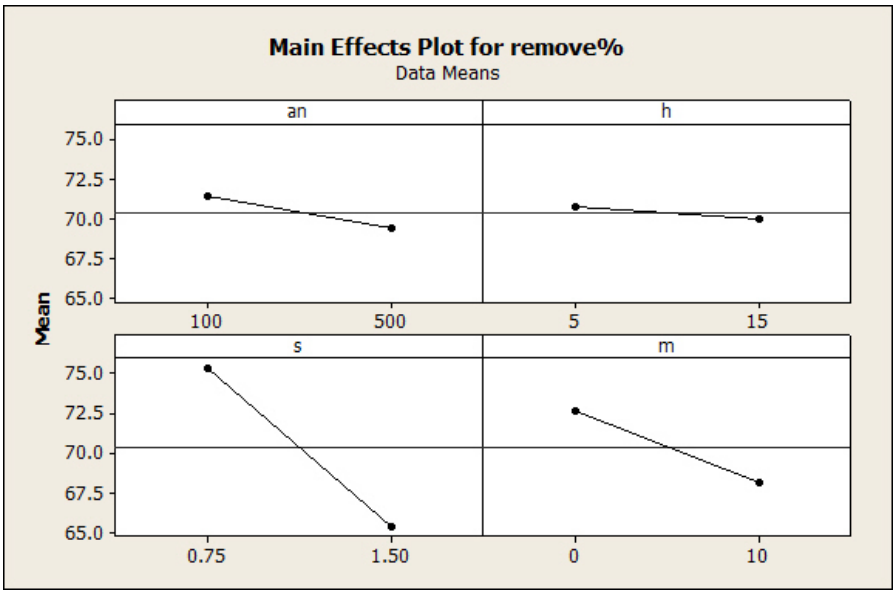


Fig.1. main effects plots for Antheracene removal from soil

Effect of particle size

According to Fig. 1, anthracene removal increases with the decrease of particle size. A finer particle size means a larger specific surface area, a higher mass transfer coefficient, and therefore a higher dissolution rate. As more ozone dissolves into an aqueous solution, more anthracene will be removed (Zhang, 2005).

Effect of moisture content

Soil moisture content is one of the most important factors to consider in characterizing the transport of gaseous ozone in unsaturated porous media. It is clear that the water content of the soil affected ozonation of anthracene. Less moisture content leads to more anthracene removal (Fig. 1). In the presence of water PAHs become inaccessible to ozone. At the same particle size, interfacial area decreases with the increase of moisture content (Zhang, 2005). So water leads to a reduced contact time for ozone in the soil. It must be noted that water molecules cover the soil surface even at lower moisture contents. Therefore, less ozone dissolves into soil moisture and oxidizes contaminants (Choi, 2001). In addition, ozone oxidizes organic pollutants via two pathways: by direct oxidation with ozone molecules and by the generation of free-radical intermediates, such as OH• radical, a powerful, effective, oxidizing agent. In the absence of moisture, OH• radical would be produced by catalytic reaction of ozone with the reactive site on the soil. When the oxidation is performed by OH• radical reactions, the destruction of PAHs will be enhanced. In the presence of moisture, the water blocks the reactive sites of the soil, so catalytic reactions with ozone reduce (Choi, 2002; Zhang, 2005). Therefore, in the aqueous media efficiency of ozonation method for remediation of contaminated soils will be low.

Effect of anthracene content in soil

The removal efficiency decreases with the increasing anthracene content. Ozonation of anthracene includes the reactions of ozone with anthracene as well as ozone with the produced intermediates (Fig. 1). When anthracene content is small and anthracene removal is high, the competing reactions of ozone with intermediate products would become dominant. Thus, significant amounts of ozone are consumed by the intermediates and ozone demand is lowered (Zhang, 2005).

Summary and Conclusions

The results showed that ozone can effectively remove anthracene from contaminated soils with average removal efficiency range between 61% - 82%. The result of full factorial design indicated that particle size, moisture content, and anthracene content are more effective factor during ozonation process and the removal efficiency increases with the decreasing these factors. Also, some of two-way and three-way interactions of effective factors were important. In this work, particle size is the most effective factor for eficiency of PAHs removal.

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Investigating Regional Model for Estimating Gully Volume Using Watershed and Gully Characteristics

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Abstract
This research project was done to provide a regional model to estimate gully volume. Three regions were selected and in each region 30 gullies were selected. Situation and height of all gullies were determined by GPS. Gully characteristics including: length, slope above headcut, drainage area, soil characteristics and volume of gullies was determined in all regions. To determine gully volume, gully was divided into segments and in each segments, cross sections and their distance were measured. Partial volume was determined by multiplying length of segment to average of cross sections. Total volume of gully was calculated by Summation of partial volumes.
Then relationship between volume of gullies and their characteristics were analyzed in SPSS. The results showed that volume of gullies had good correlation with length of gullies. So it is possible to measure the length of gully in field or aerial photos to estimate gully volume. This result is on the same line with results of researchers in the other regions in the world.
Keywords: GPS, Gully, Aerial photo.

Introduction
Gully erosion removes soil from narrow channels via the accumulation of surface runoff, tends to produce more sediment loss than other forms of soil erosion such as overland flow or rilling (Wasson et al., 2002; Poesen et al., 2003; De Vente et al., 2005; Huon et al., 2005; Wells et al., 2009). Gullies are generally defined by their channel depth, which for permanent gullies can range from 0.5 to 30 m (Soil Science Society of America, 2001). Gully represent some of the most destructive form of erosion, destroying soil, undermining infrastructure, damaging farm lands, altering transportation corridors and lowering water tables (Valentin et al 2005). Gully erosion affects sediment budgets and flux rates, and influences stream dynamics as evidenced from data on hydrograph (Costa and Bacellar, 2007, Perroy et al 2010).
The last stage of rill erosion is usually classified as gully. Gully erosion is said to take place when excessive surface run-off flowing with high velocity and force detach and carry soil particles down slope. They may also occur when runoff volume from sloppy terrain increases sufficiently or increase in flow velocity as to cut deep holes along its path (Ehiorobo and Izinyon 2011). Recent research and field studies have shown that gully erosion is one of the most soil degradation processes in most states of Nigeria as it causes considerable soil loss and produces large volume of sediment. Gullies are also catalyst for transferring surface run off and sediment from uplands to valley bottoms and creation of channels that aggravate the problem of flooding and water pollution. Field measurements and research findings in various countries have shown that the development of gullies increases the connectivity in the Landscape and hence also the sediment delivery to low lands and water courses. Many cases of damage to water courses and properties by runoff from agricultural land relate to the occurrence of gully erosion (Verstraeten and Poesen, 1999, Boardman 2001, Poesen et al 2003). Data collected in different parts of the world show that soil loss rates by gully erosion represent from minimal 10% up to 94% of total sediment yield caused by water erosion (Poessen et al 2003). Determining gully volume to evaluate gully percentage on sediment yield is necessary.
Gully erosion volume is determined by field measurements or indirect methods. Field measurements take much more time and cost. The length of gully is a key parameter to determine volume of gully erosion (Nachtergaele et al., 2001b). As there is a strong correlation between the length and volume of the gully (Cheng et al., 2007), it is suggested that gully length is a significant and useful index to estimate the volume of gully erosion especially in large scale surveying of gully erosion because it is easier to measure the gully length from historical evidence such as aerial photos or remotely sensed images (Cheng et al., 2007; Hughes et al., 2001)

Nachtergaele et al. (2001a & 2002) found a relationship between the volume and length of the gully in 80% of samples. They found that gully length is an estimator of gully volume. In 91% of the gullies that formed in one event, gully volume could be estimated by gully length correctively. Also, correct estimation of gully length would estimate the gully cross section correctly in 35% of the samples. Nachtergaele et al. (2001b) in their research in Portugale found a power relationship between gully volume and gully length.

$V= 0.05 L^{1.27}$

In which V is gully volume (m^3), L is gully length (m), a and b are 0.05 and 1.27 in Portugal and 0.1839 and -0.2385, respectively in loess plateu In China. Capra et al. (2005) in the model calibration for estimation of gully volume in Sicily, Italia, found the relationship number 5 between gully volume and length. To find higher R square, they used stepwise method in SPSS software to indicate the influence of several indices such as , Catchment area, length of catchments, Catchment gradient, Gully length, Gully slope, 24 hours rainfall, third day rainfall, threshold rainfall equal to 37 mm on the volume of gully erosion. The final equation (6) indicated that R square was a little better than equation 5 (R^2=0.72) but the most important factor is the length of gully to predict the volume of gully erosion.

$V=0082.0L^{1.416}$ $R^2= 0.64$

$V=10^{-4.91} L^{1.557}$24-h rainfall$^{1.327}$ $R^2= 0.72$

In Sardinia (Italy) the following power relationships were presented between the volume and the length of gullies (Zucca et al (2006))

$V=0.39 L^{0.92}$ $R^2= 0.57$

$V=0.114 L^{1.42}$ $R^2= 0.76$

Zhang et al. (2007) presented a power relationship between the volume and the length of gullies in the cultivated catchments of black soil region, the northeast of China as follows:

$V=0.015 L^{1.429}$ $R^2= 0.67$, $P<0.05$

Material and Methods

This research was carried out in Fars province, the south of IR. Iran. In this province, gullies are at the height of 485-2182 m. The average of rainfall is between 194.7 to 676.4 mm. This research was done to present a regional model for determining volume of gullies. At first 3 regions and 30 gullies in every region were selected. Situation of gullies were determined by GPS. Soil characteristics include organic material, SAR, infiltration and texture was determined. Vegetation percent of head area, slope of gully and head area, head area and total area of gullies, length of gullies, land use, depth of surface soil in headcut and the end of gullies were determined. To determine gully volume, gully was divided into segments and in each segments, cross sections and their distance were measured. Partial volume was determined by multiplying length of segment to average of cross sections. Total volume of gully was calculated by summation of partial volumes. After field measurements all data were analyzed in SPSS and the best model to determine volume of gullies in each region was presented.

Results and Discussion

In these regions 90 gullies were surveyed (Figure 1). In these gullies lengths was between 14 to 295 meters, average upper width of gullies was 0.92-9.8 m and floor width was 0.5-7.3 m, average depth of them was between 0.48-5.3m, head area of gullies was 24-24770m^2, gully volume was between 26-6800 m^3, upstream slope of head was 5.2 -82%, average depth of soil in surface layer at head and out of gullies was 0.12-7m and 0.17-12m respectively. Land use in these regions was bare croplands and pasture. Soil texture was 36.67% clay-loam, 23.33% sandy-clay-loam.

After surveying all data input were analyzed tjen linear and power relation between volume and length of gullies were estimated for classified and unclassified data. Charachteristics of gullies are in Table.1.

Table 1. Characteristics of studied gullies

Region	Length of gully		Depth of gully (m)		Width of gully (m)		Volume of gully (m^3)		Head area of gully (m^2)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
1	52	214	0.5	3.4	0.92	6.8	49	2800	195	2100
2	14	295	0.48	3.6	1.2	4.8	33	622	1744	27097
3	19	264	0.6	5.3	1.37	9.7	26	6800	24	1850



Fig. 1. Sample of studied gullies

The first analysis of the collected data has been carried out with the aim of analysing relationships among different morphological parameters of gullies, and in particular between length and volume. As reported by Nachtergaele et al. (2001), length value can be used to estimate indirectly the volume. This may be important in order to set up a monitoring system, mainly based on aerial photointerpretation, that allows to evaluate the length of gullies but not their volume. According to the results reported by Nachtergaele et al.(2001), for study areas located in Belgium, Spain and Portugal, a positive correlation between length and volume can be expressed through the following equation:

$V = aL^b$

where V=gully volume (m^3) and L=gully length (m).

In Dezhkord (region1), there was a good relationship between volume and length of gullies. In analysis, linear and power equations were compared. Power equation was significant in 1% and linear equation in 5%. Correlation between length and volume was stronger in power equation.

$V= 0.237L^{1.538}$ $P<0.01$, $R^2=0.252$

$V= 7.074L-252.296$ $P<0.05$, $R^2=0.173$

In Konartakhte (region2) analysis showed that linear and power equations are significant in 1% surface but correlation between length and volume was stronger in linear equation.

$V= 6.693L^{0.726}$ $P<0.01$, $R^2=0.331$

$V= 1.845L+35.774$ $P<0.01$, $R^2=0.442$

In Mishan (region3) analysis showed that linear and power equations are significant in 1% surface but correlation between length and volume was stronger in linear equation.

$V= 0.344L^{1.791}$ $P<0.01$, $R^2=0.617$

$V= 23.914L-589.553$ $P<0.01$, $R^2=0.731$

Results in this research show that there is a good relationship between length and volume of gullies in studied area. This result helps to evaluate volume of gullies by using aerial photoes. This result is on the same line with results of researchers in the other regions the world (Belgium, Spain, Portugal, and Sardinia)

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Comparison of different methods for sediment trapping in gully, Case study: Kerman province, southeast of I. R. Iran

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Abstract

This research project began in 2002 to compare three different methods for sediment trapping in gullies in Kerman province, southeast of I. R. Iran. Nine gullies were selected and linear development and long profile of selected gullies were determined by surveying. Linear development was measured after rainstorms with significant runoff which caused changes in gullies in 3 years. From the 4th year, some mechanical structures including hedge, gabion and water diversion) were established in gullies and their effects on sediment trapping was measured.

The result of this research indicated that) gullies linear development was between 22.5 and 190 cm/ year. After establishment of structures, gully development reduced to 10 and 24.5 cm/year. So all of three structures were effective and have been controlled sediment. Gabion and hedge were more effective than water diversion to control sediment. Between these structures hedge is more economic.

Keywords: Gully erosion, Headcut, Water deviation.

Introduction

Gully erosion, the removal of soil from narrow channels via the accumulation of surface runoff, tends to produce more sediment loss than other forms of soil erosion such as overland flow or rilling (Perroy et al, 2010 : Wasson et al., 2002; Poesen et al., 2003; De Vente et al., 2005; Huon et al., 2005;Wells et al., 2009). Gully erosion generates significant volumes of sediment that is delivered to waterways throughout the world (Poesen et al., 2003; Valentin et al., 2005). Gullies are generally defined by their channel depth, which for permanent gullies can range from 0.5 to 30 m(Soil Science Society of America, 2001). Poesen defines Gullies as erosional channels with cross sectional area larger than 929cm^2 (Poesen, 1993).

They are also one of the most destructive forms of erosion, destroying soil, undermining infrastructure, damaging agricultural fields, altering transportation corridors, and lowering water tables (Valentin et al., 2005). Furthermore, their damage is difficult to reverse. Gully erosion dramatically affects sediment budgets and flux rates, and influences stream dynamics as evidenced from data on hydrographs (Costa and Bacellar, 2007). Quantifying gully erosion rates and associated sediment yields is critical for the effective prioritization of management efforts aimed at reducing the environmental impact of gully erosion (Prosser and Winchester, 1996).

The gullies are considered ephemeral because they are filled in by normal tillage practices but frequently recur in the same place during the next rainy season (Poesen and Govers,1990). Predicting or calculating soil losses due to erosion by ephemeral gullies are important in quantiying the impact of this form of erosion (Cheng et al., 2007; Gabriels et al., 1977; Waston et al., 1986; De Roo, 1998; Woodward, 1999). Data collected in different parts of the world show that soil loss rates by gully erosion (SLgully) represent from minimal 10% up to 94% of total sediment yield caused by water erosion. The main factors controlling SLgully and we discuss some trends. First of all, we address the effects of spatial scale (size of study area) and temporal scale (time span) considered before focusing on environmental factors (Poesen et al, 2003). Many methods are used to control gully erosion but in Iran has been used a few of them. The first step to control gullies is reducing the volume and velocity of surface or subsurface runoff (Soufi, 2007). There are many croplands in study area and a dam is in downstream. Gullies in this region are in croplands and are extending. This research was done to introduce the best method of reducing sediment of gully erosion in this region.

Study area

The research was done in south-east of I.R.I in Kerman province. Gullies are around croplands in this area with a longitude between 56˚, 13', 31.6" and 56˚, 14', 52.4" E and latitude between 28˚, 49' and 28˚, 49', 20" N (Fig. 1). The average altitude of area is 1811m and according to modified

Domartans' method, climate is mild desertic arid. Study area is mainly rangelands and croplands and gullies are formed and distributed around them. Gully development was monitored in nine representative gullies. Selected gullies had U shape cross section and headcut of gullies are mainly cave shape. Average morphometric characteristics of gullies such as top width, depth and length were respectively about 1.3, 0.98; 17.7 meter and average slop above headcut of gullies was 6.35%. View plan and long profile of selected gullies were determined by field surveying. Fig. 2 shows a sample of gullies in this area.

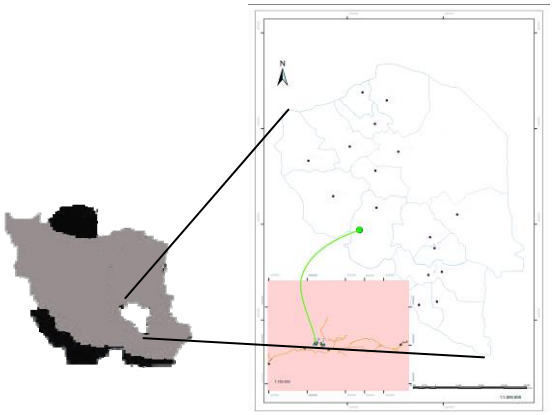


Fig. 1 . Map of study area

Methods

In order to test the impact of different mechanical measures on reducing sediment delivered of gullies and reducing gully development a research project with two phases was designed in 2002. In the first phase during three years, gullies were classified based on their location in the landscape, their general and headcut view plans, shape of their cross sections, land use above headcuts and soil material. Nine gullies of one class of so-called criteria were selected and benchmarks were installed inside and outside of gullies. Drainage area and slope above their headcuts were measured. Gully development was measured after rainstorms with significant runoff and headcuts recession. In the second phase which was started since 2005, different mechanical structure and alternatives for controlling gully erosion, including brush, gabion and water diversion were established in and above gully headcuts and measuring the length progress and length profile changes was done regularly after rainstorms. Each alternative was applied in three gullies with relatively similar condition. Finally length progress and length profile of gullies before and after establishing structures compared and the best method was choose.



Figure 2. Sample of mechanical structures

Result and conclusion

Result shows that gullies are U-shape with cave-shape headcut. Length of gullies was between 15 to 24.15 meter and average of their width and depth was 120-190, 87-130 cm, respectively. w/d was 0.897-1.72 and only in one gully it was less than 1. It shows that gullies progress in width, mostly. Headcut drainage area of gullies was between 692-3452 m^2 and slop of drainage area was 2.9 to 9.4% (Table. 1).

Table 1. Characteristic of selected gullies

Average of gully depth (cm)	Average of gully width (cm)	Height of headcut (cm)	First drainage area (m^2)	Up slope of gullies (%)	Length of gullies (m)	Repetition	Alternative
121.5	140	85	934.8654	4.5	18	1	Water diversion
99.5	120	62.5	1004.5981	4.7	18.8	2	
130	190	88	2224.2594	6	17	3	
145	130	28	692.195	9.4	18.5	1	Brush
98	160	42	2351.1286	7.4	17.3	2	
87	150	23.2	1615.8695	8.7	15.35	3	
116	180	49	1494.9235	8.8	15.5	1	Gabion
100	140	65	3452.0294	2.9	15	2	
102	150	28.5	2808.1219	4.5	24.15	3	

Length profile changes of gullies was surveyed (there are samples in fig. 3-5). These figures show that gabion and brush established in gullies, traped much sediment. Gully progress was 22.5- 190 cm before structures and reduced to 10-24.2 after establishing structures.

Result of research show that progress of gullies before and after establishing gullies was significant in all alternatives. Between alternatives, there was no significant difference but the least progress was in water diversion but in this alternative no sediment has been traped so with the object of sediment trapping, brush and gabion were useful. It is shown in fig. 1,2. Brush is more economical than gabion.

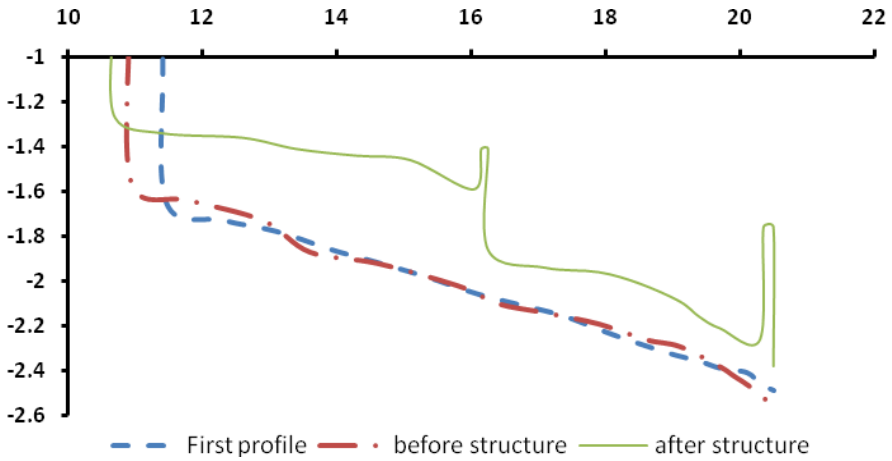


Fig. 3. Sample of length profile changes of gully with Gabion

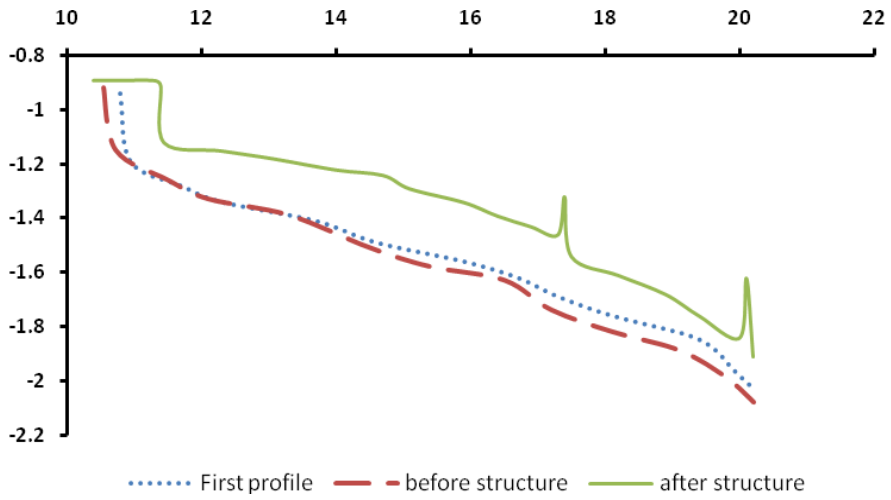


Fig. 4. Sample of length profile changes of gully with brush

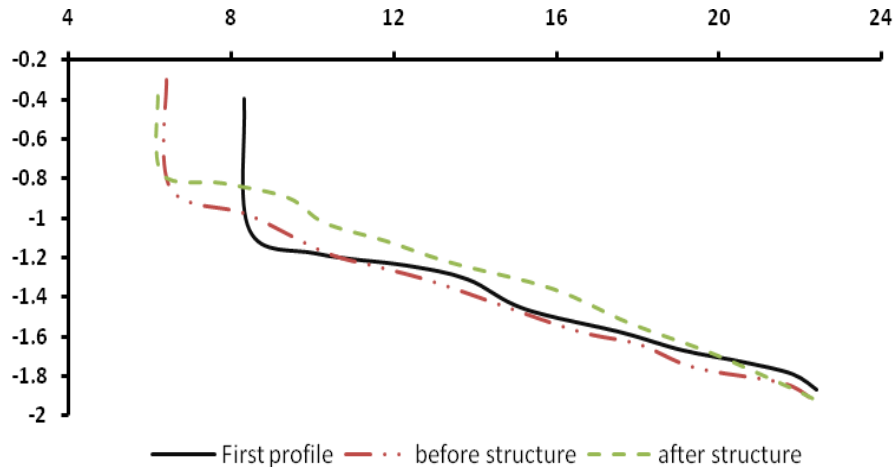


Fig. 5. Sample of length profile changes of gully with water diversion

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Environmental and Sanitary Considerations in Planning a Program for Using Sludge from Tehran Domestic Waste-Water Treatment Plants in Agriculture

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Abstract:
Global approach through health, public sanitary and development of collection networks and treatment plants shows an increase in waste and sludge production. High volume and specific chemical and biological characteristics of the sludge produced in wastewater treatment plants has attracted concerns about its environmental applications. Since sludge from treatment plants is rich with nutrients and organic chemicals, applying it in agricultural fields is one of the most useful and important alternatives. However, if had high concentrations of heavy metal, toxic chemicals and pathogenic micro-organisms, it can lead to sanitary problems or environmental contamination. The goal of this study is to discuss feasibility of using sludge from treatment plants in agricultural fields and then to plan a framework, taking into account standards and environmental considerations. Samples from 3 treatment plants in Tehran (Shahrak-e-gharb, Shoosh and Mahallati) were experimented and the results were compared with EPA (Environmental Protection Agency) standards and regulation. Samples were rich in nutrients and micronutrients and classified between classes A-B for their microbiological characteristics. The sludge from Shahrak-e-gharb plant was excellent due to its heavy metal concentrations and the other two were in the allowed range. Using the results and fields' soil properties, a program is prepared to choose suitable agricultural species and sludge loading rates for each of the treatment plants. At the end an environmental monitoring program is suggested.

Keywords: Waste water, sludge, agriculture, heavy metal, Nematode eggs

Introduction

Sewage sludge is a solid which is obtained from different methods of treatment in order to remove suspended and dissolved contaminants from wastewater by separating solids from liquids, chemical precipitation or biological treatments in waste water and in fact is an important sub-process product in refining processes (Metcalf and eddy, 1991). The goal of treating sludge is changing raw, bulky and foul-smelling sludge into inert and odorless substance that can easily lose its water.

Methods which are used for sludge treatment depends on the size, type and location of treatment plant, operation of existing units in that, characteristics and amount of solids and finally the way of final disposal of sludge (Maghol, 1995). Nowadays with developing of wastewater treatment including construction of new units or improving existing facilities, sludge management has become one of the most critical environmental issues (Ludovico, 2007). Currently, 7 million tons of sludge is produced annually in the United States, 8 million tons in Europe, 5 million tons in Japan, 43.2 million tons in Korea and 2.0 million tons Taiwan (Hwang, et al., 2007; Cakmakci, 2007). Also in Iran until the end of 1381, 50 urben refinery were being exploited in the country which their number increased to 71 and 150 until the end of 2004 and 2011 respectively and it means that the amount of produced sludge is increasing and for proper management, guidelines must be adopted (Shayegan, et al, 2005).

Various options exist for final disposal of sludge which the most important ones are incineration, disposal in sanitary landfills, application in agriculture and usage as building materials (Cakmakci, et al, 2007). In addition to the mentioned methods, new methods have developed in recent years, for example using the sludge as a raw material for producing pesticides is on of these new methods. However, application in agriculture is considered as one of the most common methods of sludge disposal in many countries. For using municipal sewage refinery in agriculture issues such as type of waste water treatment process, method of treating sludge, combining sludge, distance between refineries and desired lands, affecting social factors and other factors should be studied carefully to prevent environmental and health problems(Mesdaghinia, et al., 2004). The sludge which is obtained from waste water treatment in addition to have beneficial nutrients for plants, also has bacteria, viruses and other disease-producing microorganisms or heavy metals and toxic organic compounds that can makes it dangerous to use for agricultural products, humans and animals. The

aim of this study is to evaluate the feasibility of using dried sludge of Tehran Waste water treatment as fertilizer in agricultural with regard to valid standards and environmental monitoring programs to ensure sustainable and healthy use of this resource. In this regard three wastewater treatment of shoosh, sahrak gharb and shahid mahallaati were selected and corresponding tests were conducted in the autumn, winter and spring and were compared valid standards such as U.S.EPA standard. A summary of these standards are offered below (Table 1 and 2).

Table 1. Summary of U.S.EPA Regulations (U.S.EPA, 1992)

Regulations	**Descriptions**	
Regulation to control and reduce pathogens in sewage sludge (under Part D of section 503 Regulations 40CFR)	Class A regulations	Less than 3 MPN / g. DS Salmonella, 1 PFU of enteric virus and a fertilized egg of parasite per 4 grams of total solids by weight of dry sludge (DS) or less 1000 MPN/g.DS fecal coli form
	Class B regulations	less than 2×10^6 MPN/g.DS fecal coli form
		Use limitations: 1- Food products which their yields deal with soil should not be harvested before 14 months of sludge application 2- Food products which their yields are under the soil should not be harvested before 20 months of sludge application (in the case that sludge remains on the soil more than 4 months). 3- Food products which their yields are under the soil should not be harvested before 38 months of sludge application (in the case that sludge remains on the soil less than 4 months). 4- In other cases (food products that their yields have no contact with soil), crops should be harvested at least 30 days after sludge application in land. 5- Animals should not be allowed to grazing in these lands before 30 days from sludge application.
Regulations for Vector attraction reduction	Section 503 of regulations, 12 options has offered for reducing the carrier absorption such as insects, birds and … which have the ability of transmitting pathogens and can put human or animal in contact with pathogens of sewage sludge and are considered as a threat.	
Limitations of heavy metals and organic compounds	In addition to organic materials sludge may also contain small amounts of organic pollutants such as heavy metals that can be harmful for plants and animals	

Table 2. Ceiling Concentrations, Pollutant Concentration, and Annual Pollutant Loading Rates (from 503.EPA regulations)

Pollutant	Ceiling Concentration Limits (mg/kg)	Pollutant Concentration Limits (mg/kg)	Annual Pollutant Loading Rates (kg/ha/yr)	Cumulative Pollutant Loading Rate (kg/ha)
Arsenic	75	41	2	41
Cadmium	85	39	1.9	39
Chromium	3000	1200	150	3000
Copper	4300	1500	75	1500
Lead	840	300	15	300
Mercury	57	17	0.85	17
Molybdenum	75	-	-	-
Nickel	420	420	21	420
Selenium	100	36	5	100
Zinc	7500	2800	140	2800

Above limits for chromium and molybdenum (except for ceiling concentration) have been deleted, and the pollutant concentration limits have been revised for selenium

Material and methods:

In this study for measuring various parameters sampling was carried out From three waste water treatment of shoosh, Shahrak gharb and Shahid mahallaati. For each waste water treatment sampling was carried out in spring, summer, autumn and winter. Uniformed samples with respect to conditions stated in valid references (Standard Methods و1992; U.S.EPA, 1992), were taken from drying beds of treatment plants in strile containers and to Prevent change in samples and maintain the real conditions, sample containers were kept in appropriate conditions of temperature until to be transported to the laboratory. For collected samples according to table 1 , 2 amounts of fecal coliform, total coliform, parasite eggs, electrical conductivity (EC), dissolved salts (TDS), the percentage of stabilized materials (minerals) and the percentage of volatile materials (organic material), nutrients and heavy metals were measured. Experiments were carried out carefully using standard methods provided in references such as the standard method and EPA. For high precision measurements, all experiments in this study were carried out at least in three replicates and results are reported as mean. Then the data were analyzed using SPSS software. All three case studies of treatment plants were activated sludge and units are as follows:

- Screen Unit, grease trap and primary sedimentation unit
- Aeration Tanks and secondary sedimentation tanks
- The system of returning sludge from the final sedimentation tanks to the aeration tanks
- Sand filters and chlorination units
- System of collection, concentration, aeration and sludge stabilization (sludge treatment)
- Sand beds for drying the sludge and dry sludge storage

Results and discussion:

Results from collected samples during a year with seasonal frequency from three main treatment plants in Tehran is presented in Table 3.For qualitative assessment of sludge and its qualitative limitations for agricultural use, the laws and standards of the EPA (USEPA, 40 CFR 503) and table1, 2 are used. Amounts of fecal coliforms and total coliforms in three treatment plant of shoosh, shahrak gharb and shahid mahallati for spring, summer, autumn and winter and also annual mean in three treatment plant are given in table 3.

The results show that the rate of fecal coliforms and parasite eggs in all three treatment plants has higher doses in autumn and lower doses in spring than other seasons. Among these three treatment plants, shoosh treatment plant has lowest amount of parasite eggs (3 to 9 per gram of dried weight) and shahrak gharb treatment plant has highest amount of parasite eggs (6 to 18 per gram of dried weight). The mean number of parasite eggs in three treatment plants throughout the year is

equivalent to 8 per g dry weight. Among these three treatment plants, shahrak gharb treatment plant has lowest amount of fecal coliforms and Shahid mahallati treatment plant has highest amount of fecal coliforms. Based on results the number of fecal coliforms in all three treatment plants is more than 1000 and less than $2x10^6$ (MPN per gram of dry solids), so the sludge of these treatment plants will be in B class of EPA standard. Therefore, the sludge of these treatment plants is not suitable for grass, playgrounds, home gardens, pots and selling packaged for different uses and for other purposes the limitations in table 1 should be considered. The results of similar research in Isfahan shows that amount of fecal coliform in sludge of treatment plant in this city includes at least $1.6x10^6$ to $2.3x10^6$ (MPN per gram of dry solids) which in comparison with studied treatment plants in Tehran which have the mean equal to 11000 MPN per gram of dry solids, has more amounts.

Table 3. Results of qualitative analysis of sludge (mg/kg dry weight)

Treatment Plant / Factor	Shahrak gharb				shoosh				Shahid mahallaati			
	spring	summer	autumn	winter	spring	summer	autumn	winter	spring	summer	autumn	winter
pH	6.32	6.6	6.5	6.4	6.7	6.2	6.44	6.6	6.4	6.3	6.42	6.51
EC[1]	888	2230	1225	1242	1424	2420	1682	1649	813	1410	1364	1200
TDS	844	1310	1100	930	864	973	1270	1228	407	533	1200	930
Total Phosphorus	3000	2500	3300	2700	2600	3100	2700	2400	2800	3000	2900	2500
Total nitrogen	4708	4815	6206	5885	5270	5110	6100	5580	5270	5110	6100	5580
Ammonia nitrogen	1528	1798	850	1030	1528	1798	850	1030	1440	1360	1050	840
Nitrate nitrogen	180	127	198	272	120	98	145	172	140	105	154	187
Organic carbon (OC)[2]	46	41	38	40	42	36	44	54	53	45	54	62
Moisture[2]	0.58	1.22	1.6	2.1	1.4	0.85	1.2	1.8	0.8	1.05	1.5	1.8
Fixed solids	36.45	33.75	27.14	29.7	31.4	32. 5	30.1	30	32.3	27.6	33.4	33
Volatile materials	63.5	66.2	72.8	70.3	63.5	66.2	72.8	70.3	63.5	66.2	72.8	70.3
Mercury (Hg)	0.107	0.09	0.465	0.17	0.107	0.105	0.312	0.15	0. 09	0.110	0.230	0.12
Chromium (Cr)	21.93	21.93	17.12	20.87	21.93	22.06	19.05	18.6	23.00	20.80	18.22	15.54
Cadmium (Cd)	0.00	0.00	0.00	0.00	0.00	0.05	0.09	0.00	0.00	0.06	0.07	0.00
Lead (Pb)	138	119	82	176	126	135	122	140	85	72	55	90
Iron (Fe)	5145	4658	5201	5001	4635	4450	4900	4810	4900	5010	5100	5800
Zinc (Zn)	858	575	565	607	675	580	610	590	795	605	585	570
Selenium (Se)	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1	≤0.1
Molibdenium (Mo)	≤0.35	≤0.35	≤0.35	≤0.35	≤0.35	≤0.35	≤0.35	≤0.35	≤0.35	≤0.35	≤0.35	≤0.35
Arsenic (Ar)	0.12	0.1	0.00	9	0.08	0.40	0.15	4	0.25	0.32	0.85	1.5
Fecal coliform[2]	4200	47000	20000	56000	20000	230000	200000	48000	57000	520000	350000	96000
Total coliform[2]	3400	36000	6700	4600	3100	3100	4100	3700	5300	42000	24000	7000
Nemathod eggs[3]	4	8	11	5	3	5	9	4	6	16	19	9

1-µs/Cm 2- Percentage 3- MPN (per gram of dry solids) 4- Number per gram of dry solids

According to the importance of parasite eggs existence, whole egg parasites count test was performed for all samples and results are given in table3. The amounts of parasite eggs in treatment plants has the highest amount is in autumn and the lowest amount is in spring. The minimum amount of parasite eggs is observed in shoosh treatment plant (Annual mean equal to 5) and the maximum amount of parasite eggs is observed in Shahid mahallati treatment plant (Annual mean equal to 12) which in comparison with Isfahan treatment plants has less amounts. This index in treatment plants which are located in south of Isfahan, north of Isfahan and Shahin shahr is respectively equal to 16, 12, 58 per gram of the weight of dry sludge (Bina, et al., 2005). According to the results of parasite eggs, the sludge of studied treatment plants were not qualify category A and on this basis for application, the limitations and requirements provided in Table1 should be considered. Summarized the biological conditions(Fecal coliform and nematode parasitic eggs), sludge of studied treatment plants with considering EPA rules shows that the sludge has lack of qualitative conditions for being in class A (density of fecal coliform less than 1000MPN per g dry weight of sludge and lack of parasite eggs). This represents the lack of full and proper sludge stabilization, especially in terms of microbiological criteria. The limits of heavy metals is one of the major concerns in using sludge for agriculture which can lead to soil pollution in the short term or long term. Comparison of metal concentrations with the standard provided by the EPA (Table2) fortunately will be noted that concentrations of heavy metals in the sludge of all three treatment plants are low and based on the standard they have no restrictions for agricultural usages. Good quality of sludge in case of heavy metals may indicate a lack of industrial units in the area covered by these treatment plants and further assurance of safety for agricultural usages and also the least side effects for soil and the environment. Evaluating the sludge of studied treatment plants in case of (N, P) and also organic matter shows that the sludge in all three treatment plants has notable amounts of organic matter and nutrients and also fertilizer values which can be considered in recycling this nutrients. Investigating the sludge physical properties of studied treatment plants sludge shows little moisture and this indicates good fixation and high proportion of dry and solid sludge materials and consequently low odor and fewer effects in attracting insects and vectors of diseases. Noting the results of sludge qualitative analysis in studied treatment plants, a plan which is proposed for using the sludge with considering health and environmental aspects is presented in Figure1 also with its relevant procedures. Despite the existing standards and regulations on using sludge in agriculture, due to health and environmental effects of prolonged use of treatment plants sludge in agriculture and also for insurance of optimal usage of this resource, formulation and implementation of monitoring programs is proposed in table 4 and 5.

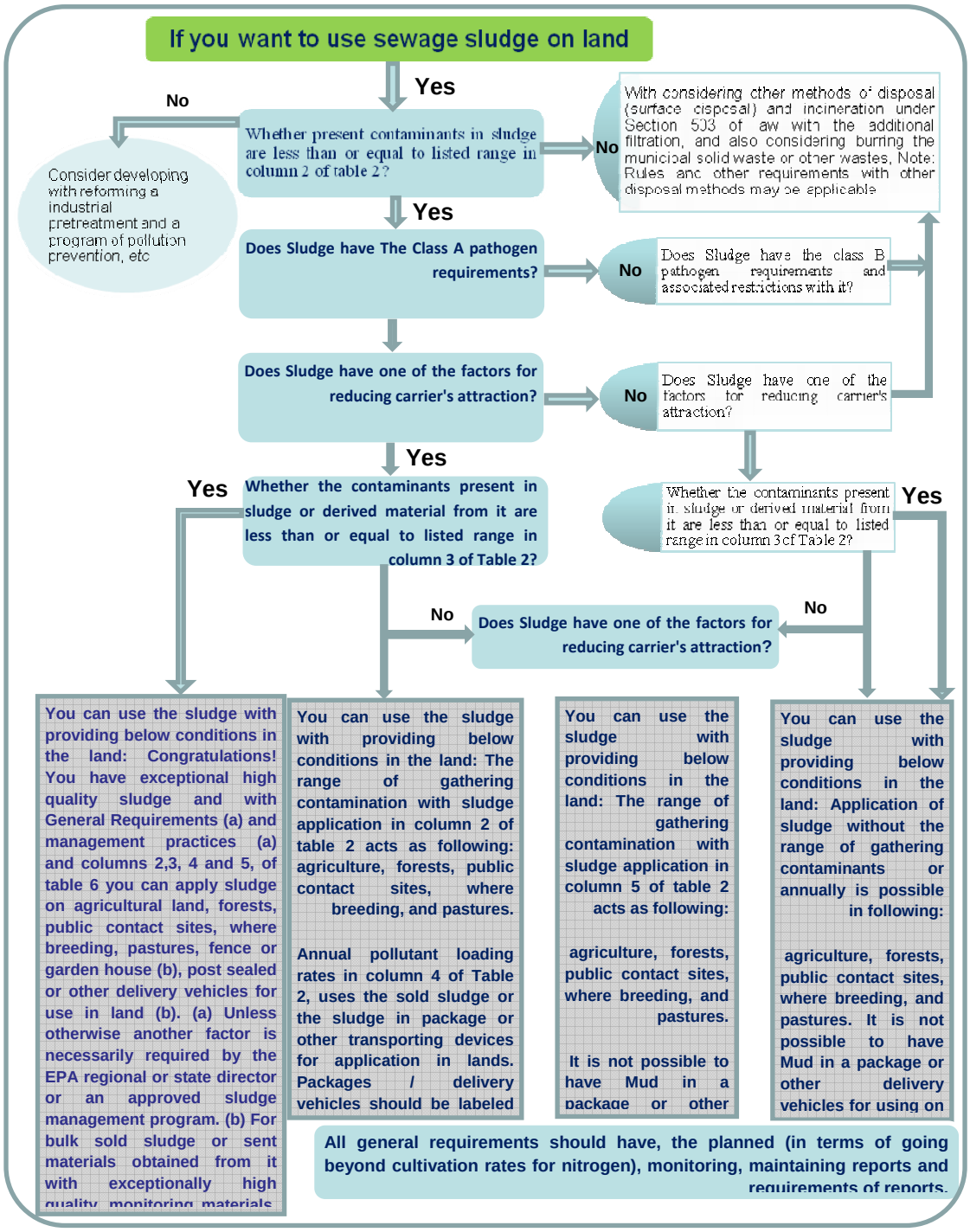


Figure 1. The graphic for determining the capability of the land application of sludge

Table 4. Parameters to be monitored in land-applied

Pollutants	Pathogens	Vector Attraction Reduction
Arsenic,Cadmium, Copper,Lead, Mercury , Molybdenum, Nickel, Selenium, Zinc	Fecal coliform or *Salmonella* Enteric viruses Helminth ova	Percent volatile solids reduction Specific oxygen uptake rate pH, Percent solids

Table 5. Monitoring frequency for land application

Biosolids Quantity[a] (dry metric tons/365-day period)	Frequency[b]
0 to <290 290 to <1500 1500 to <15,000 15,000 or greater	Once per year Once per quarter (4 times/year) Once per 60 days (6 times/year) Once per month (12 times/year)
a- Bulk biosolids or biosolids sold or given away in a bag or other container. b- After two years the permiting authority may reduce the frequency for pollutant concentrations and for the pathogen density rerquirements.	

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Identification of Soils and Land unit as one of The First Step in Controlling Erosion (case study: Gharah Ghayah Watershed in East Azerbaijan province, Iran)

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Abstract
The final aim of optimum utilization from capacity and potential of watershed is the knowledge so as to deal with natural disasters and particularly reduction, control of erosion and sediment process. In order to identification of soils and land units in Gharah Ghayah watershed, were selected. This watershed is a part of dam's Arasbaran watershed and Moghan's vast plain is located in the north of the city of Kalibar in East Azerbaijan province. The confinement of the field was done by satellite images and topographic map. The main basin is divided into sub basin and Land unit's components were determined. Separating of main types, lands and determining of each field was done according to physiographic standard of Soil and Water Research Institute of Iran. With field survey, boundary of land units was adapted in site and the soil profiles were drilled in each unit. The results showed that Gharah Ghayah watershed have the four main types including Mountains, hills, plateaus and upper terraces and plains range that these has been covered separate lands unit and results also showed that watershed Gharah Ghayah has vast range of soils include Entisols, Inceptisols, Mollisols and debris soils with different depth. Since that, mountain's type encompasses a part of considerably watershed, in order to improve status current of landuse that is mainly rangeland and conserving lands. In order to controlling erosion and improve of vegetation, we can perform biological methods alongside watershed's mechanical structures.
Keywords: Lands Unit, Watershed, Gharah Ghayah, Kalibar, East Azerbaijan

Introduction
The soils, as one of natural resources are probably the infrastructure main of civilization in any country and infect principles and utilization method from soils determining the progressive or retrogressive in each community (Ayobi and Jalaliyan, 2006). Soil erosion is risky to human's welfare and even for his life, because it will cause fertility reduction, poor and farms abandoned, materials sequestration in waterways, reservoirs, dams, ports and capacity reduction of basin (Ahmadi, 2006). Today, soil conservation and combat with erosion is most essential measures in each country, because the final aim of optimum utilization from capacity and potential of watershed is the knowledge how to deal with natural disasters and particularly reduction and control of erosion and sediment process (FAO, 1983). For this purpose, the researches of resource evaluation and land suitability is done for types of main use to development and restoration of natural resources, watershed planning and especially flood control, soil and water conservation, increasing land productivity, reducing sediment and preventing from destruction of downstream lands and or reducing to destructive effects of floods in watersheds (Ayobi and Jalaliyan, 2006). Despite climate diversity in Iran is expected the variety soils occurred or is being formed in centuries past but soil erosion of Iran per annum is three and five times of global average and Asian countries respectively (Mosavibaygi and Ashraf, 2009). Since, development and agriculture programs will require that soil resources and its unit's identification and assessment with carefully to relevant projects be implemented successfully and considering to soil of different areas, strategies offered can be the protection guarantee of this important source of non-renewable. Regarding that, study aimed to identification of lands and soils of Gharah Ghayah watershed as one of the first step in controlling erosion is done.

Materials and Methods
Study Area Features
This study has conducted in part of dam's Arasbaran watershed and Moghan's vast plain that it is located in north of Kalibar city in East Azerbaijan province is called Gharah Ghayah. Public

features of area with details in Table 1 are given (Alizadeh et al, 2011). Location of the study area in Iran regional map has given in Figure 1.

Table 1. Study Area Features

Site	Area (He)	Longitude	Latitude	Climate	Annual rainfall (MM)	Altitude from free sea level (M)	Temperature Maximum (C°)	Temperature Minimum (C°)	Vegetation type
Watersheds Gharah Ghayah	7446.2	47° 17′ 24″ to 47° 27′ 55″	39° 11′ 17″ to 39° 16′ 12″	Semi-arid cool	330.7	to 800	19.5	6.3	*Artemisia sieberi* Besser

Note: He (Hectare), MM (millimeter), M (Meter), C° (Centigrade degree)

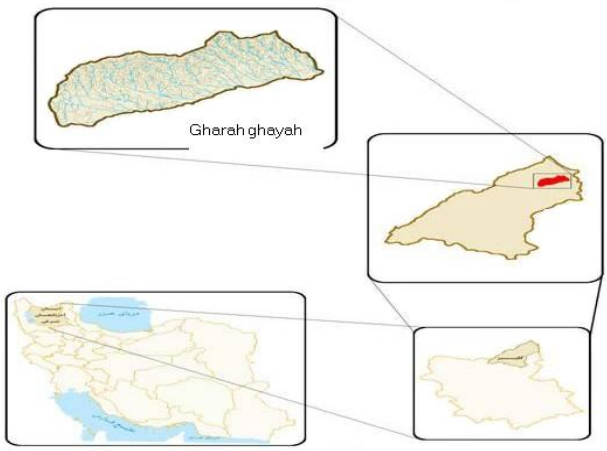


Figure 1: Location Of The Study Area In Iran Regional Map

Research Methods

In first step, preliminary identification including provides for aerial images, satellite images, topographic and geologic maps on 1:50000 scales, is determining range of study under by using determination of aerial image guide on these images and types, units and lands unit components determined. So through field survey, boundary of watershed and primary types was controlled and its changes were corrected. In second step, after drilling soil profiles in each unit were done study, description of profiles and selection of soil samples in lands unit components. Separation of the main types and determination of each of these areas was done according to physiographic standard of Soil and Water Research Institute of Iran (Mohajer Shojai, 1985) which the lands are divided to main type's nine. Considering its features such as appearance form, slope, topography, erosion, altitude, soil type, constituent primary material, vegetation and etc lands type are divided to land units and it is separated to several lands unit components according to minor changes. If a kind of lands have been the characteristics of apart main types of land so- called miscellaneous types of land that showed with "RW" symbol. So if into apart of lands, the main types be clear but not possible to separate them from each other due to scale small of map, all those parts so- called types complex that showed with "C" symbol. There were no "RW" and "C" in study area. In order to study of soil characteristic, the profiles were dug in land unit's component. In regard to laboratory results, the soils were classified by method of USDA Soil Taxonomy (2010) in each land unit's component.

Results and Discussion

General Features of Main Type of Lands in Study Area

The feature of each of the main types has given in Table 2. The results showed that Gharah Ghayah watershed is included main types four of lands in different altitude range. So that mountains and highlands has been allocated a considerable part from watershed surface. The length of range and slope in highlands is more than plains and regarding that, soil of this area is sensitive and risk of soil erosion is more. Research results of Bayani Khatibi (2004) showed that if length of range and slope is more, will increase risk of erosion especially gully erosion. Also, Bahrami et al (2005) in their studies concluded that lands type is important factor in the erosion as changing on it's would change would the amount of soils erodible.

Table 2: General Features of Main Type In Study Area

Lands type	General and effective slope (%)	Area (He)	Level difference (M)	General features
M; 1 (Mountains)	<25 In different aspect and non-clear	1918.3	>100 and generally 500-1500	This lands is destructive with very high topography in aspects northwest to southeast with moderate to very high altitudes
H; 2 (Hills)	8-25 In different aspect and non-clear	1837.4	50-500	This area is vast and the form often is convex ridge and high altitude
T; 3 (Plateau and upper terraces)	To 5 generally convex	2056.7	<50 and generally <25	These lands are including old sequestrated alluvial due to moving runoff and it is vast and often rangeland and dry farming land use, boiling lime shows from evolution of land.
P; 4 (Plains)	<1 1-5 and rarely <1	1443.5	<5	These areas are dispersion in border of river or to form relatively vast plains
Total		7446.2		

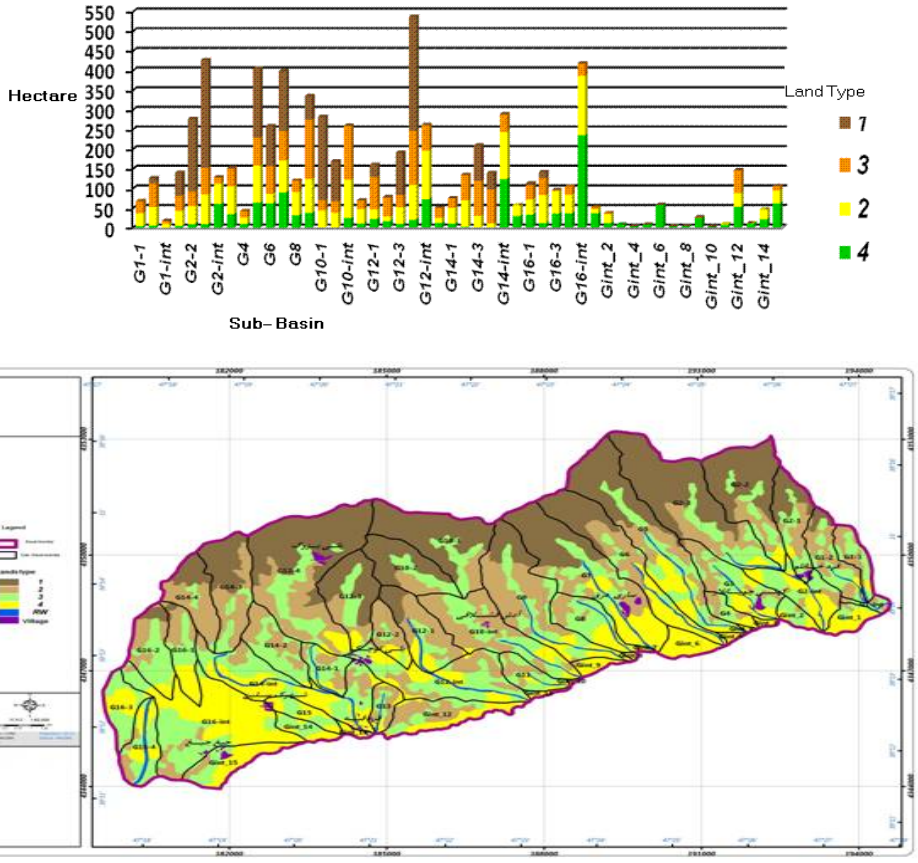


Figure 2: Lands Type Map And Its Area In Sub Basin

Determination of Features of Land Unit and Land Unit Component

According to important and fundamental differences that there were in each of land types, the land types are divided to smaller area so- called "land units". Considering to climate, facies, slope and condition of soil depth, each of land units are divided to one or more smaller parts so- called "land units component" (Table 2). Hence, land units and land units component was separated seven and eleven respectively. So that, these components was found in specially range of the watershed. Considering to features of land units component in Gharah Ghayah watershed, the land use only has been in two forms of forming (Irrigated and dry) and rangelands. In other words, land units component be determinate land use and topography and soil depth was been as two effective factors. Regarding that the rangelands in high altitude and low depth soils and agriculture lands in plains and deep soil is used by beneficiaries. Intense utilization of rangelands as the result of high stocking rate and the vast of uncultivated follow dry forming has led to lands degradation in area. Mohajer Shojayi (1985), Holechek et al (2004) and Bahrami et al (2005) have reported same consequence.

Table 3: General Features of Lands Unit Component in Study Area

land type	Land unit	Land unit component	Land form	Altitude range from sea level (M)	Land slope (%)	Lands range in basin	Land use type	Lands erosion	Lands facies and destructive cover	Lands soil depth
M; 1	1.2	1.2.1	High mountains with circular peaks	480-800	30-60	North to northeast	Rangeland	Surface and geologic	Regular 50-75%	Low deep and non-uniform
		1.2.2		560-800	20-40	North to west			Regular 75-100%	Low deep and uniform
H; 2	2.1	2.1.1	Low and High rather hills with circular, convex and flat peaks	540-560	8-15	Southwest	Rangeland and uncultivated follow dry forming	Surface and gully	Regular 50-75%	Semi deep and uniform
	2.2	2.2.1		500-650	8-20	Central to half east				Low deep and uniform
		2.2.2		560-620	8-20	Central to southwest				Semi deep and uniform
		2.2.3		640-700	8-25	Southwest				Low deep and non-uniform
T; 3	3.2	3.2.1	upper terraces	<300	3-8	Central to west	Uncultivated follow dry forming	Surface and gully	-	High deep
	3.4	3.4.1		<300	2-5	Central to west				Semi deep
P; 4	4.1	4.1.1	Plain with micro topography	<100	1-2	East	Irrigated and dry Forming	Surface	-	Semi deep
	4.2	4.2.1		<100	1-2	Central	Uncultivated follow dry forming			High deep
		4.2.2		<100	2-5	Central	Uncultivated follow dry forming			High deep

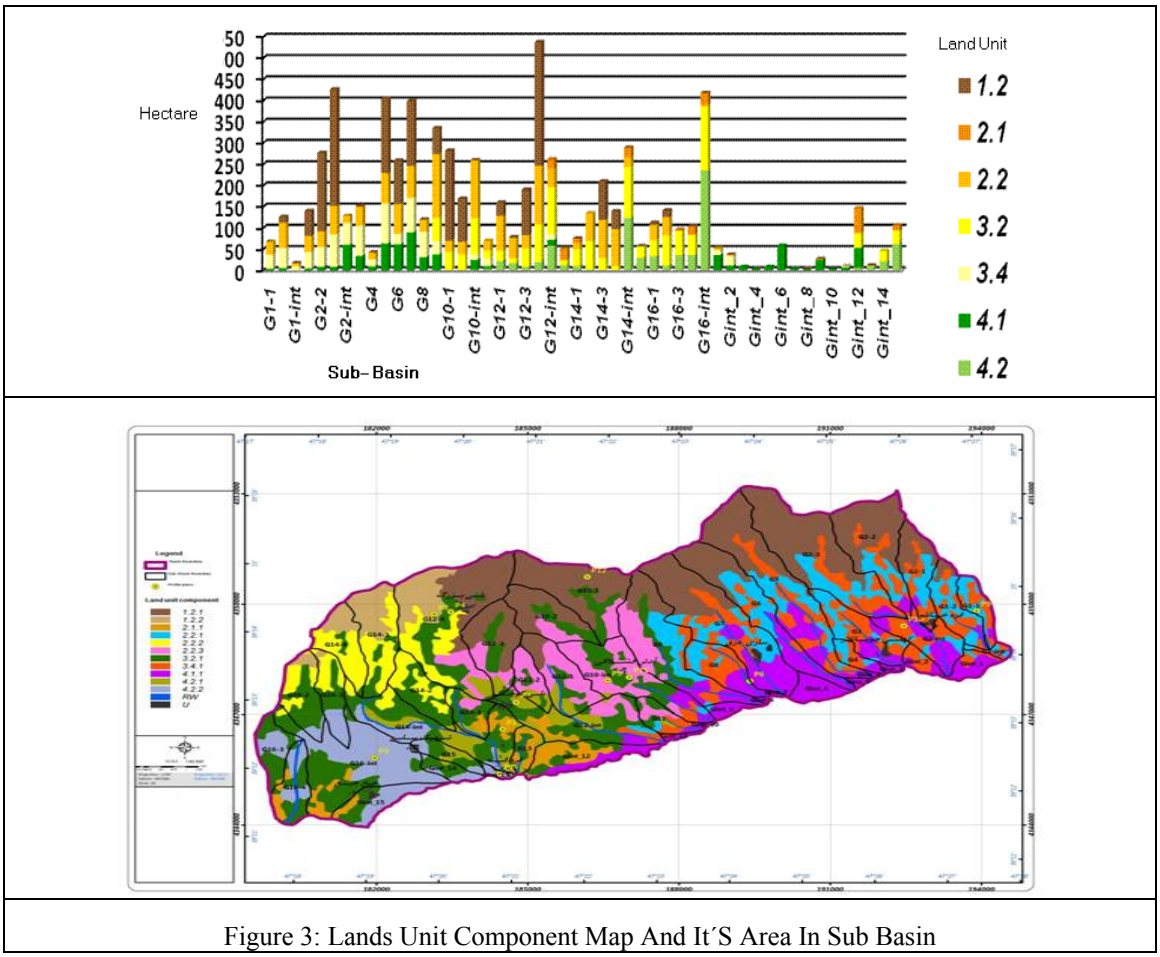


Figure 3: Lands Unit Component Map And It´S Area In Sub Basin

Determination of Soil Type in Study Area

Regarding to USDA Soil Taxonomy (2010), the factors of soil including color, texture, structure, the amount and concentration of materials as lime, chalk in sub soil was caused separation of various order of soil. As the result of three categories Entisols, Inceptisols and Mollisols under large groups were identified to be given in Table 4. The importance of each mentioned soil order depends to capability of infiltration and structural stability of soil in controlling process of erosion and sediment (Sadeghi et al, 2011). Entisols was found in northwest of watershed, where steep slope and erosion very high is not allowed to formed lower horizons. In these soils is the amount of grit and rubble very much. So that it has been more than 35% volumetric. Also, the amount of organic carbon was reduced when soil deep decreased. The vast part of Gharah Ghayah watershed included Inceptisols. These soils order expanded in plains that they are characterized by lower horizons of Typic and Calcic (calcium carbonate and magnesium) and it is located in sub- order of xerepts. Mollisols identified in central and highlands of watershed that it has been high alkali saturation and its amount increased when soil deep more. These soils are characterized by a thick, dark surface horizon. This fertile surface horizon, known as a mollic epipedon, resulting from the long-term addition of organic materials derived from plant roots.

Table 4: Soil Type In Study Area

Soil category	U.S.D.A, Keys to Soil Taxonomy 2010, (Sub group)	Symbols on map	Land unit component
Entisols	Lithic Xerorthents	L.X.O	1.2.2, 2.2.2
Inceptisols	Typic Haploxerepts	T.H.X	4.1.1, 3.2.1, 4.2.2, 2.2.1, 3.4.1
	Calcic Haploxerepts	C.H.X	2.1.1
Mollisols	Calcic Pachic Argixerolls	Cp.axl	4.2.1
	Lithic Haploxerolls	L.H.xl	1.2.1, 2.2.3

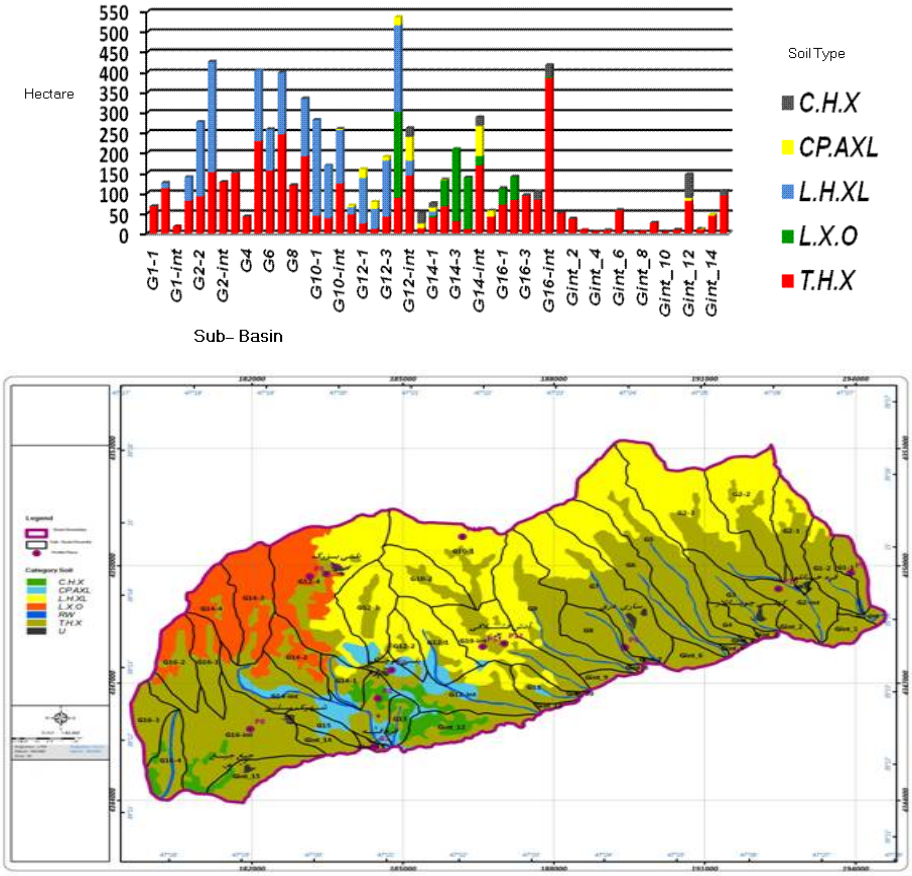


Figure 4: Soil Type Map And Its Area In Sub Basin

Conclusion

It is especially important to recognizing of production capacity of lands and its assignment to profitable and best of land use. Now, utilization from Gharah Ghayah watershed is conducted to form traditionally and no specific plans and improper management provides to destruction these resources. Incorrect planning and improper management will cause irreparable damage including vegetation loss, infiltration reduce, runoff production, creating of uncontrollable flood and intense erosion (Holechek et al, 204). In regard to any kind of lands utilization that it is capabilities superior will cause to damages and its fertility reduce in long- term. In order to, resources and land units of Gharah Ghayah watershed is identified to from soil be utilized to best form as integral component of lands. Differences in soils type and its constituent elements and main topography features (slope steepness and slope aspect) have been the main causes of erodibility in land units that caused to change soil's hydrological process (especially potential of runoff and sediment production) directly or by effect on other environmental factors. Since that, mountain's type encompasses a part of considerably watershed, in order to improve status current of landuse that is mainly rangeland and conserving lands. In order to control erosion and improvement of vegetation, researchers can perform biological methods alongside watershed's mechanical structures.

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A New Soil Water Retentıon Technology: Retaining Soil Water and Nutrients in the Plant Root Zone

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Abstract

Water scarcity is the major problem for agriculture in dry and semi-dry regions. New technological solutions are needed to save water in soil and benefit from winter precipitation as much as possible. Researchers have developed many methods to save irrigation water within soil profile such as asphalt barriers. However application difficulty of this material under the root zone caused loss of interest to this method. Recently soil water saving membranes (SWSM) were tested in sandy soils in USA and Turkey. SWSM installed in sandy soils doubled the water holding capacities within the root zone of maize plants. SWSM membranes placed at 30 and 40 cm depths, different levels of irrigation were applied and soil water contents were monitored with frequency domain reflectometry (FDR) continuously under turfgrass. Aboveground plant biomass of turfgrass and maize increased 33% for turfgrass and 350% for maize compared to controls. Water use efficiency expressed as grams of plant per liter of water, increased 378% for maize grown in sands lined with water saving membranes below their root zones compared to control plants without membrane liners. Currently, Michigan State University patented membrane installation device for installing polyethylene membranes into field soils easily. Greater plant production profits improved by these new SWSM water and nutrient saving membranes can accelerate manufacturing, employment and local businesses in regions surrounded by sandy soils where adequate rainfall and/or supplemental irrigation are available.

Introduction

Demand of water is increasing due to global warming and increasing population and industrialization are decreasing quality of water resources. New technological solutions are needed to use water more efficient and sustainable. One of the precautions to save water resources is to benefit from winter precipitation as much as possible. Permeable soils such as Sandy soils and Oxisols have been left to native succession because of water holding problem in many years. Researchers have developed technologies that utilize rainfall to retain water for longer periods of time in arid and semiarid regions. Most of these approaches achieved 30 to 400% increases in biomass while using 40 to 80% less supplemental irrigation water (Erickson, et al., 1968; Ethan et al, 2007). Application of mulch saves water within soil (Clarkson and Frazier, 1957). Erickson et al. (1968) placed asphalt barriers at a depth of 20 cm below soil surface to save water for rice cropping. However installation of asphalt barriers was very hard to apply in larger areas. Management method must be both economical and easily applicable.

Current researches on soil water saving membranes (SWSM)

Demirel (2011), conducted a fieldwork to test the effects SWSM made of polythene sheets, turfgrass (*Lolium perenne c.v caddieshack*) was sown on April 25, 2010 and May 1, 2011 and the measurements were completed on July 23, 2010 and August 15, 2011. Plots were designed according to randomized blocks and each treatment was replicated three times at randomized locations within the blocks. Each plot was 1.7 m wide and 2 m long. There was a gap of 1.5 m width between each plot. To see the effect of SWSM, two different depths (30 cm and 40 cm) were selected in this study. Also, there was a gap of 10 cm wide and 2 m long for drainage.

FDR (ECH_2O, EC-5, Decagon) sensors were located at 15 cm depth in the plots. Three different irrigation treatments were selected as 100 %, 66% and 33% of available water-holding capacity. Also, control (without SWSM) plots were made to compare with SWSM treatments. The plots were irrigated by micro sprinkler irrigation. The treatments were fertilized on 25 April 2010 and 1 May 2011 with the $N_{15}P_{15}K_{15}$ type of fertilizer as 250 kg ha^{-1} and as a nitrogen source, the fertilizers of ammonium sulfate were applied 400 kg ha^{-1} all plots for the growing season in both years.

Irrigation treatments were; 30/100, 30/66, 30/33 (SWRB installed at a depth of 30 cm, replenishing of soil moisture to field capacity, replenishing of soil moisture up to 66 % of available water holding capacity and replenishing of soil moisture up to 33 % of available water holding capacity respectively). 40/100, 40/66, 40/33 (SWSM installed at a depth of 40 cm, and irrigation treatments were same as above). Control treatment indicates no SWSM and replenishing of soil moisture to field capacity

The amount of water saved and total irrigation water applied after starting water deficit ($TIWA_{deficit}$) are presented in Table 1.

Table 1. The amount of water saved and total irrigation water applied after starting water deficit ($TIWA_{deficit}$)

Treatments	$TIWA_{deficit}$ (mm)			Water saving percentages with respect to control (%)		
	2010	2011	Average	2010	2011	Average
Control	576	915	746	-	-	-
30/100	361	616	489	37	33	35
30/66	253	544	399	56	41	49
30/33	88	345	217	85	62	74
40/100	325	600	463	44	34	39
40/66	232	523	378	60	43	52
40/33	122	356	239	79	61	70

$TIWA_{deficit}$ values were between 88-576 mm in 2010, and were between 345-915 mm in 2011 (Table 1). The minimum and maximum water saving percentages with respect to control was 37% (30/100) and % 85 (30/33) in 2010 and 33% (30/100) and 62% (30/33) in 2011. The highest water savings were obtained from 30/33 and 40/33 treatments.

Average of two years data showed that, when plants were irrigated to 100,66 and 30% of available water retention capacity, water savings were % 35 and % 39, % 49 and % 52, % 74 and % 70 for $SWSM_{30}$ and $SWSM_{40}$ respectively.

Yang et al (2011), studied the influence of the membrane on water retention and drainage. For this purpose, three homogeneous sand columns were installed. Membrane was installed on the bottom of the upper part of the column. Hole density was 1/50 cm^2 in Column 1, and its hole size was 6 mm in diameter. Hole density was 1/50 cm^2 in Column 2, and its hole size was 1 mm in diameter. Column 3 had no membrane. Water was added to the columns and TDR was used to determine volumetric water contents of sand. Water content changed faster in column 3 (no membrane), but it changed slower in column 1 and column 2. Water content changed slower with 1 mm diameter holes than that of with 6 mm diameter holes. Drainage speed was 2.29, 3.48 and 19.03 L/h for columns 2,1 and 3 respectively. The membrane reduced saturade hydraulic conductivity of sand columns.

Similar experiment was carried out in Michigan, USA. SWSM water saving membranes installed in pure sand, directly below the root zone of corn, increased cellulosic biomass of corn stover by 260 to 350% beyond controls grown without water and nutrient retaining membranes. Another study was conducted in lysimeters for sandy soils. Treatments were water membrane depths, shapes and perforations. Lysimeters equipped with 48 Decagon 5 TE Probes (TDR), 27 suction lysimeters and 3 minirhizothron tubes. SWSM was placed in the soil with two different shapes: V shape and U shape. Volumetric soil water contents within the two different membrane configurations and depths were similar, however the unsaturated soil water diffusivity above the larger U-shaped membrane was twice ($1.75x10^{-3}$) the diffusivity above the shallower V-shaped barrier ($0.85x10^{-3}$) (Smucker et al, 2012 unpublished).

Corn height was greater in SWSM treatment than that of control. Average single plant weight was 208.5 g with SWSM while it was only 57,3 g under control (no SWSM) (Smucker et al, 2011)

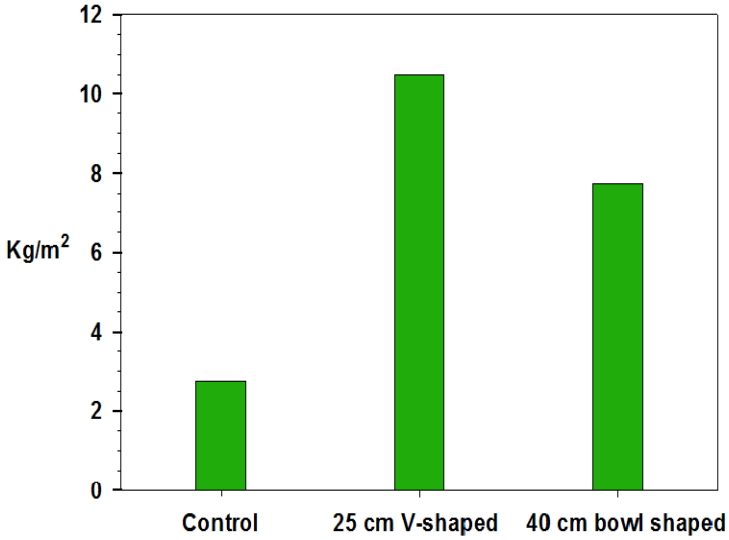


Fig 1. Corn biomass under control, SWRB (V shaped) and SWRT (bowl shaped)

Results from Turfgrass study showed that, SWSM saved 35-74% water compared to control (no SWSM) treatment. Maximum water saving (74 and 70% for 30/33 and 40/33 respectively) obtained when soil was irrigated to reach 33% of available water retention capacity (Demirel and Kavdir, 2012). Therefore, SWSM application represents a promising technology because of the water savings. Using SWSM under semi-dry climate conditions can save water and increase yield. This research is the first experiment of SWSM in Turkey. Future researches are needed to use SWSM for different crops in different soil texture under different climate conditions.

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A proposed model to determine the river protection zones in the water basin areas in Istanbul

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Abstract: Istanbul province has been supplying the drinking and potable water demand from surface resources. Surface hydrological network in Istanbul comprises of two kinds of creeks which classed as the creeks feeding the lakes in the water basin areas and the creeks discharging to the sea out of the water basin boundaries. According to the Regulation Drinking Water Basins which issued by Istanbul Water and Sewerage Administration, the creek protection bands are described as the distance of 100 m from the both sides of creeks that continually flow in the water basin areas for the prevention of the pollution. Because of the limitations and prohibitations along the creek protection bands which are applied as the standart distance for all creeks, some problems occur in terms of providing the protection and use balance, especially in the settlements located near the creek protection bands. In this study a new model proposed while adopting the variable distance approach to determine the protection distances of the creek protection bands in Istanbul. In this model; a multi criteria decision making system has been developed in geological information system environment while taking into consideration the parameters such as stream network and relief properties, basin geomorphology, geological and topographical features, precipitation, hydrological soil properties and vegetation in the water basin areas which are sorted by analytic hierarchy process technique. As the result; the proposed expansions of the creek protection bands have been graded and mapped into three levels as the distances of 30m, 70m and 100m.
Keywords: Basin modeling, river protection zone, Analytic Hierarchy Process, GIS

Introduction

Nowadays, one of the current issues to provide the sustainable management about natural resources and environment is the Multi-Criteria Decision Analysis (MCDA). MCDA is an effective tool for the solution of the complex problems including many parameters. One of the most using decision making tools is Analytic Hierarchy Process (AHP). AHP which based on mathematics and psychology is a structured model for making complex decisions. AHP offers numerous benefits as a synthesizing mechanism in group decisions and it is so well-suited to group decision making (Dyer and Forman, 1992). Also AHP can be applied within the decision situations called as choice making, ranking, prioritization, comparing, quality management, resorce allocation and conflict resolution (Omkarprasad and Kumar, 2006). According to Herath (2004) AHP can explicitly incorporate stakeholder preferences and multiple objectives to evaluate wetland management options and also provides several approaches for policy makers to arrive at policy decisions, while the AHP can be useful in regional forest planing as it can accommodate conflictual, multidimensional, incommensurable and incomparable set of objectives (Ananda and Herath,2003). The AHP applications have been widely and successfully used in terms of ecological conversation planning (Wang and Tang, 1999; Moffeth et al., 2005) and management of the agricultural and forest resources (Alphonce, 1997; Wolfslehrer et al., 2005).

The adaptation of the AHP to Geographic Information System (GIS) enables spatial analysis and explanation of the MCDA. There are many examples on GIS based MCDA and the AHP techniques in literature like ASSESS which provides an interface in the ArcInfo Grid GIS environment that accesses GIS functionality and enables simple linear addition and combination of data layers, quantised into rankings for the development of output scenarios (Hilla et al., 2005). And also Marinoni (2004) focused on the development of an ArcGIS VBA macro and the implementation of the AHP in ArcGIS and Bruen (2008) identified concordance methods and the AHP as appropriate tools. While increasing GIS applications the GIS supported AHP models became widespread and many researchers developed the methods to decision making in terms of landslide susceptibility mapping using analytic hierarchy process and GIS (Yalcin, 2008; Xiaodan et al., 2010; Yalcin et al., 2011).

Riparian zones generally can be described as long, linear strips of vegetation adjacent to streams, rivers, lakes, reservoirs and other inland aquatic systems that affect or are affected by the presence of water. Riparian corridor is a strip of vegetation that connects two or more larger patches of vegetation and through which an organism will likely move over time. These landscape features are often referred to as conservation corridors, wildlife corridors and dispersal corridors (Fischer and Fischenich, 2000). Riparian buffers are vegetated areas next to water resources that protect water quality, bank stabilization, and aquatic and wildlife habitat. Natural riparian buffers are composed of grasses, shrubs, trees, or mixed vegetation (Osmond at all, 2002).

Surface hydrological network in Istanbul comprises of two kinds of creek which classed as the creeks feeding the lakes in water basin areas and the creeks discharging to the sea out of the water basin boundaries. According to the Regulation Drinking Water Basins (ISKI Regulation) which issued by Istanbul Water and Sewerage Administration, the creek protection bands are described as the distance of 100 m beginning from the both sides of creeks that continually flow in the water basin areas for the prevention of the pollution. The river protection bands in the water basin areas in Istanbul can be described as generally the natural riperian zones along the rivers. Mainly natural vegetation covers these protection zones while some regions have been afforestated. There are some limitations and prohibitations along the river protection bands according to the ISKI Regulation. But some problems occur in terms of providing the protection and use balance, especially in the settlements located near the creek protection bands because of the standart distance of the protection bands for all rivers. In this study a new model proposed while adopting the variable distance approach to determine the protection distances of the creek protection bands in Istanbul. In this model; a multi criteria decision making system using Analytic Hierarchy Process has been developed in geological information system environment (GIS) while taking into consideration the parameters such as stream network and relief properties in the sub-basins, basin geomorphology, geological and topographical features, rainfall, hydrological soil properties and vegetation in the water basin areas. As the result; the proposed expansions of the creek protection bands have been graded and mapped into three levels as the distances of 30, 70 and 100 meters.

Materials and Methods

The study area is the metropolitan area of Istanbul province. Istanbul has been supplying the drinking and potable water demand mainly from surface resources. There are seven water basin areas in Istanbul named Terkos, Buyukcekmece, Sazlidere, Alibeykoy, Elmali, Omerli and Darlik. It has been described that the protection zones in water basin areas beginning from the shore line of the reservoirs respectively absolut distance (0-300 meters), short distance (300-1000 meters), medium distance (1000-2000 meters), long distance (from the medium distance to water basin boundary) and the river protection zones with 100 meters distances beginning from the both side of the rivers. Study area shown on Fig. 1.



Figure 1. Study area

The AHP model used as the multi criteria decision making to prioritize the parameter groups which are related to the natural resources. The comparison criterias between two parameters are shown on Table 1.

Table 1. The AHP Evaluation Scale Between Two Parameters

1	A and B Equally important
3	A is weakly more important than B
5	A is strongly more important than B
7	A is very strongly more important than B
9	A is absolutely more important than B
2, 4, 6, 8	Intermadiate values

The main parameter groups which prioritized through the AHP called as strahler stream order (SSO), vegetation (VEG), hydrogeological properties (HYG), annual average rainfall (AAR), hydrological soil properties (HYS), erosion intensity (ERO), flow retention time (FRT), slope degree (SLP) and basin ruggedness (BRS). The paired comparisons of these parameters are shown on Table 2. The weighted scores of the parameter groups and the priority coefficients have determined through the AHP. The calculated priority coefficients are ranked so: SSO: 0,263; AAR: 0,176; HYG: 0,166; ERO: 0,094; VEG: 0,091; HYS: 0,070; BRS: 0,065; SLP: 0,054 and FRT:0,025 while the consistency value for the AHP model is 0,0525 < 0,1. The scores of the all parameters in terms of protection the ecological values and prevention from the factors that affect water quality negatively and pose a risk are shown on Table 3. The point scale is between 1-8 and 8 means the highest risk in terms of water pollution while 1 is the lowest risk.

Table 2. Paired Comparisons of The Parameter Groups

Parameters	SSO	VEG	HYG	AAR	HYS	ERO	FRT	SLP	BRS
SSO	1	3	3	2	3	2	7	5	5
VEG	1/3	1	1/3	1/3	1	1/3	5	3	3
HYG	1/3	3	1	1	2	3	5	3	3
AAR	1/2	3	1	1	3	3	5	3	3
HYS	1/3	1	1/2	1/3	1	1	3	1	1
ERO	1/2	3	1/3	1/3	1	1	3	2	1
FRT	1/7	1/5	1/5	1/5	1/3	1/3	1	1/3	1/5
SLP	1/5	1/3	1/3	1/3	1	1/2	3	1	1
BRS	1/5	1/3	1/3	1/3	1	1	5	1	1

The calculation procedure which used by model is given below. All calculations are made in GIS environment within spatial quarries and results are linked spatial explanations. All results classified into three main groups in terms of river protection overlay distances as 30, 70 and 100 meters.

$$P_1 \times S_1 = R_1 \quad (1)$$

$$R_1 + R_2 + R_3 + \ldots = TR \quad (2)$$

$$R = 100 \times (TR - \text{minTR}) / (\text{max TR} - \text{min TR}) \quad (3)$$

P_1: priority coefficient of each parameter; S1: score of each parameter; R1: relative score of each parameter; TR : Total relative score; R: Normalized score

Classification:	R	River protection overlay distance
	100-65	100 meters
	64-35	70 meters
	34-0	30 meters

Table 3. Scores of The Parameters

GROUP	PARAMETERS	CLASSIFICATION	SCORES							
			1	2	3	4	5	6	7	8
GROUP A	SSO (Strahler Stream Order Degrees)	1 (main river course)								x
		2							x	
		3					x			
		4				x				
		5		x						
		6	x							
	HYS (Soil Drainage)	good								x
		insufficient					x			
		bad		x						
	ERO (Erosion Intensity)	none or very low		x						
		medium				x				
		high						x		
		very high								x
	VEG (Vegetation and Land Use)	rainfeed agriculture					x			
		irrigated agriculture								x
		forest			x					
		pasture/meadow				x				
		marsh area								x
		builded area						x		
	HYG (Hydrogeological Permeability)	nonpermeable		x						
		semi-nonpermeable			x					
		semi-permeable rock				x				
		semi-permeable granular					x			
		permeable rock						x		
		permeable granular							x	
		rush area								x
GROUP B	AAR (Annual Average Rainfall)	very high								x
		high							x	
		medium					x			
		low			x					
		very low		x						
	SLP (Sub-Basin Average Slope Degree)	very high								x
		high							x	
		medium					x			
		low			x					
		very low		x						
	BRS (Sub-Basin Ruggedness Degree)	very high								x
		high							x	
		medium					x			
		low			x					
		very low		x						
	FRT (Flow Retention Time on Main River Course)	very high								x
		high							x	
		medium					x			
		low			x					
		very low		x						

Results and Discussion

Total 210 number of creeks located in the seven water basin areas and in the Kucukcekmece region in Istanbul taken into consideration. The river protection overlay zones of these creeks have the distance of 100 meters beginning from the river shore line according to the ISKI Regulation. After this study the new expansions of these river protection bands have been determined. According to the approach of this study the new proposed river protection overlay zones have been graded and mapped into three levels as distances of 30, 70 and 100 meters beginning from the river shore line. The new proposed river protection overlay zones shown on Fig. 2. Also the rivers and their new proposed protection zones in Istanbul have been listed including their names, expansions, specific properties related evaluation parameters and stream lenghts.

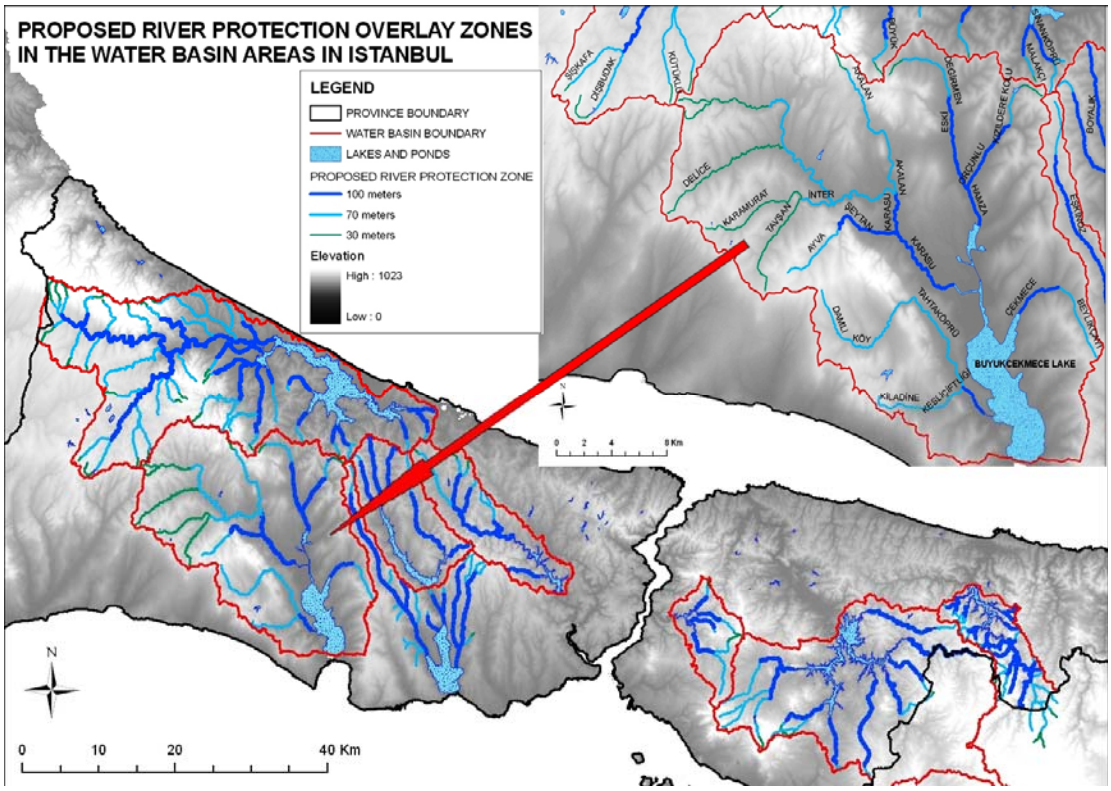


Figure 2. The New Proposed River Protection Overlay Zones

This study aims at the subjects of a new approach in terms of determining the new proposed river protection overlay zones in the water basin areas in Istanbul and also research for determining the applicability and performance of the GIS supported Analytic Hierarchy Process (AHP) Model in case of environmental planning activities. Because of the limitations and prohibitations along the river protection zones including an expansion of 100 meters beginning from both sides of rivers described by ISKI Regulation, some problems occur in terms of providing the balance between protection and use, especially in the settlements located near the river protection zones. In other words, the result of this study aims at the solution of some problems generating standart expansion of river protection zones through the new approach which can be described as the graded river protection overlay zones.

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Weighted Average Estimate of 40 Sediment and Erosion, Watershed and Assess the Impact Factors Using MPSIAC of Province Sestan and Balochastan

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Abstract
Erosion and deposition conditions need to be informed of watershed, such information is essential for each country is planning and implementing soil conservation programs. Between measurements and estimates were also large differences are observed. So one of most practical ways to achieve a documentary for National Statistics, Provinces of studies by different researchers and consulting engineers in the analysis surveys conducted throughout the province, we can deliver better results for and figures for the whole country. Number of Watersheds upstream storage dam in the province was limited and they are also great, and the accuracy of the sampling stations on representative samples for the time being, and the flood estimation methods, Suspended load of the samples, most statistics are also doubts. Plans will be used. Sedimentation and erosion rates in the present study of forty Sestan watershed province, the model for estimating the amount of sediment and erosion MPSIAC examined , After review and field operations of some of the areas mentioned and corrected in some points of 9 , Then calculate the weighted average of all factors mentioned above, the total amount of sediment and erosion, particularly in the field of 40 has been calculated As the weighted average of the sediment and erosion, especially in areas mentioned above respectively, are 2.24 and 6.8 tons per hectare per year, and two wear lands upstream and erosion level of factor 8 and 9 of MPSIAC as two factors that most influenced erosion and sediment production areas have been introduced.
Keywords: Sestan and Balochastan**,** Erosion and Sediment**,** MPSIAC

Introduction
Role in reducing erosion and sediment production and loss of soil fertility, reduce the volume of dewatering of dams and reservoirs are filling in, clogging waterways and irrigation and Hungarian, Mud contaminated river water and reduce water quality and water pollution the downstream areas (some sediment pollutants act as a carrier) Always identified and considered by the experts of the Water and Earth Sciences. Therefore, to prevent or reduce the need for planning and implementing the measures mentioned effects of soil conservation and sediment control in the context of soil conservation and watershed management plans are. But requires planning and decision making about how to prevent erosion and sedimentation control, subject to having knowledge of the production rate Sediment and erosion, and factors affecting its production in the watershed is now planning for soil conservation and erosion of the most necessary measures against any country is considered. As the information was accurate expression of the rate of erosion in different provinces of the country and it is not available, And between measurements and estimates made of the differences can be seen, the young field of research and lack of measurement Long-term erosion rates and sediment production and development of appropriate spatial scale survey stations in the country, has been prevented from obtaining reliable numbers. For example, several different estimates of annual soil erosion rate in the country following the announcement of different sources. Distribution and summary statistics on the true story of country shows.
1- more than one billion tons per year (Nakhjavani 1351)
2- More than one billion tons per year (Roze talab 1369
3-5/1 billion tons per year, 56 million hectares in 1980 (source quoted FAO)
4-2 billion tons per year, 60 million hectares in 1989 (source quoted FAO)

5-5/1 billion tons in 1360 (Department of Watershed Management Ministry of Construction) 6-5/1 billion tons per year from 100 million hectares (Planning and Economic Research Institute and the State, 1381).
The practical way to achieve the correct statistics for the entire province of studies by different researchers and consulting engineers has, When analyzing the results of surveys conducted throughout the province to provide more reliable statistics for the whole country can be invoked. While the results can be adapted to the watershed basins across the country in terms of number and severity of erosion and sediment production, they can act. Province Sestan- Balochastan with an area of 18750200 hectares, 4 / 11 percent of the total area allocated to, And the country's largest province with a population of over 2405742 people is a And placed in northern latitude and 25 degrees to 31 degrees and 27 minutes and 3 minutes and 50 minutes eastern longitude 58 degrees to 63 degrees and 21 minutes from North to South Khorasan province , From East to Pakistan and Afghanistan, and Oman to the south of the West and the South West of Kerman province is limited to. The province has five large basin, called the watershed Hirmand, Lut Desert, Mashkyd, plain and Oman is Jazmvryan. Province has a warm, dry climates with mild winters, and the summer was very hot that day and high temperature changes in the annual thermal amplitude is high, And air relative humidity was low and the average annual rainfall is about 110 mm (approximately less than one third of the rainfall), the intensity of rainfall in most parts of the province.

Background Investigation: Experimental methods PSIAC (PSIfic Southwest Inter - Agency Committee) for the first time in 1968 AD by the water management and agricultural America**,** By (Renard) for estimating dry deposition areas in Arizona and the Southwest Watershed Research (Walenut Gulch) was presented**.**Fazneya (And also for the first time in Iran PSIAC model by consulting engineers in research and development in 1972 used Dez dam watershed**.** Then, due to its relatively good accuracy in comparison with other methods and experimental models in some other countries, such as watershed**,** Dokhahran, Kaher, Zayandrud, Marun, Halil rud, Was used..(Rafahi.2008). Then in 1982, employing this model in watershed research (Reynolds Creek) in southern Idaho, America West was caused by Janson in the model. And the factors affecting erosion relationships in this model were presented to the model name MPSIAC (Modified Psiac) was known. Later, this model also was used in the country, and now also for estimating soil erosion and sediment production in the comprehensive plans of the Soil Conservation and Watershed Management Projects, especially in the case of used.

Materials and Methods

Areas examined in this study of 40 watershed areas and small and medium-sized province has been selected. Scatters so that the province from north to south and cover each city has been selected as a watershed to 3, About 9 of the report detailed studies of MPSIAC Executive Vice Watershed Watershed Management Department of Natural Resources and Watershed province was drawn. Availability of relevant reports, data reports, the erosion and sediment re-evaluated. To confirm the accuracy and false information, visits of some areas has been done, It hits the result, leading to erosion and sedimentation in some areas for improvement have been. Finally, rates of 9 MPSIAC model for each area together in a formula to estimate the amount of deposits placed with the SDR, ultimately, the estimated rate of erosion is particularly. Sediment and erosion, then the weighted average production of about 40-fold above were calculated, the following process will be described. For each factor in a relationship is based on the relationship of each factor is assigned a score, then the sum of 9 scores in both the R model shown. Based on the amount of R, class rate of erosion of the watershed has been done. The relationship between the amount of sediment production and erosion scores and R are as follows.

The initial PSIAC

$Q_s = 38.77_e^{0.0353\ R}$**,** Qs - The annual deposition rate in cubic meters per square kilometer
R - The degree of deposition of the total score of 9**,** e- Number Npr approximately 2/ 718

In MPSIAC

$Q_s = 18.6_e^{0.036\ R,}$ Qs - The annual deposition rate in cubic meters per square kilometer**.**
R - The degree of deposition of the total score of 9**,** e- Number Npr approximately 2 /718

Factors in the erosion of properties on each agent, and the range of scores for each of them to model PSIAC Table (1) and the factors and relationships intended for the MPSIAC in Table 2 is presented.

Table 1 - Factors affecting soil erosion, and operating characteristics investigated in the range of scores for each factor based on PSIAC

About the scores	Features of Property	Factors affecting erosion	Row
10-0	Type of rock, hard rock, the weathering and cracking	Geology Surface	1
10-0	Texture, salinity, the amount of lime, organic matter, a hunk, a contraction and expansion, the percentage of gravel	Soil	2
10-0	Frequency, intensity and duration of showers, the amount of snow, freezing,	Weather	3
10-0	Volume per unit area, peak flow per unit area	Runoff	4
20-0	The steep slopes, ups and downs, the development of alluvial fans and floodplain	Low and high	5
10 > 10	Vegetation, rock cover, under trees, vegetation, litter	Land cover	6
10 > 10	Percentage of arable land, because the trees are cut and road construction	Land use	7
25-0	Tracks and ditches, land slip, the wind deposited in the channel	Land surface erosion and watershed	8
25-0	The sides and bed erosion, stream depth, and vegetation within the active waterways	Erosion of stream	9

It is estimated that erosion in the watershed land surface MPSIAC been considered as the eighth of America Department of Land Management BLM (Bureau of land management) with the seven factors described in Table (3)**.**
Is the action that it also plays an important role in the calculation and recognition of land surface erosion in the watershed model will play MPSIAC .And even can be based on this method (BLM) erosion types (surface, tracks, ditches and waterways or lateral) and classified them according to type of work units (fancies geomorphology and land elements) to determine**.**

Table 2 - relationships and factors affecting soil erosion in MPSIAC

Description	MPSIAC The relations	Factors affecting erosion	Row
Rocks sensitivity to erosion $= Y_1$	$X1=Y1$	Geology Surface	1
Susceptibility to soil erosion, soil erosion using global formula $= K$	$X_2 = 16.67\ K$	Soil	2
6-hour rainfall with return periods of two years $= P_2$	$Y2 = 0.2\ P_2$	Weather	3
Qp = peak discharge and runoff particularly high annual = R	$X_4 = 0.006\ R + 10\ Qp$	Runoff	4
The average slope in percentage $= S$	$X_5 = 0.33\ S$	Low and high	5
Percentage of bare land and lack of coverage $= P_b$	$X_6 = 0.2\ P_b$	Land cover	6
Percent canopy $= P_c$	$X_7 = 20 - 0.2\ P_c$	Land use	7
Operating point of the soil surface is calculated using the BLM $= SSF$	$X_8 = 0.25\ SSF$	Land surface erosion and watershed	8
Gully erosion in the BLM method of operating points $= SSF_g$	$X_9 = 1.67\ SSF_g$	Erosion of stream	9

Sediment delivery ratio SDR

Sediment delivery ratio SDR (Sediment Delivery Ratio), usually using the curve in terms of area and the soil is determined to be**,** therefore, the SDR for each of the areas were calculated and compared with the deposition rate and specific areas, particularly the erosion of the desired calculation is presented.

$$SDR = \frac{Sediment\ production}{Erosion}$$

With a production rate of sedimentation and erosion in the watershed 40, to calculate the weighted average of the sediment and erosion, Province has 40 branches in Table 4 is presented.

Table 3: Rate of erosion of the watershed land surface (SSF) to BLM

Physical environment	Some points	Description
There is no visible movement.	0-3	Mass movement of soil
Slight movement of soil particles	4-5	
Moving average and the soil is visible. Terrace with a height of less than 5.2 cm	6-8	
Aggregation of soil particles in the runoff with little barriers, the action happens.	9-11	
Most regions have seen the appearance of the soil. Sand dunes and wind erosion occur.	12-14	
Accumulation of plant debris in a spot	0-3	Litter cover
Motion of residue is less.	4-6	
The average litter is obvious and has been deposited in the hurdles.	7-8	
Motion is very clear and large amounts of litter and sediment has raised the barriers.	9-11	
Surface litter is very low.	12-14	
Well developed and uniformly dispersed	0-2	Surface rock cover
Scattered spot to spot	3-5	
The small and large rocks with very low dispersion	6-8	
The individual level and at the show	9-11	
There are separate rates by grooves and Galy	12-14	
There is considerable evidence	3-0	Consolidation of stone fragments
The flow paths are low	4-6	
There are small rocks and plants in the network	6-7	
Small stones and lumps of plants to become root and commonly seen.	10-12	
Much of the consolidation of rocks and plants	13-14	
Grooves on the surface of water erosion is not observed	0-3	Surface grooves
Deep grooves in the surface grooves are evident but less than 5.1 cm and the distance between them is about 3 meters.	4-6	
Grooves with a depth of 5.1 to 15 cm of soil at intervals of about 3 m from each other occur.	7-9	
Grooves with a depth of 5.1 to 15 cm in the soil can be seen that the distance between them is about 3 meters.	10-12	
Grooves with a depth of 5,7 to 15 cm with a distance of 5.1 m below the soil surface is observed.	13-14	
Seen in the stream below the surface.	0-3	Waterways form
Material remained in the stream bottom are partly visible.	4-6	
The particles are deposited onto the bottom of waterways, respectively	7-9	
Particles in the channel bottom of silt, sand and be seen	10-12	
Channel density at the surface is high and barren lands in the area of Thnshst	13-15	
May be in steady state conditions and vegetation in the channel bottom and side slopes are located	0-3	Development of gully erosion
Some gully erosion and bed nearby, low inclination, there is some vegetation on the slopes.	4-6	
Gully erosion has developed a number of fully active in less than 15 percent of its length.	7-9	
Gullies in large quantities, are 55-10 percent of attrition	10-12	
Gullies in the active region covers more than 50 percent of erosion are active.	13-15	

Table 4 - Model MPSIAC nine factors in 40 province and watershed erosion and sedimentation areas of the forty

	Name of sub basin	Surface geology (y1)	Soil (y2)	Climate (y3)	Run off (y4)	Topog-raphy (y5)	Ground cover (y6)	Land use (y7)	Up land erosion (y8)	Chanel erosion and sediment transport (y9)	Rating (R)	Erosion class	Specific sediment (M3/HA/Y)	Specific gravity (T/M3)	Specific sediment (T/HA/Y)	Area (HA)	SDR	Specific erosion (t/ha/y)
1	Ladiz7	5.78	6.33	6.9	4.47	5.44	2.03	16.26	8.28	0.57	56.06	2	1.4	1.3	1.82	12022	31.5	5.8
2	Sandgol	4.59	7.42	2.1	0.71	6.29	1.58	18.84	7.88	1.71	51.12	2	1.17	1.3	1.52	10278	32.21	4.7
3	Pishin c8-2	4.48	6.08	5.9	4.09	4.8	3.01	19.05	14.87	10.83	73.11	3	2.58	1.3	3.35	5509	35.2	9.5
4	Sangan	4.07	6.26	6.6	3.68	3.81	8.69	15.43	9.17	1.56	59.27	2	1.57	1.3	2.04	8614	33.03	6.2
5	Kote vasnib	2.98	6.51	5.4	2.53	7.65	2.17	16.36	9.51	7.51	60.62	2	1.65	1.3	2.15	4330	36.42	5.9
6	Meydan sorkh	4.7	6.61	5.5	2.01	2.11	1.75	15.98	12.01	2.63	53.3	2	1.27	1.3	1.65	10580	32.08	5.2
7	Umar	2.38	2.75	4.6	0.18	8.92	3.24	18.95	11.62	10.18	62.82	2	1.78	1.3	2.31	5458	35.24	6.6
8	Pishin c8-1	6.56	4.99	5.2	1.69	4.79	8.27	17.4	14.98	10.13	74.01	3	2.67	1.3	3.47	4874.2	35.8	9.7
9	Baftan c8-1	7.71	7.7	5.58	2.29	3.78	4.63	10	15.34	7.85	64.88	2	1.92	1.3	2.5	7530	33.67	7.4
10	Baftan c8-2	6.34	6.36	5.3	4.4	4.38	1.66	18.5	10.07	2	59.01	2	1.56	1.3	2.03	7447	33.72	6
11	Chanef	4.66	5.78	4.8	2.19	5.47	1.83	17.56	7.4	1.73	51.42	2	1.18	1.3	1.53	13223	31.08	4.9
12	Gharib abad	4.71	8.33	7.71	0.1	11.35	9.34	16.98	9.21	6.57	74.3	2	2.7	1.3	3.51	3040	.38.30	9.2
13	Govanich	2.17	2.82	5.9	1.1	7.42	2.23	18.18	11.26	9.18	60.26	2	1.63	1.3	2.12	6306	34.53	6.1
14	Baftan c8-3	3.92	6.19	5.16	3.41	5.34	2.42	18.93	10.9	7.51	63.78	2	1.88	1.3	2.44	4657	36.04	6.8
15	pashamak	5.94	6.2	7.7	10.8	9.7	0.83	18.4	6.16	0	65.73	2	1.98	1.3	2.57	9196.2	32.73	7.9
16	Baftan c8-4	5.69	6.7	5.18	4.58	3.86	2.81	18.28	11.6	4	62.7	2	1.78	1.3	2.31	4509	36.21	6.4
17	Bidak	5.88	5.39	3.86	1.45	3.71	12.15	18.02	8.81	2.4	61.67	2	1.71	1.3	2.44	9301.3	32.67	7.5
18	Sarkahoran	5.55	4.44	4.12	4.31	9.87	12.16	19.51	8.08	7.78	75.82	3	2.84	1.3	3.6	4564	36.14	10
19	Milan	6.04	6.28	3.98	0.83	6.71	7.99	19.34	8.8	1.75	61.72	2	1.71	1.3	2.31	10498	32.12	7.2
20	Garok hanzaman	4.98	3.83	4.52	1.1	1.52	7.44	19.34	5.02	0	47.75	2	1.04	1.3	1.39	7367.7	33.77	4.1
21	Eter	5.31	3.91	3.85	1.94	4.94	9.06	19.32	4.49	0	52.82	2	1.25	1.3	1.77	9203.97	32.72	5.4
22	Mohtaram abad	4.96	4.62	4.6	2.07	6.07	7.51	19.34	8.24	0	57.41	2	1.47	1.3	2.12	11080	31.87	6.7
23	Moltan	7.09	6.32	4.14	0.83	2.25	3.43	17.71	8.97	4.79	55.53	2	1.36	1.3	1.97	8942.16	32.86	6
24	Nekoch	3.58	5.18	4.54	0.34	17.73	2.23	17.1	3.89	0	54.59	2	1.33	1.3	1.73	3305.58	37.84	4.6
25	Garbon	6.04	4.7	4.76	0.179	10.38	2.72	17.72	4.33	0	50.83	2	1.16	1.3	1.51	8189.24	33.27	4.6
26	Morti bamposht	6.47	6.05	3.89	2.19	6.41	3.93	16.98	8.88	9.3	64.1	2	1.87	1.3	2.73	7464	33.71	8.1
27	Ghader abad	7.16	6.84	4.07	2.65	4.66	3.36	16.46	9.25	7.98	62.43	2	1.76	1.3	2.52	8810.37	32.92	7.7
28	Jorika	5.73	6.73	2.81	1.58	5.58	4.74	19.48	13.86	6.18	66.69	2	2.05	1.3	2.67	9196.39	32.73	8.2
29	Bandman kahiri	5.73	8.87	3.76	0.5	10.54	6.57	10	12.18	10.32	68.47	2	2.18	1.3	2.83	7907.3	33.43	8.5
30	Kashigan	7.38	7.67	5.27	0.44	4.6	9.6	10	15.25	14.21	74.42	2	2.71	1.3	3.52	9524	32.56	10.8
31	Kalegan	4.22	5.17	4.42	0.24	3.46	3.6	19.32	9.38	2.44	52.25	2	1.22	1.3	1.59	12130	31.46	5
32	Bandan	6.11	3.5	3.18	0.11	3.05	4.19	19.3	12.2	8.03	59.67	2	1.59	1.3	2.07	6840	34.13	6.1
33	Sarzardan	6.31	7.5	6.18	1.65	3.37	2.8	17.06	11.84	8.35	65.06	2	1.94	1.3	2.52	12910.83	31.19	8.1
34	Kahir	4.09	6.33	4.42	0.41	11.59	1.91	18.06	14.55	14.25	75.61	3	2.83	1.3	3.7	12500	31.33	11.8
35	Jon abad	5.77	5.5	5.38	0.19	3.46	10.03	17.48	15.04	10.72	73.57	3	2.63	1.3	3.42	10142.58	32.27	10.6
36	Hichan	6.05	7.5	6.88	1.09	7.01	1.48	18.71	10.05	8.5	67.27	2	2.09	1.3	2.72	9092.67	32.77	8.3
37	Pishin c8-3	6.21	8.34	5.62	0.225	2.19	2.03	17.54	8.95	7.2	58.31	2	1.59	1.3	1.98	15200	30.47	6.5
38	Bazman	4.26	8.18	5.76	0.144	11	1.72	18.3	12.4	13.1	74.86	3	2.75	1.3	3.58	7569.34	33.6	10.7
39	Ashar	5.02	7.5	6.8	0.205	3	1.8	18.93	12.33	10.02	65.61	2	1.97	1.3	2.56	8984.2	32.83	7.8
40	Erfandak	5.42	6.19	5	1.8	5.67	4.44	17.4	10.2	5.72	61.81	2	1.57	1.3	2.04	6085	34.7	5.9
Total sub basin		***5.4***	***6.2***	***5***	***2***	***5.67***	***4***	***17***	***10***	***6***	***62***	***2***	***1.72***	***1.3***	***2.24***	***334382.03***	***32.9***	***6.8***

Discussion and Results

Erosion and sediment production factors affecting the distribution points in areas MPSIAC province of watershed 40-fold (Table 4) indicate how these factors influence the amount of sediment and erosion can be. The contribution of each factor in the rate of deposition and erosion have been analyzed, the highest degree of correlation between the deposition areas, respectively, with the erosion of the river (with linear correlation 0.77) and soil erosion upstream erosion level (with linear correlation 0.62is. Graphs 1 and 2) In Table 4, according to the minimum and maximum rates of sediment production, especially in the case of 40-fold, respectively, 39 / 1 and 7 / 3 tons per hectare in the The specific wear rate also arrange 1 / 4 and 8 / 11 tones ha per year can be . That the scope of Kaher, Hnzaman, Saravan in the city and the hives are in the city of Konarak is Therefore, the choice of a 40-fold in a way that covered the province from north to south, and distribution are also relatively well So the entire city within the province of one to three sets of 40, are The weighted average of the sediment and erosion areas can, especially the erosion and sediment production in a relatively tell the whole province and Balochastan Sytan be considered Thus the calculations, especially sediment production-weighted average of three times

the area of 40 2/24 tons per acre in years. Including the entire area above the (334382 hectares), the total amount of sediment it produced 749000 tones per year is equivalent to , The average weight of 40-fold, especially the erosion of the 6 / 8 tons per hectare per year that the total erosion (334382 ha) as against 2274000 tons per year will As the province with a review of 40 watershed could produce sediment and erosion related to the relative numbers we get Certainly be even more careful approach to the production rate of deposition and erosion can move to other provinces as well Several studies in the province of the country in relation to erosion and sedimentation done numbers are more reliable, and more documentaries to achieve nationwide**.** While enjoying the results can be compared to the watershed basin area classified in terms of erosion and sediment production, and even the severity of their reach**.**

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Multivariate Statistical Techniques for Evaluation of Spatial and Temporal Variations of Water Quality (case study:Gorganrood river, Iran)

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Abstract: Water quality assessment and management are major issues having profound impact on our lives. However, due to spatial and temporal variations in water quality, a monitoring program, providing a representative and reliable estimation of surface waterquality, is necessary. Because, there are manyphysical andchemical parameters influence the water quality, multivariate statistical techniques would be very useful and suitable for comparison, prediction and identification of the most effective parameters in spatial/temporal water quality. Principal component analysis (PCA) is a technique for reducing dimension of parameters and defining new parameters with separate information in which one can not only sort these new parameters by their importance but also sort the original parameters by their importance in variation of water quality. Multivariate Analysis of variance (MANOVA) can be used for multiple spatial/temporal comparison of parameters with respect to their covariance structure. It also provides Post Hoc comparison like Duncan's multiple range test for comparison the PCA scores or original parameters separately. Canonical Discriminant Analysis (CDA) can be utilized for discrimination of stations and prediction of new observations. In this study these techniques applied for evaluation of temporal/spatial variations in water quality inGorganrood river (Iran), during 1985–2010, with monitoring at seven different stations for nine parameters. PCA identified three factors in which the first factor explain 78% of the total variation in water quality. It also identified that the parameters Na, EC and Cl are the most effective parameters in variation of water quality. The MANOVAtest showed that summer has the worst and winter has the best water quality in all stations. Alsoregarding to stations revealed that surface water of the stations on downstream of dam have the worst quality among the stations. Since dam construction cause significant difference in water quality of station in downstream and upstream along the river, CDA was utilized for providing criterion to distinguish these two subdivisions.

Keywords: Multivariate Statistical techniques, water quality, water resources management, Gorganrood river.

Introduction

Rivers playa major role in carrying off the municipal and industrial wastewater and run-off from agricultural land. Water quality is an important aspectinenvironmental management and decision-making and itprovides a scientific basis for rational utilization andprotection of water resources(Han Yan et al., 2010).Water quality is considered the main factor controlling health and the state of disease in both man and animals. Surface water quality in a region is largely determined both by natural processes (weathering and soil erosion) and by anthropogenic inputs (municipal and industrial wastewater discharge). The anthropogenic discharges constitute a constant polluting source, whereas surface runoff is a seasonal phenomenon, largely affected by climate within the basin (Singh et al., 2004; Vega et al., 1996). Large investigations have been carried out on anthropogenic contamination of ecosystems (Szymanowska et al., 1999; Issa et al., 1996). However, due to spatial and temporal variations in water quality (which are often difficult to interpret), a monitoringprogram, providing a representative and reliable estimation of the quality of surface waters, is necessary (Dixon and Chiswell, 1996). These results are a large and complex data matrix comprised of a large number of physico-chemical parameters, which are often difficult to interpret and to draw meaningful conclusions. The application of different multivariate statistical techniques, such as Principal Component Analysis (PCA),Multivariate Analysis of Variance (MANOVA) and Canonical Discriminate Analysis (CDA) lead to interpretation of complex data

matrices for a better understanding of water quality and ecological status of the study region andhave widelybeen used as unbiased methods in analysis of water-qualitydata for drawing meaningful information (Brown et al., 1996; Helena et al., 2000; Voncina et al., 2002; Reghunath et al., 2002; Liu et al., 2003; Bengraine and Marhaba, 2003). These techniques allow the identification of the possible sources that influence water systems and offers a valuable tool for reliable management of water resources as well as rapid solution for pollution problems (Reghunath et al., 2002; Simeonov et al., 2004).
In the present study, three different multivariate statistical techniques (PCA, CDA, MANOVA) were applied to evaluate both the spatial and temporal variations in water-quality data matrix of the Gorganroud River (Iran).

Materials and Methods

Study area and water quality data

The study area is located at Gorganroud basin in the Golestan Province in Iran and between latitude 38˚ 15́ N, 36˚ 35́ S, 54˚ 10́ W, 56˚ 26́ E, respectively. The area of a catchmentis about 11339 km^2. Water samples were collected monthly in the following seven locations ofGorganroud's main river: Basirabad (Site-1), Aghghala (Site-2), Voshmgir Dam (Site-3), Ghazaghli (Site-4), Gonbad (Site-5), Haji Ghoshan (Site-6) and Tamer (Site-7),during 1985-2010 (Fig. 1).The samples were analyzed for 9 parameters, includingpH, electrical conductivity (EC), chloride (Cl^-), sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), magnesium(Mg^{2+}), sulfate (SO_4^{2-}) and HCO_3.

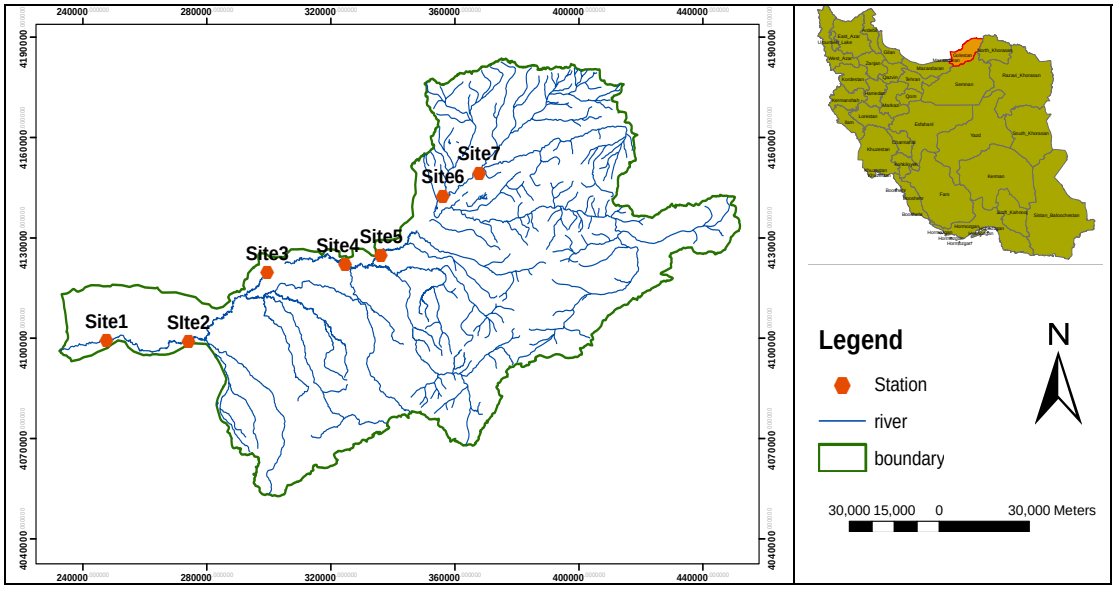


Fig. 1. Map of study area and sampling sites in theGorganroud river

All the computations and statistical analyses were made in Excel 2010 and SPSS 17 software. The multivariate methods are summarized below:

Principal Component Analysis (PCA)

PCA technique extracts the eigen values and eigen vectors of the covariance matrix or correlation matrix of original variables. Eigen vectors contribute in PCs as coefficients of original variables in which larger components in an eigen vector show more effective original variables. The eigen values on the other hand, show the proportion of total variation that each PC can interpret. The more eigen values is associated with a PC, the better it will be for analyzing the original data (Vega et al., 1998; Helena et al., 2000). .

Multivariate Analysis of Variance (MANOVA)

This method can be used for multiple spatial/temporal comparison of parameters with respect to their covariance structure. In order to spatial/temporal comparison, one can use the original data or

PCscores , because they contain approximately similar information. If the MANOVA test happens to be significant, at least one variable in temporal/spatial comparison is significant. Thus, in this case, the Anova and post Hoc test should be performed for each variable to identify the source of significance.
In this study MANOVA were performed on monthly samples data for detecting station and season with best water quality.

Canonical Discriminate Analysis (CDA)
If G_1,…,Gg are g separate groups and g samples corresponding to each group are available, CDA can be used for constructing criteria to distinguish these groups from each other.Also it provides a powerful method to assign a new observation to one of these groups. The best way to check the reliability of CDA is considering misclassification rate. Less rates show more reliable discrimination in groups. CDA also can be performed by PCs instead of original data. (Johnson and Wichern, 1992; Wunderlin et al., 2001).

Result and discussion
Principal Component Analysis (PCA)
PCA was applied to the standardized data to compare the compositional patterns between the analyzed water in each PC and also to identify the factors that influence each one from the PCA scores that were obtained from the standardized analytical data . The result of PCA analysis on samples data in total station are displayed in table 1.

Table1: Scores of the Principal Component in stations of Gorganroud river

parameter	Rotated Component		
	1	2	3
EC	**0.983**	0.127	0.072
PH	0.063	0.067	**0.992**
Hco3	0.145	**0.983**	0.069
Cl	**0.971**	0.100	0.078
So4	**0.957**	0.119	0.057
Ca	**0.926**	0.186	0.110
Mg	**0.971**	0.135	0.073
Na	**0.979**	0.117	0.061
K	**0.597**	-0.027	-0.068

The Scree plot was used to identifythe number of PCs to be retained in order to comprehend the underlying data structure (Jackson, 1991; Vega et al., 1998) and rotation of the principal components were executed by the Varimax method. PCA identified three factors in which the first factor explains 78% of the total variation in water quality in which it was correlated with EC, Cl, So_4, Ca, Mg, Na and K. The second PC accounting for 12% of total and it was correlated with HCo_3whereas third PC accounting for 10% of total variance and it correlated with PH. results also showesthat the parameters Na, EC, Mg and Cl are the most effective parameters in variation of water quality. The high level of major cations (Na, Ca andMg) and concentration of major anions Cl and SO_4 in river water increase EC, is consistent with other studies (Zacheus and Martikainen, 1997). EC and SO_4 can be related to atmospheric pollution from vehicular exhausts. Na, K and Mg may be related to anthropogenic pollution of industrial, domestic and agricultural sources. Also PCA performed on data in each station and similar results with total station were observed.

Multivariate Analysis of Variance (MANOVA)
This method was used to evaluate spatial and temporal of water quality variations. The results showed that water quality variationshavesignificant difference between stations and also between seasons. Therefore Duncan's multiple range testwas done for water quality compression in spatial and temporal scales. Because PCs1 explain 78% of the total variation in water quality, Whole

analysis were done on PCs1that obtained from PCA in total stations' data without separated based on stations or season . Temporal and spatial variations assessing were presented in table 2 and 3, respectively.

Table 2: Results of Duncan's multiple range teston PC1 for temporal variation analysis

	Mean of PC1 scores
Spring	-0.147[b]
Summer	**0.483[a]**
Autumn	-0.052[b]
Winter	**-0.226[b]**

a and b……

The MANOVA showed that summer has the worst and winter has the best water quality in all stations. In summer worst water quality is mainly due to decrease of flow discharge in river result in increasing contaminant concentration in water. Further use of fertilizers for agricultural areas have been increased in this season.Best water quality in winter is because of increasing flow discharge due to increasing rain in this watershed and also there are not agricultural activitiesin this season .

Table 3: Results of Duncan's multiple range teston PC1 for spatial variation analysis

	Mean of PC1 scores
Site1	0.570[a]
Site2	**0.638[a]**
Site3	-0.266[c]
Site4	-0.414[c]
Site5	-0.271[c]
Site6	0.300[b]
Site7	**-0.500[c]**

The result of MANOVA base on the PCA scores in Table 3 revealed that Site2 has highest water pollutiondue to local anthropogenic pollution produced by people who lived in vicinity of river. It also corresponds todomestic wastage and agricultural sources from the upstream agricultural areas. Against Site7 located in the upstream of basin with more undeveloped areas . Quality of water in the upstream stations of the dam are better than other stations in all season. Water quality in the downstream stations were the worst in all season. This figure is because of flow variations in summer and winter and remaining of large portion of water in the reservoir. In addition to applied MANOVA on data set, this method performed on each station and season separately and showed similar results with data set(table 4 and 5).

Table 4: Results of Duncan test on PC1 scores in each station for temporal variation analysis

	Site1	Site2	Site3	Site4	Site5	Site6	Site7
Spring	-0.160	-0.245	0.017	-0.325	-0.223	0.055	-0.339
Summer	**0.615**	**0.614**	**0.312**	**1.149**	**0.975**	**0.248**	**1.075**
Autumn	-0.074	0.394	0.213	-0.143	0.283	0.104	-0.282
Winter	**-0.276**	**-0.432**	**-0.493**	**-0.556**	**-0.440**	**-0.267**	**-0.442**

Table 5: Results of Duncan test on PC1 scores for spatial variation analysis

	Spring	Summer	Autumn	Winter
Site1	0.609315[a]	0.606519[a]	0.494429[a]	0.467396[a]
Site2	**0.764367[a]**	**0.994294[a]**	**0.623393[a]**	**0.670141[a]**
Site3	-0.34816[b]	-0.42741[b]	-0.05124[b]	-0.1472[b]
Site4	-0.36934[c]	-0.35638[b]	-0.44402[c]	-0.48196[b]
Site5	-0.32405[c]	-0.05665[b]	-0.29838[c]	-0.39719[b]
Site6	0.157888[c]	0.013207[b]	0.311102[c]	0.34256[b]
Site7	**-0.50996[d]**	**-0.56735[b]**	**-0.56667[c]**	**-0.49512[d]**

Note: the cases with similar letters(a,b,c,…) have no significant difference

Canonical Discriminate Analysis

all stations divided in 2 separate groups, upstream and downstream dam, because of an environmental conditions of stations. since pollutants concentration have opposite relationship with flow discharge, decreasing flow discharge resulting from dam constructing lead to increase pollutant concentration Therefore there is significant difference between stations that located before and after of dam. CDA with these two groups was performed on PCscores. The results showed that misclassification rate was less than 15%, thus, discrimination by dam boundary was reliable.

Conclusion

In this study, different multivariate statistical techniques were used to evaluate variations in surface water quality of the Gorgan river. principle component analysis helped in identifying the factors or sources responsible for water quality variations. The main cause of degradation of the river isindustrial, domestic and agricultural pollution, soil erosion, atmospheric pollution and vegetal effect. As a result of this study showed, water quality in the upstream stations were better than the downstream stations. This figure is due to increasing of pollution sources, such as non point sources (agricultures activities, municipal sources) and point sources such as industrial sources. And also the landuse of upstream stations were rangland and forest and also limitation of agriculturallanduse industrial activities.

This study presents necessity and usefulness of multivariate statistical techniques for evaluation and interpretation of large complex data sets with a view to get better information about the water qualityand design of monitoring network for effective management of water resources.

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Identification and Prioritization of Critical Sub-Basins in A Highly Mountainous Watershed Using SWAT model

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Abstract
A few areas in a large watershed might be more critical and responsible for high amount of runoff and soil losses. For an effective and efficient implementation of watershed management practices, identification of these critical areas is vital. In this study, we used the Soil and Water Assessment Tool (SWAT, 2009) to identify and prioritize the critical sub-basins in a highly mountainous watershed with imprecise and uncertain data (Bazoft watershed, southwestern Iran). Three different SWAT models were first developed using different climate input data sets. The first data set (denoted as CRU) was derived from the climate research unit data set developed by the British Atmosphere Data Center (BADC). The second data set (denoted as CDW) was included the climate data obtained from the precipitation and air temperature stations in the study area. The third set (denoted as COM) was a combination of CRU and CDW climate data. The Generalized Likelihood Uncertainty Estimation (GLUE) program was used for calibrating and validating the SWAT model. Daily rainfall, temperature, and runoff data of 20 years (1989-2008) were used in this study. In results, the constructed SWAT model using COM data set simulated the runoff more satisfactorily than the two other developed SWAT models according to the statistical evaluation criteria. The correlation coefficient and Nash-Sutcliff values for the constructed SWAT model using COM data set were 0.40 and 0.38, respectively. The model simulated the runoff satisfactorily; however, the predicted runoff values were much more in agreement with the measured data for the calibration period than those for the validation period. Sub-basins S10, S12, and S13 were assigned as the most top critical sub-basins in runoff production in the watershed. The study revealed that the SWAT model could successfully be used for identifying the critical sub-basins in a watershed with imprecise and uncertain data for management purposes.
Keywords: Runoff, watershed management, SWAT model, GLUE algorithm, uncertainty analysis.

Introduction

The Resource considerations for implementation of watershed management programs related to administration or even political considerations may limit the implementation of management programs to a few sub-basins of a watershed only. Even otherwise, it is always better to begin management measures from the most critical sub-basins, which makes it mandatory to prioritize the sub-basins available. In other word, identification of these critical areas is essential for an effective and efficient implementation of watershed management programs. Watershed prioritization is thus the ranking of different critical sub-basins of a watershed according to the order in which they have to be taken up for treatment and soil conservation measures (Tripathi et al., 2003).
Hydrometric stations are quite limited in Iran and many of them have sparse data. Therefore, management plans are difficult to develop due to the lack of measured data. Hence, identification of critical sub-basins plays a crucial role in the proper planning and development of local resources. Recently, mathematical models of watershed hydrology and transport processes have been employed to address a wide spectrum of environmental and water resources problems. In this study, a calibrated and validated Soil and Water Assessment Tool (SWAT) model was used to determine the critical sub-basins in a highly mountainous watershed with imprecise and uncertain data (the Bazoft watershed, southwestern Iran). The effects of different climate input data sets on prediction accuracy of the model were also evaluated.

Materials and Methods

Study area

The study area was Bazoft watershed (31° 37′ to 32° 39′ N and 49° 34′ to 50° 32′ E) located in northern part of the Karun river basin in southwestern Iran (Fig. 1). The major river in the watershed is AbBazoft which is joined by Karun River at the outlet of the watershed. The elevation ranges from 880 m at the southern of the watershed to 4300 m on Zardkuh mountain. The long-

term average rainfall and temperature in the region are around 800 mm and 10 °C, respectively. The slope class of 40-70 % is the major class of slope in this watershed which covers about 46 % of the study area. The dominant slope shape in the watershed is also convex. Approximately 56 % of the watershed is covered by pastures and the rest is covered by forest and bare lands.

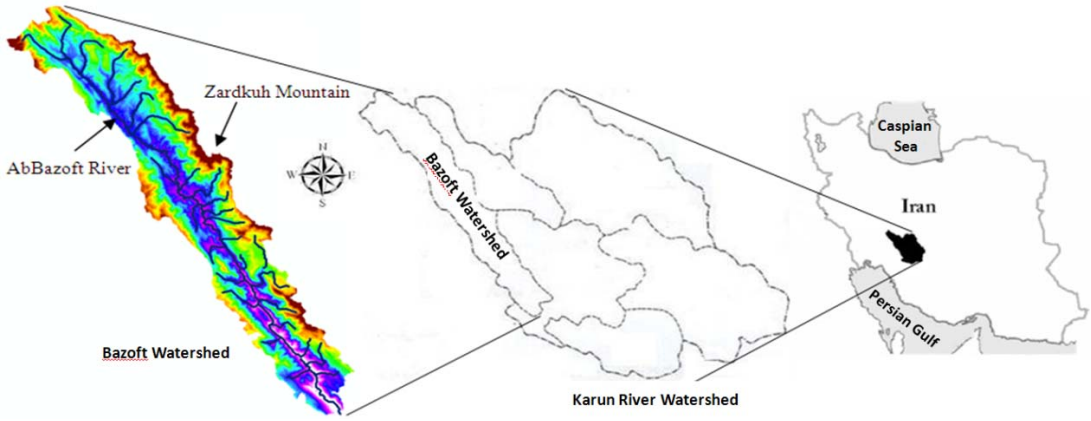


Fig. 1. Location of Bazoft watershed in south western of Iran (31° 37′ to 32° 39′ N and 49° 34′ to 50° 32′ E).

SWAT model

The ArcSWAT (2009) program was used to simulate runoff and sediment in the study area. The SWAT model is a basin-scale, continuous time model that operates on a daily time step and evaluates the impact of management practices on water, sediment and agricultural chemical yields in ungauged basins. The basic input data to SWAT are digital elevation model (DEM), stream network coverage, landuse, soil maps, and climate data. A DEM with grid size of 53m × 53m was used in this study. Stream network creation was done in the environment of ArcGIS using DEM. Soil data including sand, silt and clay contents, rock fragment content, organic carbon content, soil electrical conductivity (EC), water content, porosity, bulk density, saturated hydraulic conductivity (Ks), and soil hydrologic groups were obtained by studying soil profiles in the main landscape subunits. The land use map was prepared by interpretation of IRS-1D 2008 satellite image at a spatial resolution of 24 m by 24 m (Indian Space Applications Centre, Ahmedabad, India) in the ArcGIS software environment (Fig. 2). Based on the DEM and stream network maps, the SWAT delineates the watershed boundaries and divides it into sub-basins. By entrance of soil and land use maps into the model, sub-basins subdivide into the hydrologic response units (HRUs) which are assumed to be spatially uniform in terms of soil, landuse and, topographic characteristics. The watershed was subdivided into 55 sub-basins and 946 hydrological response units (HRUs).

Climate data sets

Three different climate input data sets were developed in this study. The first data set (denoted as CRU) was derived from the climate research unit (CRU) data set developed by the British Atmosphere Data Center (BADC). The BADC holds the CRU TS3.1 dataset for the period 1901-2009. The time-series datasets are month-by-month variation in climate over the last century or so. These are on high-resolution grids. They allow the comparison of variations in climate with variations in other phenomena. Variables include cloud cover, diurnal temperature range, frost day frequency, precipitation, daily mean temperature, monthly average daily maximum temperature, vapour pressure and wet day frequency. The second data set (denoted as CDW) was included the climate data obtained from the precipitation and air temperature stations in the study area. The third set (denoted as COM) was a combination of the CRU and CDW climate data sets.

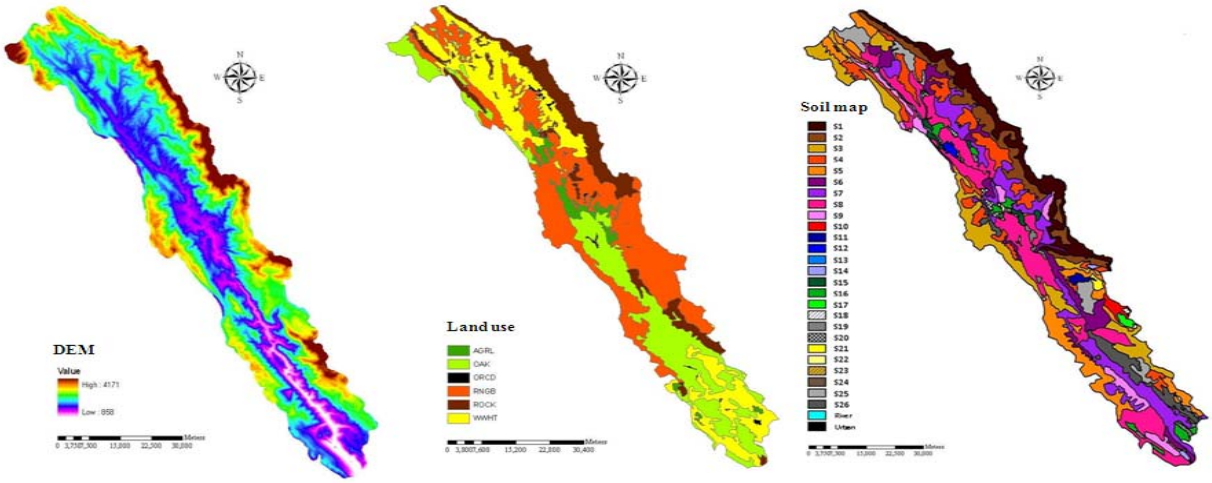


Fig. 2. The input maps to SWAT (DEM: digital elevation model, landuse, and soil maps)

GLUE algorithm description

Generalized Likelihood Uncertainty Estimation (GLUE) is an uncertainty analysis technique inspired by importance sampling and regional sensitivity analysis (RSA; Hornberger and Spear, 1981). In GLUE, parameter uncertainty accounts for all sources of uncertainty, i.e., input uncertainty, structural uncertainty, parameter uncertainty and response uncertainty, because ‘‘the likelihood measure value is associated with a parameter set and reflects all these sources of error and any effects of the covariation of parameter values on model performance implicitly’’ (Yang et al., 2008). Also, from a practical point of view, ‘‘disaggregation of the error into its source components is difficult, particularly in cases common to hydrology where the model is non-linear and different sources of error may interact to produce the measured deviation’’ (Gupta et al., 2005). In GLUE, parameter uncertainty is described as a set of discrete ‘‘behavioral’’ parameter sets with corresponding ‘‘likelihood weights’’. A GLUE analysis consists of the following three steps:

(1) After the definition of the ‘‘generalized likelihood measure’’, $L(\theta)$, a large number of parameter sets are randomly sampled from the prior distribution and each parameter set is assessed as either ‘‘behavioral’’ or ‘‘non-behavioral’’ through a comparison of the ‘‘likelihood measure’’ with a selected threshold value.

(2) Each behavioral parameter set is given a ‘‘likelihood weight’’ according to:

$$w_i = \frac{L(\theta)}{\sum_{k=1}^{n} L(\theta_k)} \tag{1}$$

where N is the number of behavioral parameter sets.

(3) Finally, prediction uncertainty is described by quantiles of the cumulative distribution realized from the weighted behavioral parameter sets (Abbaspour, 2009).

The most frequently used likelihood measure for GLUE, the Nash–Sutcliffe coefficient (NS), was also used in this study:

$$NS = 1 - \frac{\sum_{i=1}^{n} (Q_i - Q_i')^2}{\sum_{i=1}^{n} (Q_i - \mathrm{Q})^2} \tag{2}$$

where subscripts Q_i and Q_i' represent measured and simulated, respectively, and Q is the average of measured data.

Sensitivity analysis, calibration, and validation

An initial sensitivity analysis was done to determine sensitive parameters among the input parameters selected for the calibration of SWAT model (Table 1). The simulation time period was

from 1989 to 2008, where the first three years were used as a warm-up. Two-third of the available daily runoff data for the station at the outlet of the watershed were used for calibration (from 1998-2008) and the remainders were used for validation (1992-1997). In combination with SWAT, the GLUE program was used to calibrate and validate the model using the daily river discharge (Abbaspour, 2009). The objective function was the Nash–Sutcliffe coefficient. The calibrated and validated SWAT model was then used to identify the critical sub-basins on the basis of average annual runoff production.

Table 1. Description of SWAT (2009) input parameters selected for calibration.

Parameter	Description	Range	
		Min	Max
*r_CN2.mgt	Curve number for moisture condition II	-0.4	0.4
r_SOL_BD.sol	Soil bulk density	-0.3	0.3
r_SOL_AWC.sol	Soil available water storage capacity	-0.3	0.3
r_SOL_K.sol	Soil hydraulic conductivity	-0.8	0.8
r_SOL_ALB.sol	Moist soil albedo	-0.5	0.5
v_ALPHA_BF.gw	Baseflow alpha factor	0	1
v_GW_DELAY.gw	Groundwater delay time	0	400
v_REVAPMN.gw	Threshold water in shallow aquifer	0	100
v_GW_REVAP.gw	Revap coefficient	0.02	0.2
v_SHALLST.gw	Initial depth of water in the shallow aquifer	0	1000
v_RCHRG_DP.gw	Deep aquifer percolation fraction	0	1
v_GWQMN.gw	Threshold depth of water in the shallow aquifer required for return flow to occur.	0	500
v_EPCO.hru	Plant uptake compensation factor	0.01	0.2
v_ESCO.hru	Soil evaporation compensation factor	0.01	0.3
v_SLSUBBSN.hru	Average slope length	10	150
v_OV_N.hru	Manning's *n* value for overland flow	0	0.8
v_CH_N2.rte	Manning's *n* value for the main channel	0	0.3
v_CH_K2.rte	Main channel conductivity	0	150
v_SFTMP.bsn	Snowmelt temperature	-5	5
v_SMTMP.bsn	Snowmelt base temperature	-5	5
v_SMFMX.bsn	Melt factor for snow on 21 June	0	10
v_SMFMN.bsn	Melt factor for snow on 21 December	0	10
v_TIMP.bsn	Snow pack temperature lag factor	0.01	1
v_MSK_CO1.bsn	Muskingum coefficient	0	10
v_MSK_CO2.bsn	Muskingum coefficient	0	10
v_SURLAG.bsn	Surface runoff lag coefficient	1	24
r_PCPMM.wgn	Average amount of precipitation falling in month	-0.5	0.5
r_PCPSKW.wgn	Skew coefficient for daily precipitation in month	-0.5	0.5
r_PCPSTD.wgn	Standard deviation for daily precipitation in month	-0.5	0.5

* r_ means the existing parameter value is multiplied by (1 plus a given value) and v_ means the default parameter is replaced by a given value

Results and Discussion

SWAT models

The SWAT model constructed using a combination of the CRU data and the climate data obtained from the precipitation and air temperature stations in the study area (i.e. COM climate data set) had higher prediction accuracy than the other two developed SWAT models (Fig. 3). The correlation coefficient and Nash-Sutcliff values for the constructed SWAT model using COM data set were 0.40 and 0.38, respectively. Furthermore, simulated runoff values by the constructed SWAT model using CDW data set were more in agreement with the measured values than those simulated by the constructed SWAT model using CRU data set (Fig. 3).

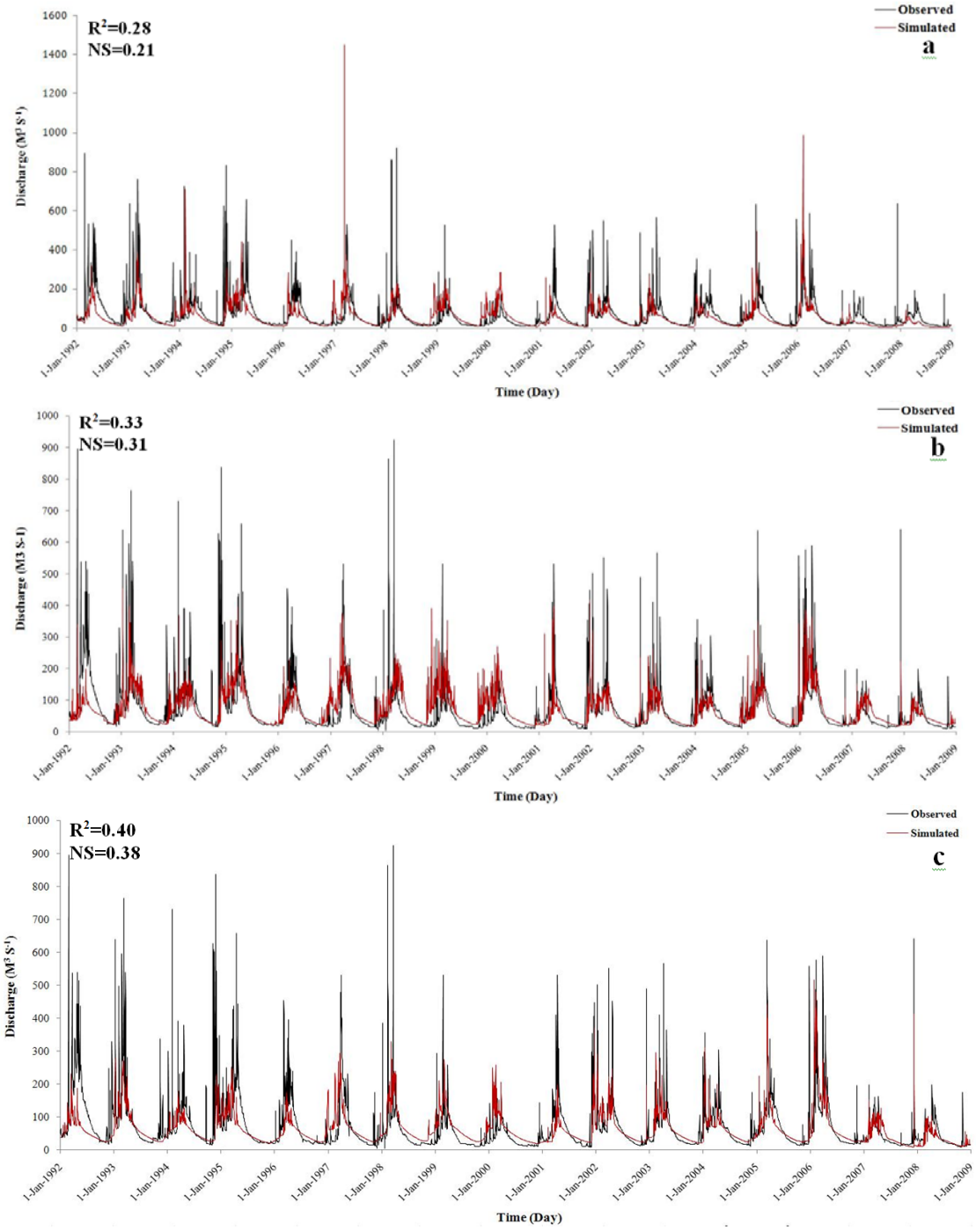


Fig. 3. Daily runoff prediction using SWAT models developed by different input climate data sets (a: CRU, b: CDW, and c: COM). R^2: coefficient of determination and NS: Nash-Sutcliff coefficient**.**

Calibration and validation of the model

The results of daily runoff calibration and validation using GLUE algorithm are presented in Table 2. The model simulated the runoff satisfactorily; however, the predicted runoff values were much more in agreement with the observed data for the calibration period than those for the validation period. The R^2 and NS coefficients for the calibration period were 0.54 and 0.51, respectively; while, they were 0.48 and 0.47 for the validation period, respectively. Although the simulation of daily runoff was satisfactory during the calibration period, the model exhibited larger uncertainties in the calibration period. The *P* factor (percentage of data being bracketed by 95PPU) for the calibration period was 0.64, while it was 0.73 for the validation period (Table 2).

Table 2. Summery statistic results for the daily runoff calibration and validation periods.

Evaluation criteria	Calibration	Validation
R^2	0.54	0.48
NS	0.51	0.47
P factor	0.64	0.73

R^2: coefficient of determination, NS: Nash-Sutcliff coefficient, and *P* factor: percentage of data being bracketed by 95PPU**.**

Identification of the critical sub-basins

Fig. 4 shows location of the 3 most top critical sub-basins in Bazoft watershed according to the SWAT model results. Based on the spatial distribution of the runoff production hazard in the watershed, sub-basins S10, S12, and S13 were assigned as most top critical sub-basins in runoff production in the study area. The high runoff production rate predicted in these sub-basins may be attributed to insufficient use of the land, scanty vegetative cover, steep sloping areas, high population pressure, cultivating of the steep-lands, and other environmental problems. These 3 critical sub-basins were, hence, assigned as the top priorities and were recommended to be considered for the future conservation plans.

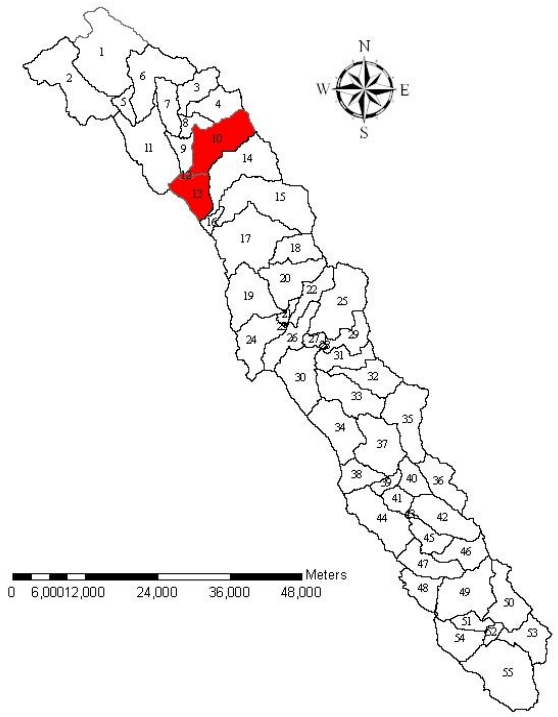


Fig. 3. Location of the 3 critical sub-basins in Bazoft watershed according to the SWAT model results.

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Using gamma test to determine the optimum input variables for soil shear strength prediction by neural networks

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Abstract

Surface soil shear strength can be proposed as a useful dynamic index for soil erodibility and thus as a measure of soil resistance to water erosion. In this study, gamma test was first used to determine the 5 optimum input variables affecting soil shear strength out of 12 different input parameters (including soil properties, topographic and vegetation attributes). Two different artificial neural network (ANN) models were then developed using different input data sets (Models 1 and 2). In Model 1, all of the input variables (12 parameters) were used as input of the model. Model 2 was constructed using only the 5 optimum parameters obtained from the gamma test analysis. According to the gamma test analysis, the fine sand and mean weight diameter (MWD) parameters had the lowest and highest gamma and V_{ratio} values among the other parameters, respectively. The vegetation index (NDVI), sand, very fine sand, and aspect parameters had gamma values of 0.2177, 0.2280, 0.2313, and 0.2318, respectively. Therefore, sand, fine sand, very fine sand, NDVI, and aspect were determined as the 5 optimum input variables for modeling of soil shear strength using ANNs. The proposed ANN model using the optimum 5 input variables resulted from the gamma test analysis (i.e. Model 2), had a similar accuracy with the constructed ANN model using all of the 12 input variables (i.e. Model 1). The correlation coefficient (*CORR*) and root mean square error (RMSE) values for Model 2 were 0.885 and 0.045, respectively, while they were 0.891 and 0.058 for Model 1, respectively. Therefore, it appears that there is a possibility of using gamma test technique for input data selection to reduce experimental expenses and to save a great amount of time and effort in modeling of soil shear strength.

Keywords: gamma test, soil mechanical properties, artificial neural networks, input data selection, modeling.

Introduction

Soil erodibility is usually defined as the ease of soil detachment by splash during rainfall and/or surface flow (Renard et al., 1997). During rainfall, raindrop compaction and soil suspension movement by water result in high shear stress, leading to an intensive local deformation in soil erosion (Rose et al., 1990). As a concomitant process the soil surface transfers into a layer, ranging from 1 to 10 mm, and results in higher bulk density, lower porosity, and lower hydraulic conductivity (Moore, 1981) and in an increase in soil shear strength (Bradford et al., 1992). Critical shear strength has been also proposed as a key-parameter for rill formation; hence, the condition at which rill flow becomes erosive would be controlled by surface soil shear strength (Zimbone et al., 1996). Consequently, soil shear strength (SSS) can be proposed as a measure of soil resistance to water erosion (Zhang et al., 2001).

Determination of the shear strength of soils in a direct way has been a priority issue for engineers and soil scientists for a long time (Goktepe et al., 2008). Many techniques have been developed to measure SSS directly. However, most of these techniques are rather complicated, time consuming, and/or difficult to apply on a large scale (Besalatpour et al., 2011). In addition, shear strength is an incidental, nonlinear, and complex property of soils; hence, it is difficult to derive an accurate formula to represent all the physical processes involved. As a result, there is a new trend in using data mining techniques such as artificial neural networks (ANs) to estimate SSS (Besalatpour et al., 2011).

One major problem with all the data mining methods is the selection of input data for the model. It is very tedious to trial different input combinations in the modeling process. Moreover, there is no guideline about how many data points are sufficient for model calibration (Moghaddamnia et al., 2009). In this study, a new approach call the Gamma test was designed to work with ANNs to find the best input combination. This can greatly reduce the work involved the model development. The

efficacy of ANNs in developing prediction functions using soil and vegetation properties for estimating SSS was also evaluated in the current study.

Materials and Methods

Study area, soil sampling and analysis

The study area was a part of the Bazoft watershed (31° 37′ to 32° 39′ N and 49° 34′ to 50° 32′ E) located in northern part of the Karun river basin in south western of Iran. A total of 160 soil samples were collected from the top 5 cm of soil surface to produce a measurement of diversity of soil properties within each land unit tract defined using geology, topography, and land use maps. Soil organic matter (SOM) content was determined by the Walkley-Black method (Nelson and Sommers, 1986). Percentage of soil particles and calcium carbonate equivalent (CCE) content were measured using the procedures described by Gee and Bauder (1986) and Nelson (1982), respectively. The method of Kemper and Rosenau (1986) was used to determine the wet-aggregate stability (mean weight diameter, MWD). A shear vane (model: BS1377-9) was also used to measure soil shear strength (SSS). The topographic attributes including slope and aspect were characterized using a 20-m by 20-m digital elevation model (DEM). The normalized difference vegetation index (NDVI) was derived using IRS-1D April 2008 at a spatial resolution of 24-m by 24-m. Descriptive statistics of the experimental data including mean, minimum, maximum, range, standard deviation (SD), variance, and skewness were determined using the statistical software SPSS (IBM Com., Chicago, USA). Scatter plot matrices, displaying relationships among the data were obtained using VisuLab software (ETH University, Zurich, Switzerland). All the data were then normalized within the range of 0-1 and used for SSS prediction using ANNs.

Gamma test analysis

The Gamma test estimates the minimum mean square error (MSE) that can be achieved when modeling the unseen data using any continuous nonlinear models. The basic idea is quite distinct from the earlier attempts with nonlinear analysis. Suppose we have a set of data observations of the form: $\{(x_i, y_i),\ 1 \leqslant i \leqslant M\}$ (1)

where the input vectors $x_i \in R^m$ are m dimensional vectors (with a record length of *M*) confined to some closed bounded set $C \in R^m$ and, without loss of generality, the corresponding outputs $y_i \in R$ are scalars. The vectors x contain predicatively useful factors influencing the output *y*. The only assumption made is that the underlying relationship of the system is of the following form:

$y = f(x_1, ...x_m) + r$ (2)

where *f* is a smooth function and *r* is a random variable that represents noise. The Gamma statistic *C* is an estimate of the model's output variance that cannot be accounted for by a smooth data model.

The Gamma test is based on *N [i,k]*, which are the *k*th $(1 \leqslant k \leqslant p)$ nearest neighbours $x_{N[i,k]}(1 \leqslant k \leqslant p)$ for each vector $x_i(1 \leqslant i \leqslant M)$. Specifically, the Gamma test is derived from the Delta function of the input vectors:

$$\delta_M(k) = \frac{1}{M}\sum_{i=1}^{M}\left|x_{N[i,k]} - x_i\right|^2, (1 \le k \le p) \quad (3)$$

where |…| denotes Euclidean distance, and the corresponding Gamma function of the output values:

$$\gamma_M(k) = \frac{1}{2M}\sum_{i=1}^{M}\left|y_{N[i,k]} - y_i\right|^2, (1 \le k \le p) \quad (4)$$

where $y_{N[I,k]}$ is the corresponding *y*-value for the *k*th nearest neighbour of x_i in Eq. (3). In order to compute *C* a least-squares regression line is constructed for the *p* points $\{\delta_M(k), \gamma_M(k)\}$:

$y = A\delta + \Gamma$ (5)

The intercept on the vertical axis $(\delta=0)$ is the Γ value, as can be shown:

$\gamma_M(k) \to Var(r)$ in probability as $\delta_M(k) \to 0$ (6)

The Gamma test is a non-parametric method and the results apply regardless of the particular techniques used to subsequently build a model of *f*. We can standardize the result by considering

an- other term V_{ratio}, which returns a scale invariant noise estimate between zero and one. The V_{ratio} is defined as:

$$v = \frac{\Gamma}{\sigma^2(y)} \tag{7}$$

where $\sigma^2(y)$ is the variance of output *y*, which allows a judgment to be formed independent of the output range as to how well the output can be modeled by a smooth function. A V_{ratio} close to zero indicates that there is a high degree of predictability of the given output *y*. If the standard error (SE) value is close to zero we have more confidence in the value of the Gamma statistic as an estimate for the noise variance on the given output (Moghaddamnia et al., 2009). In this study, the WinGamma™ software was used for the Gamma test analysis.

Neural network analysis

Two different artificial neural network models were developed in the current study (Models 1 and 2). In Model 1, all of the input variables (12 parameters) were used as input of the model. Model 2 was constructed using only the 5 optimum parameters obtained from the gamma test analysis. For neural network analysis, the multilayer perceptron (MLP) with back-propagation (BP) learning algorithm was used. The training set of 99 samples was obtained out of total 165 and the remained 66 soil samples were used equally in two parts as the testing and validation sets. The number of neurons and epochs were determined by a trial and error procedure. For Model 1, 17 hidden neurons and epoch set number of 15000 were generated as the satisfactory result (evaluated by the network performance). Eight hidden neurons and epoch set number of 1000 gave satisfactory result for Model 2. Neural network analyses were performed using MatLab 7.6, Neural Networks Toolbox (Mathworks, Inc., Natick, MA). The mean square error (MSE), mean estimation error (MEE), and correlation coefficient (*CORR*) between the measured and the estimated SSS values were used to evaluate the performance of the proposed models.

Results and Discussion

Soil characteristics and vegetation index

Table 1 shows mean, minimum, maximum, range, standard deviation (SD), variance, and skewness of soil properties, topographic and vegetation index used to develop the SSS prediction models. There was little variability in the sample distributions of the variables used in this study to develop the SSS prediction models, indicating that their values were all normally distributed. Fig. 1 also shows the scatter plot matrices displaying interrelations between the input variables and SSS. This figure revealed the dependencies between the SSS and input variables; however, the existing patterns and trends seem to be relatively complex and intricate. In other word, although variation in change of SSS seems to be depended on the changes in the other investigated characteristics, the nature of the relationships is not simply understandable. Nevertheless, it appears that the investigated soil properties, topographic and vegetation attributes may directly or indirectly affect the SSS in the studied sites and thus soft computing techniques might be useful to be used to derive the functions translating such data into predictions of SSS.

Table 1. Summary statistics of soil properties, topographic and vegetation attributes used in developing the SSS prediction models

Parameter	descriptive statistics					
	Mean	Minimum	Maximum	Variance	SD	Skewness
Clay (%)	31.08	8.00	53.60	70.96	8.42	-0.23
Sand (%)	20.53	3.20	65.60	164.10	12.81	0.92
Silt (%)	48.40	21.60	81.60	86.19	9.28	0.12
VFS (%)	6.65	0.70	28.04	29.66	5.45	1.46
FS (%)	4.13	0.18	16.02	11.43	3.38	1.43
SOM (%)	2.58	0.22	6.33	1.67	1.29	0.49
CCE (%)	25.32	1.00	80.65	445.90	21.12	0.61
MWD (mm)	0.37	0.03	1.47	0.08	0.29	1.39
Slope (%)	28.31	3.10	80.61	237.89	15.42	0.61
NDVI	0.13	-0.31	0.47	0.01	0.08	-0.66
Aspect (radian)	171.82	8.87	365.85	10162.83	100.81	-0.03
Elevation (m)	1714.53	907.00	2639.00	88484.45	297.64	-0.49
SSS (KPa)	6.34	3.33	9.70	1.37	1.17	0.12

soil shear strength (SSS), clay content (Clay), silt content (Silt), sand content (Sand), very fine sand content (VFS), fine sand content (FS), mean weight diameter (MWD), soil organic matter content (SOM), calcium carbonate equivalent content (CCE), slope (Sl), aspect (As), normalized difference vegetation index (NDVI), and standard division (SD).

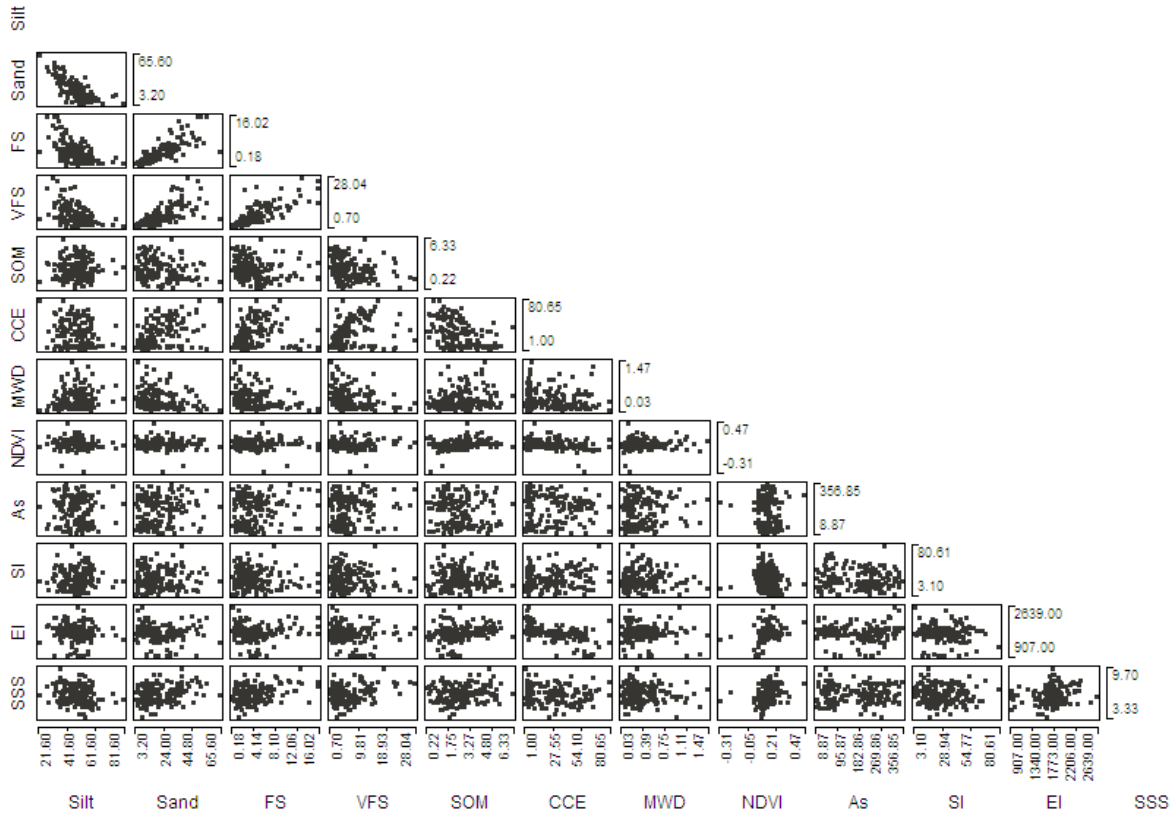


Fig 1. Scatter plot matrices displaying the relationships between the analyzed variables; soil shear strength (SSS), clay content (Clay), silt content (Silt), sand content (Sand), very fine sand content (VFS), fine sand content (FS), mean weight diameter (MWD), soil organic matter content (SOM), calcium carbonate equivalent content (CCE), slope (Sl), aspect (As), and normalized difference vegetation index (NDVI).

Soil shear strength prediction

The values of the Gamma at the nearest neighbours are shown in Fig. 2. The first reduction in the Gamma value is a noise and the second has happened at the 9th neighbour and thus it appears that the 12 input variables were enough to achieve minimum error in modeling of SSS. In the gamma

test analysis, fine sand had the lowest gamma and V_{ratio} values among the parameters and seems to have more effect on modeling of SSS in comparison with the other input variables (Table 2). The mean weight diameter (MWD) had also the highest gamma value of 1.0820 among the other parameters. The gamma values for the vegetation index (NDVI), very fine sand, and aspect parameters were 0.2177, 0.2280, 0.2313, and 0.2318, respectively. Therefore, fine sand, very fine sand, sand, NDVI, and aspect were determined as the 5 optimum input variables for modeling of the soil shear strength using ANNs. In neural network analysis, the prediction accuracy of the proposed ANN model using the optimum 5 input variables resulted from the gamma test analysis (i.e. Model 2), was similar to that of the constructed ANN model using all of the 12 input variables (i.e. Model 1). The *CORR* and RMSE values for Model 2 were 0.885 and 0.045, respectively, while they were 0.891 and 0.058 for Model 1, respectively (Table 3). The similar prediction accuracy of the proposed ANN models using different input data sets can also be seen in Fig. 3, where a relatively same coefficient of determination (R^2) obtained for the both ANN models. Therefore, it appears that the Gamma test has a huge potential to save a great amount of time and effort and to reduce experimental expenses for a modeler to select the best input data variables for the estimation of soil shear strength.

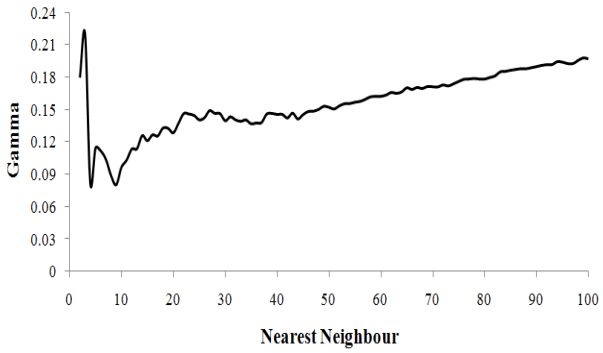


Fig. 2. The Gamma values at the nearest neighbours on the SSS estimation data set.

Table 2. The Gamma test results on the SSS estimation data set.

Input	Parameter			
	Gamma(Γ, mm^2)	Gradient (A)	Standard error of Γ (mm^2)	V_{ration}
Clay (%)	0.2381	-0.0016	0.0092	0.9523
Sand (%)	0.2280	0.0861	0.0085	0.9119
Silt (%)	0.2481	-0.1106	0.0135	0.9925
VFS (%)	0.2313	-1.0034	0.0249	0.9251
FS (%)	0.2013	0.4538	0.0195	0.8052
SOM (%)	0.2332	1.0262	0.0143	0.9327
CCE (%)	0.2467	-2.0961	0.0237	0.9868
MWD (mm)	0.2705	-1.3811	0.0362	1.0820
Slope (%)	0.2666	-3.2550	0.0226	1.0663
NDVI	0.2177	0.1022	0.0153	0.8707
Aspect (radian)	0.2318	2.8943	0.0136	0.9271
Elevation (m)	0.2387	-0.8673	0.0337	0.9548

soil shear strength (SSS), clay content (Clay), silt content (Silt), sand content (Sand), very fine sand content (VFS), fine sand content (FS), mean weight diameter (MWD), soil organic matter content (SOM), calcium carbonate equivalent content (CCE), slope (Sl), aspect (As), and normalized difference vegetation index (NDVI).

Table 3. Goodness-of-fit for the proposed ANN models in predicting SSS.

Model type	Evaluation criterion		
	CORR	MSE	MEE
Model 1	0.891	0.058	-0.005
Model 2	0.885	0.045	-0.0002

CORR: correlation coefficient, MSE: mean square error, and MEE: mean estimation error

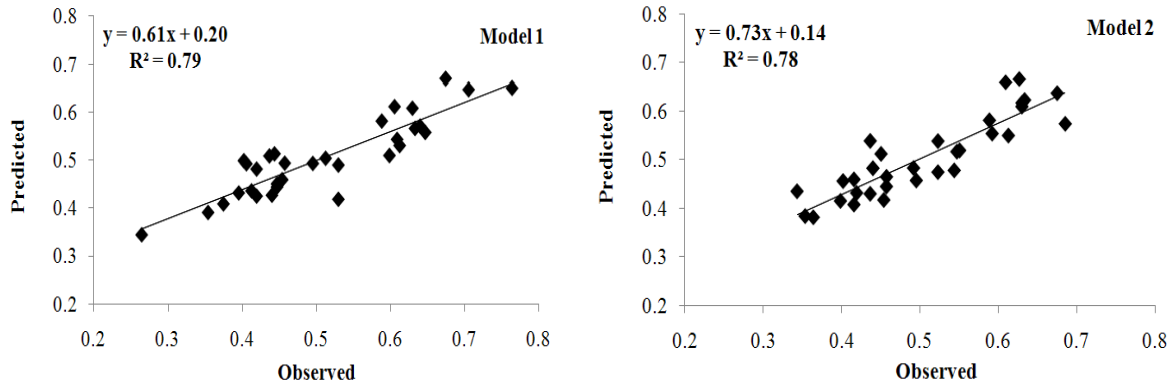


Fig. 3. Comparison of normalized predicted and measured SSS values for the testing data sets of ANN models.

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Cadmium Sorption from Aqueous Solutions onto an Iranian Sepiolite: Kinetics and Isotherms

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Abstract
A thorough understanding of the capacity of clay minerals to adsorb heavy metals help predict the fate of these pollutants in the environment. This study aims to investigate the efficiency of Fariman sepiolite from Iran as an adsorbent to remove Cd from aqueous solutions. The effects of different experimental factors such as the initial concentration of adsorbate, contact time and the sorbent dose were investigated through a series of batch adsorption experiments. Results showed that the adsorption capacity of sepiolite for Cd increased with the contact time, the initial concentration of Cd solutions and the sorbent dose. Sorption of Cd by Fariman sepiolite was rapid within the first hour of experiment and then slowly continued until a pseudo equilibrium approached at 8 h. Results also showed that the time dependent Cd sorption data were well described by pseudo second-order (r^2 > 0.999) and pseudo first-order (r^2 > 0.971) kinetic models. Equilibrium isotherm studies showed that the experimental data were better correlated by the Freundlich adsorption isotherm (r^2 >0.995) than the Langmuir (r^2 >0.825). Results of this study reveal that both adsorption and cation exchange reactions are responsible for the sorption of Cd by the sepiolite. To conclude, it seems that Fariman sepiolite have a very good potential to remove Cd from aqueous solutions.

Keywords: Sepiolite, Cadmium, Adsorption capacity, Kinetics, Isotherm.

Introduction
Heavy metal contamination has aroused considerable public concern with respect to potential damage to human health and ecosystems. Cadmium (Cd) is one of the most hazardous trace elements to human health (Álvarez-Ayuso and Garcia-Sanchez, 2007). It can cause chronic health problems such as bone disease, lung edema, renal dysfunction, liver damage, anemia and hypertension (Staessen et al., 1999). Because of the frequent appearance of such heavy metals in waste streams from many industries including electroplating, metal finishing, metallurgical, tannery, chemical manufacturing, mining and battery manufacturing industries (Potgieter et al., 2006), removal of such metals are of prime importance.
A number of methods for the removal of metal ions from aqueous solutions have been developed over the years. The most important of these techniques include chemical precipitation, filteration, ion-exchange, reverse osmosis, and membrane systems (Potgieter et al., 2006). However, all these techniques have their inherent advantages and limitations in application. Due to the relative simplicity of application, adsorption technique can be considered as an alternative method for removing dissolved metal ions from liquid wastes (Potgieter et al., 2006).
Clay minerals are important constituents of all soils and play a key role to filter out pollutants from the solutions (Murray, 2000). Sepiolite [$Si_{12}Mg_8O_{30}$ $(OH)_4(H_2O)_4 \cdot 8H_2O$] is a fibrous clay mineral which is naturally abundant in arid and semiarid pedospheres worldwide. The low cost of these minerals along with the high specific surface area, chemical and mechanical stability, and layered structure have made these clay minerals as excellent adsorbent materials for the removal of heavy metals from wastewaters. Large deposits of sepiolite have been recently found in several locations of Iran and mining of them have already been started. Although there are several reports about the adsorption characteristics of sepiolites from different regions of the world (Kocaoba, 2009; Álvarez-Ayuso and Garcia-Sanchez, 2007; Shirvani et al., 2006), such information is not available about the Iranian sepiolite samples.
This study aims to investigate the sorption of Cd to a natural sepiolite sample from Iran with focus on sorption capacity, sorption kinetics and isothermal studies.

Materials and Methods
Materials and reagents

All chemicals employed in this study were analytical grade and used without any pretreatments: $CdCl_2.2H_2O$ (from BDH Chemicals, UK), HCl and NaOH (from Panreac, Spain). Cd-containing solutions were prepared from a standard of 1000 mg l^{-1} concentration and their initial pH was adjusted to 7.0 using 0.1 M HCl and NaOH solutions.
The sepiolite sample used as the sorbent in this study was taken from a mine in the Fariman region, northeastern Iran and its properties are given in Table 1. The mineralogical composition of the samples was determined by a Philips PW 1840 X-ray diffractometer, and the semi-quantitative analysis was based on the XRD pattern of unoriented powder sample using the method described by Schultz (1965). Total elemental analysis of sepiolite sample was determined using X-ray Fluorescence Spectrometer, Bruker S4 Pioneer. The specific surface area and cation exchange capacity of the sepiolite sample was measured by N_2-BET sorption analysis and NH_4-acetate method, respectively.

Table 1- Physicochemical properties of Fariman sepiolite (< 0.1 mm) employed in this study.

Property	Value
Mineralogical composition (%)	Sepiolite (70%), Quartz (15%), Dolomite (15%)
Specific surface area (m^2g^{-1})	179.91
Specific total volume pore (cm^3g^{-1})	0.378
Cation exchange capacity (cmol kg^{-1})	11.80
SiO_2 (%)	55.32
Al_2O_3 (%)	0.30
MgO (%)	15.73
Na_2O (%)	0.02
K_2O (%)	0.01
TiO_2 (%)	0.02
MnO (%)	0.00
CaO (%)	2.74
P_2O_5 (%)	0.00
Fe_2O_3 (%)	0.59
SO_3 (%)	0.00
LOI (%)	25.11
Total (%)	99.84

Kinetic experiments
All sorption studies were conducted in batch experiments in 0.01M $CaCl_2$ at pH 7, at sorbent concentration of 0.5% and at ambient temperature of 25±1ºC. The batch adsorption technique was selected because of its simplicity and reliability (Potgieter et al., 2006).
Initially, a kinetic study was performed to investigate the effect of contact time on the adsorption processes. In the kinetic experiment, a constant mass of sepiolite (0.25 g) and a fixed concentration of Cd solution (50, 100 or 150 mg/l) were added to 80 ml polypropylene centrifuge tubes. Then the total volume of mixture was set to 50 mL. The mixtures were shaken vigorously on an orbital shaker (200 rpm) and at specified times (0.5, 1, 2, 4, 8, 12, and 48 hour), bottles were removed from the shaker and centrifuged at 2,500 rpm for 25 min. Then, the Cd concentration in the supernatant was measured using an Aanalyst 200 Perkin-Elmer Atomic Absorption Spectrophotometer (AAS). The detection limit of AAS machine for Cd was 10 ppb.
Control treatments with no addition of adsorbent were also run to test possible adsorption and/or precipitation of Cd onto the container walls. Preliminary experiments showed that metal losses due to the adsorption onto the container walls were negligible.

The amount of cation adsorbed by sepiolite, Q_e (mg/g), was obtained as follows:

$$Qe = \frac{[(C_0 - C_e)] \cdot V}{M} \quad (1)$$

where C_0 and Ce (mg/l) are the initial and final (equilibrium) concentrations of Cd, respectively, V (ml) is the volume of solution and M is the mass of sorbent (mg). All measurements were carried out with three replications.

Effects of sorbent dose

In order to investigate the effects of sorbent dose on the percentage removal of Cd, different amounts of sepiolite (0.1, 0.25, 0.4, 0.6, and 0.8 g) were mixed with an appropriate milliliter of known concentrations of Cd solutions. The suspensions were shaken vigorously on an orbital shaker and centrifuged after 24 hours and the Cd concentration was measured in the supernatants using an AAS instrument.

Isothermal studies

For the adsorption isotherms, one set of bottles containing an equal amount of sepiolite (0.25 g) and variable concentrations of Cd (10, 25, 50, 75, 100, 125, and 150 mg/l) was prepared. The volume of the mixture was set to 50 ml. All samples along with blank treatments were vigorously shaken for 24 h to reach equilibrium. Bottles were then removed from the shaker, centrifuged and the Cd and Mg concentration and the pH values in the supernatants were measured.

The equilibrium data were analyzed using the Langmuir and Freundlich isotherms and their constants were determined. Satisfactory conformity between experimental data and the model predicted values was evaluated by correlation coefficient (r^2) and the standard error of estimation (S.E). The S.E. values were calculated from Eq. (2):

$$S.E. = \left[\frac{\sum (Q_e - Q_e^{'})}{n-2} \right]^{1/2} \tag{2}$$

where, Q_e and $Q_e^{'}$ are measured and model estimated amount of Cd which sorbed at equilibrium, respectively, and n is the number of measurements.

Results and Discussion

Kinetic studies

Contact time is an important parameter because it can reflect the adsorption kinetics of an adsorbent for a given initial concentration of the adsorbate (Wang et al., 2007). Fig. 1 shows the effect of contact time on the adsorption capacity of sepiolite for Cd. Based on that three steps can be seen for the sorption of Cd by sepiolite in this experiment. A first fast step which happened within the first hour of experiment, continued by a relatively slow speed step until 8 h, followed by a constant step upon further increase in contact time. The two plausible explanations for this finding are that the adsorption sites on sepiolite particle are not well exposed and there might have been more complex adsorption mechanisms in the study. Similar results were previously reported by Chen and Wang (2007) who studied the adsorption of lead ions on palygorskite clay.

In order to identify the adsorption kinetics of Cd on sepiolite, two kinetic models including pseudo-first order, and pseudo-second order were employed. The pseudo-first-order kinetic model has been widely used to predict metal adsorption kinetics. It has been suggested by Lagergren (1898) for the adsorption of solid/liquid systems and its equation is given below:

$$Log(Q_e - Q_T) = LogQ_e - \frac{K_1 \cdot T}{2.303}, \tag{3}$$

where Q_T (mg g^{-1}) is the adsorption capacity at time T and K_1 (h^{-1}) is the rate constant of the pseudo-first order model.

The kinetic data were also analyzed using pseudo-second-order kinetic model of Ho and Mc Kay (1999), expressed as equation 4:

$$\frac{T}{Q_T} = \frac{1}{K_2 \cdot Q_e^{\,2}} + \frac{1}{Q_e}, \tag{4}$$

where K_2 (g $mg^{-1}h^{-1}$) is the rate constant pseudo-second order adsorption.

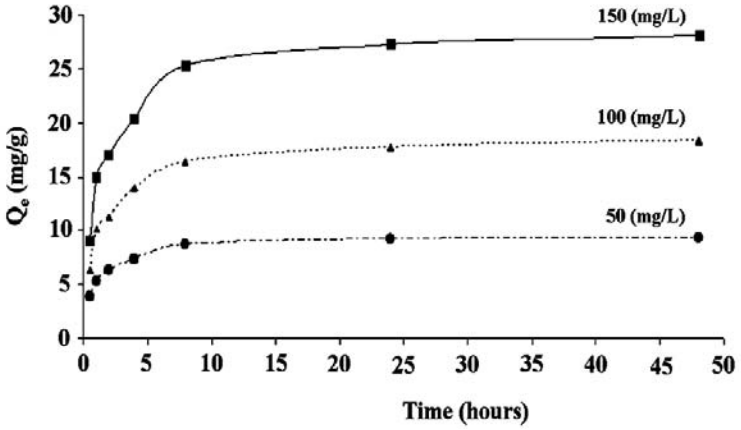


Figure1. Effects of contact time and initial concentration of Cd on the Cd adsorption from solution.

By plotting *log (Qe −Q_T)* versus *T*, and (*T*/Q_T) versus *T*, the rate constants K_1, and K_2 and their correlation coefficients were calculated (Table 2). As compared to the pseudo-first-order kinetic model, a very good correlation coefficient (r^2) was obtained for the pseudo-second-order kinetic model. This indicates that Cd adsorption onto sepiolite is highly depended on the concentration of ions at the adsorbent surface. This also suggests that the behavior over a whole range of Cd concentrations is in agreement with chemical adsorption as the rate-controlling step (Baskaralingam et al., 2006).

It is known from the literature that retention of heavy metals by fibrous clay minerals can be through adsorption and/or cation exchange reactions (Vico, 2003). Adsorption occurs on the functional groups on the broken edges of minerals which correspond with the release of H^+. Cation exchnge reactions may also happen through replacement of Mg^{2+} in the edges of octahedral layers by Cd^{2+} (Shirvani et al., 2006; Chen and Wang, 2007). The variations of pH and Mg contents of the final solutions as a function of Cd ions sorbed show that the amount of proton and Mg in the equilibrium solutions increases with the amount of Cd sorbed on the minerals (data not shown). This implies that both the adsorption and cation exchange reactions controlled the sorption of Cd onto sepiolite.

Table 2- Parameters of pseudo first-order and pseudo second-order kinetic models fitted to the experimental data at different initial Cd concentrations.

C_0 (mg L^{-1})	Pseudo first-order				Pseudo Second-order			
	Q_e (mg g^{-1})	K_1 (h^{-1})	R^2	S.E	Q_e (mg g^{-1})	K_2 (g mg^{-1} h^{-1})	r^2	S.E
50	7.93	0.2410	0.965	0.55	8.11	0.054	0.991	0.13
100	15.19	0.1954	0.954	0.64	17.98	0.0313	0.989	0.16
150	23.18	0.2812	0.931	0.75	29.19	0.0338	0.999	0.09

Effect of sorbent dose

The amount of sorbent is an important factor which determines the sorption capacity of a sorbent for a given initial concentration of sorbate (Chen and Wang, 2007; Hamidpour et al., 2010). The influence of sepiolite dose on the removal of Cd is shown in Fig. 2. As expected, the percent removal of Cd increases as the amount of the sorbent increases. This simply happens because of an increase in the number of sorbent sites after the addition of more mineral particles in the suspension (Kaya and □ren, 2005). Results also indicate that the removal efficiency after addition of 0.4 g sepiolite mass remains constant at 100% for all concentrations of Cd solutions. Similar results were reported by Potgieter et al. (2006) and Hamidpour et al. (2010) for Pb and Cd adsorption from aqueous solutions onto palygorskite and bentonite, respectively.

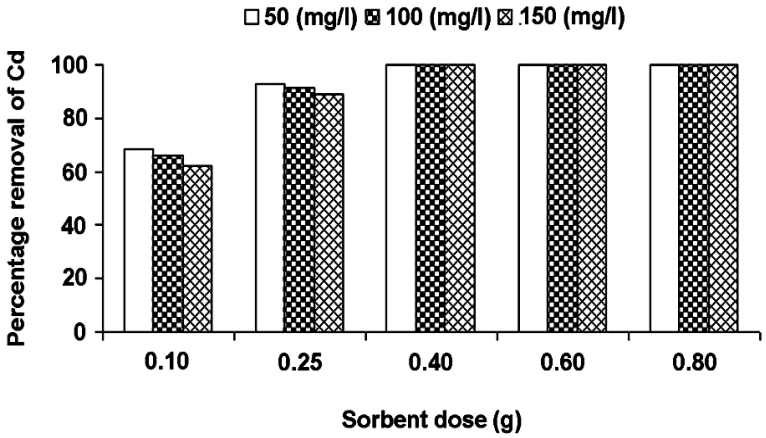


Figure 2. Effects of mass of sepiolite on the adsorption of Cd onto sepiolite.

Adsorption isotherms

The adsorption of Cd onto sepiolite was plotted as a function of equilibrium concentration of Cd (Ce) to identify the mechanism of adsorption process. The data could then be correlated with a suitable isotherm (Table 3). The adsorption process is normally described by the Langmuir and the Freundlich isotherms. The Langmuir adsorption isotherm assumes that adsorption occurs at specific homogeneous sites within the adsorbent and has found successful application in many studies of monolayer adsorption. The linear form of the Langmuir model (Eq. (5)) is given below:

$$\frac{Ce}{Q_e} = \left(\frac{1}{Q_{\max}}\right) C_e + \frac{1}{K_L Q_{\max}} \tag{5}$$

where Q_{max} and K_L are the Langmuir constants related to the adsorption capacity (mg/g) and the equilibrium constant (l/g), respectively.

The adsorption equilibrium data was also applied to the linear form of Freundlich model (Eq. (6)) as given below:

$$LogQ_e = \left(\frac{1}{n}\right) LogC_e + LogK_F \tag{6}$$

where K_F and n are the Freundlich constants related to adsorption capacity and adsorption intensity, respectively. The comparison of experimental and predicted data from Freundlich model is presented in Table 3. Results showed that sorption of Cd by sepiolite can better be explained by the Freundlich equation. The r^2 value is higher for the Freundlich isotherm than for the Langmuir isotherm. This may be due to heterogenous distribution of active sites on the sepiolite surface. Shirvani et al. (2006) also suggested that sorption of Cd ions onto sepiolite was better described by the Freundlich equation.

The K_F value of the Freundlich equation (Table 3) indicates that sepiolite sample used in this study has a very high adsorption capacity for Cd ions in aqueous solutions. The value of 1/n ranges between 0 and 1, and indicates the degree of non-linearity between solution concentration and adsorption (Sevim *et al.,* 2011). If the value of 1/n is equal to unity, the adsorption is linear. If the value is below unity, this implies that the adsorption process is chemical. If the value is above unity, adsorption is a favorable physical process. The more heterogeneous the surface, the closer 1/n value is to 0 (Sevim *et al.,* 2011). In our study, the value of 1/n is below unity suggesting that the adsorption of Cd by Fariman sepiolite is a spontaneous and chemical process.

Table 3- Constants, correlation coefficients (r^2), and standard error of estimates (S.E.) of Cd sorption data fitted to the Langmuir and Freundlich equations.

Parameters	Value
Langmuir	
Q_{max} (mg g^{-1})	29.1
K_L (L g^{-1})	0.038
R^2	0.825
S.E.	0.27
Freundlich	
K_F (L g^{-1})	3.926
N	1.104
R^2	0.995
S.E.	0.09

The maximum adsorption capacity (Q_{max}) calculated from the Langmuir isotherm in this study is much higher than those reported in the literature (Table 4). This suggests that the studied sepiolite possesses a very high adsorption capacity. Therefore, that the mineral is very useful in removing Cd ions from aqueous solutions (Chen and Wang, 2007).

Table 4- Comparison of the maximum adsorption capacities of Cd on different clays.

Clays	Q_{max} (mg g^{-1})	References
Anarak Bentonite	17.80	Hamidpour et al., (2010)
Firouzkouh Zeolite	9.30	Hamidpour et al., (2010)
Tenebrón Palygorskite	3.15	Alvarez-Ayuso and Garcia Sanchez, (2007)
Bercimuel Palygorskite	5.83	Alvarez-Ayuso and Garcia Sanchez, (2003a)
Vallecas Sepiolite	17.1	Alvarez-Ayuso and Garcia Sanchez, (2003b)
Orera Sepiolite	8.26	Garcia-Sanchez et al., (1999)
Vicalvaro Sepiolite	5.18	Shirvani et al., (2006)
Fariman Sepiolite	29.1	This Study

Conclusions

The following conclusions have been drawn from this study:

1. Commercial Iranian sepiolite from Fariman seems to be poyentially very good to remove Cd from aqueous solutions.
2. The amount of Cd which sorbed by Fariman sepiolite increases with an increase in initial Cd concentrations, contact time and the sorbent dosage.
3. Adsorption of Cd onto Fariman sepiolite can be well expressed with the Freundlich adsorption isotherms.
4. The observed metal ion uptake by the mineral is complex and involves both ion exchange and surface adsorption mechanisms.

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Comparison of Sediment Delivery Ratios in Guvenç Basin

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Abstract

In this study, different sediment delivery ratios were calculated and compared for Güvenç, a rural basin in central Anatolia. Basin sediment yield was measured by using an echo sounder for 17 years in Güvenç pond as 1.76 t/ha yearly. Potential soil loss of the basin was estimated by using USLE method is 16.30 ton/ha annually. According to the obtained values, sediment delivery ratio (SDR) of the basin calculated is 10.80 %. Basin sediment yields were estimated by using MUSLE and EIEI equations. Basin sediment yields and SDRs were estimated as 1.28 t/ha/year (7.85 %) and 1.41 t/ha/year (8.71 %) for MUSLE and EIEI methods, respectively. SDR values were calculated according to MUSLE and EIEI methods when potential soil losses were based for the basin. These results showed that EIEI equation can be useful when there is any data for estimation of sediment yield at similar small catchments.

Keywords: USLE, MUSLE, potential soil loss, sediment yield, sediment delivery ratio

1. Introduction

Soil erosion and sedimentation are two processes that follow each other (Karaş and Demirkıran, 2010). The SDR is defined as the ratio of sediment delivered at a location in the stream system to the gross erosion from the drainage area above that point. This ratio varies widely with size of area, steepness, density of drainage network and many other factors (Ward and Trimble, 2004). Numerous models have been proposed for estimation of SDR by using different catchment characteristics since the last 50 years. The long-term average annual sediment yield from a basin can be predicted by applying a delivery ratio to estimated gross erosion. Average annual sediment yield is the only information required for some problems like sediment pool design for small reservoirs. Applying a delivery ratio to estimated gross erosion is convenient and can be fairly accurate if delivery ratios can be predicted accurately (Williams, 1977).

MATERIAL

Area Description

Ankara - Yenimahalle - Güvenç pond basin is on the Kayaönü Creek, which is east side of the Ankara-İstanbul highway. Kayaönü Creek, located in the Sakarya River basin, is fourth degree tributary of river system on the 1/25000 scale map. The altitude of outlet of the basin is 1053m, basin latitude is 42°08'10" N and longitude is 32°45'15" E. Runoff measurement station is about 2.5 far from Güvenç village and pond reservoir was built about 7.5 m high of the maximum water level. Basin area is about 15.83 square kilometer (Cebel et al. 2003).

Topographic map of the basin and sub basins were given respectively in figure 1.

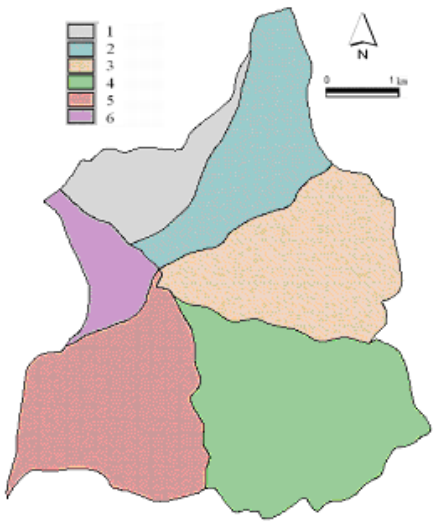


Figure 1. Sub basins of Güvenç basin

According to data from the basin annual rainfall is 482.0 mm, annual runoff is 119.00 mm, average temperature is 11.4 °C, mean relative humidity is 62%.

Drainage characteristics

Some drainage characteristics of the basin obtained from topographic map are given in Table 1.

Table 1. Some drainage characteristics of the basin (Karaş and Demirkıran, 2010)

Drainage characteristics	Sub basins						General
	1	2	3	4	5	6	
Area (A), km^2	1.35	2.39	3.23	4.49	3.53	0.94	15.83
Perimeter (P), km	6.75	8.25	7.75	9.25	8.50	5.00	19.50
The greatest height (H_{max}), m	1325	1370	1360	1325	1459	1310	1459
The lowest height (H_{min}), m	1053	1060	1095	1100	1100	1053	1053
Relief (R), m	272	310	265	225	359	257	406
Relatively relief (R_n), %	4.03	3.76	3.42	2.43	4.22	5.14	2.08
Average height (H_{or-1}), m	1189	1215	1227	1212	1279	1181	1256
Median height (H_m), m	1180	1210	1215	1210	1270	1175	1235
Average slope (S_H), %	22.8	17.6	24.8	27.0	23.4	32.8	24.3
Main stream length, (L_s), km	1.58	3.00	2.43	2.88	2.75	1.50	5.25
Main stream waterway slope (S_s), %	9.7	9.3	7.7	10.0	10.9	6.2	6.1
Total length of waterway (L_u), km	1.88	4.00	10.25	15.00	10.50	3.00	44.62
Drainage density (D_d), m/km^2	1371	1657	3132	3380	2935	3145	2785

Soil Properties

Area, depths and K factor values for each soil series in the basin are given in table 2, soil series map is shown in figure 2.

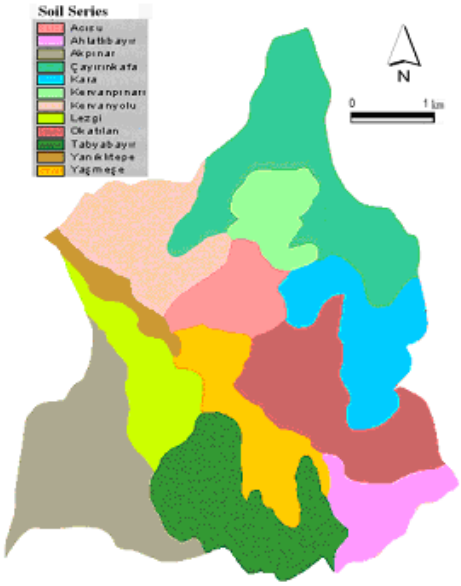


Figure 2. Soil serial map of the basin

Table .2. Area, depths, K factor for each soil series

Serial name	Area, km^2	Depth, mm	K Factor
Çayırınkafa	2.48	1300	0.52
Kervanyolu	1.39	850	0.46
Kervanpınarı	0.69	1300	0.57
Acısu	0.78	850	0.50
Kara	1.33	200	0.52
Okatılan	1.84	200	0.58
Ahlatlıbayır	0.78	200	0.31
Yaşmeşe	1.15	600	0.39
Tabyabayır	1.80	200	0.60
Akpınar	2.23	100	0.21
Lezgi	1.02	250	0.47
Yanıklıtepe	0.35	1200	0.46
Total/mean	15.83	556	

Sediment measurements

Sediment measurements in the basin were found by taking the difference of accumulated sediment in bottom of the Güvenç pond using laser assisted echo sounder and preparing bathymetric map in specific time interval. Sediment yield were found as 1.76 t/ha yearly between 1989 and 2006 according to sediment measurement (Demirkıran 2007)

Land use

Land use of the basin is given in figure 3 and table.3

Table 3. Land use distribution of Güvenç basin

Land use/ crop type	Area km^2	Area, %
Agricultural (moderate)	5.57	35.44
Pasture (poor)	6.66	42.45
Contour pasture (good)	0.84	5.59
Horticultural (moderate)	0.18	0.96
Forest (moderate)	0.66	4.19
Brush land (moderate)	0.18	1.16
Bare land (very poor)	1.62	10.21
Total	15.83	100.00

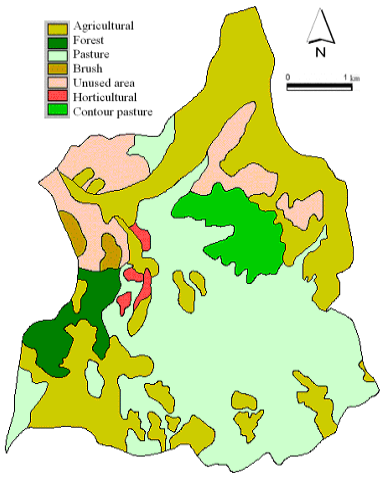


Figure 3 Land use of the basin

Methods and Results

USLE

Potential soil loss for the basin was estimated using Universal Soil Loss Equation (USLE) developed by Wischmeier and Smith (1978). The USLE can be used to compare soil losses from a particular field with a specific crop and management system to "tolerable soil loss" rates. Alternative management and crop systems may also be evaluated to determine the adequacy of conservation measures in farm planning.

$$A = RKLSCP \quad (1)$$

Where A, Average annual soil loss (in tons per hectare per year); R, Rainfall and runoff factor; K, Soil erodibility factor; LS, Slope length-gradient factor; C, Crop/vegetation and management factor; P, Support practice factor

R factor value for the basin was used as 40.71 according to the studies carried out by Doğan and Küçükçakar (1994).

Soil K factor values were calculated by equation for each soil series using organic matter, texture, structure, hydraulic conductivity values on taken soil samples.

LS factor values were calculated by GIS using the method proposed by Moore and Burch (1986).

C factor was determined by selecting the crop type and tillage method for existing land use. C factor values were taken from the table given by Doğan and Küçükçakar (1994), Cebel et al. (2003) and Çanga (1995). C factor values are 0.24 for agricultural area, 0.005 for forest and contour pasture, 0.05 for poor pasture vegetation and brush, 0.10 for horticultural area and 1.00 for bared used area according to crop type.

P factor was taken as 1.00 for whole basin except the contour pasture area.

Potential soil losses, calculated by USLE method are given in table 4, figure 4- 5

Table 4.. Potential soil loss for different land use at the basin

Land use	Area (km^2)	Area (%)	Potential Soil Loss (ton/ha/year)
Agricultural	5.5668	35.17	16.05
Pasture	6.6593	42.07	0.98
Contour pasture	0.8844	5.59	0.49
Forest	0.6696	4.23	0.46
Brushland	0.1827	1.15	8.42
Horticultural	0.1524	0.96	5.90
Bareland	1.6260	10.27	97.52
Total/Mean	15.8300	100.00	16.30

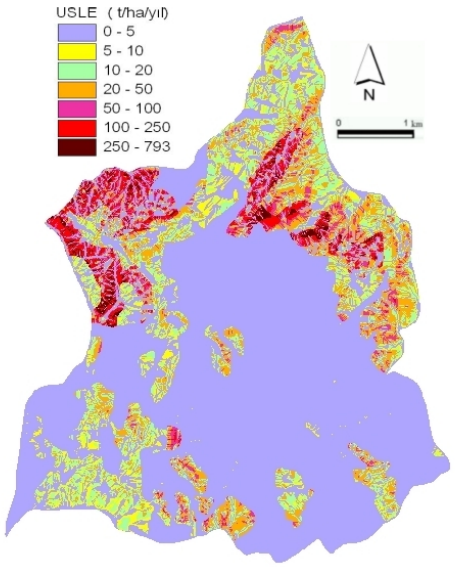


Figure 4. Potential soil loss according to USLE

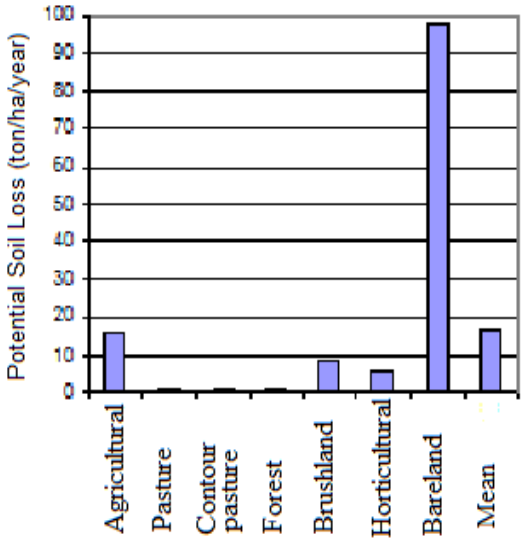


Figure 5. Potential soil loss graphic for the basin

MUSLE

A sediment yield model requiring runoff input was attached to runoff models to predict daily, monthly, and annual sediment yield. The MUSLE, the sediment yield model, is expressed as:

$$Y = 11.8\ (Q \times q_p)^{056}\ KCPLS \qquad (2)$$

where Y is the sediment yield from an individual storm [in tonnes] ; *Q* is the storm runoff volume [in m^3]; q_p is the peak runoff rate [in m^3/s] ; K is the soil-erodibility factor; LS is the slope length and gradient factor; C is the crop management factor; and P is the erosion control practice factor. Procedures for determining area-weighted values of the K, C, P, and LS factors for basins were described previously (Williams and Berndt, 1976).

The sediment yield of the basin was used according to MUSLE method by using 129 individual runoff events, between 1989 and 2006. It was calculated the sediment yield for each of them using MUSLE equation. Total sediment yield was calculated as 68627 m^3 or 102940 ton results obtained for 17 years. It means that the sediment yield of the basin is 3.83ton/ha/year.

Sediment Delivery Ratio (SDR)

The ratio of sediment yield of a drainage basin to the total amount of sediment moved by sheet erosion and channel erosion. There is no precise procedure to estimate SDR, although the USDA has published a handbook in which the SDR is related to drainage area (USDA SCS, 1972).
SDR can be affected by a number of factors including sediment source, texture, nearness to the main stream, channel density, basin area, slope, length, land use/land cover, and rainfall-runoff

factors. The relationship established for sediment delivery ratio and drainage area is known as the SDR curve.
In order to estimate sediment delivery ratios, mean value of the methods given Table 5 were used.

Table 5. Used Equations of SDR for the basin

Equation name	Equation
Roehl	$SDR = 36 (A)^{-0.20}$
Williams and Berndt	$SDR = 0.627 (SLP)^{0.403}$
Renfro	$Log (SDR) = 1.7935 - 0.14191 log (A)$
Vanoni	$SDR = 0.42 (A)^{-0.125}$
Williams	$SDR = 1.366 \times 10^{-11} (A)^{-0.0998} (ZL)^{0.3629} (CN)^{5.444}$
USDA-SCS	$SDR = 0.51 (A)^{-0.11}$
Julien	$SDR = 0.41 (A)^{-0.3}$
Linear Method	Presented in (USDA, 1972)

SDR, Sediment delivery ratio (%), A Basin Area (km^2), SLP Main stream channel slope (%), ZL ratio of relief-length (m/km), CN average curve number

Basin sediment yield was estimated by multiplied the potential soil loss calculated by USLE and mean sediment delivery ratio obtained via equations. Calculated mean SDR values for sub basins displayed in table 6, are changing between 32.77 and 44.43 % and mean SDR value for the basin is 26.94 % and sediment yield is 3.35 t/ha yearly. Measured sediment yield is 1.76 t/ha as yearly. This means that there are important differences between calculated and observed sediment yield.

Table 6.SDR values for subbasins of Güvenç basin (%)

Used Equations	Sub basin						General
	1	2	3	4	5	6	%
Roehl	33.90	30.24	28.47	26.78	27.97	36.45	20.72
Williams and Berndt	16.37	24.11	22.31	24.76	25.68	20.47	20.31
Renfro	59.38	54.79	52.47	50.25	51.81	62.50	41.88
Williams	29.29	29.67	30.45	21.15	36.06	54.00	18.39
Vanoni	55.33	51.15	49.61	47.74	49.06	57.89	40.67
USDA-SCS	49.34	46.34	44.83	43.34	44.39	51.35	37.64
Julien	37.47	31.56	28.84	26.12	28.08	41.77	17.90
Linear Method	30.00	25.00	24.00	22.00	23.00	31.00	18.00
Mean	38.89	36.61	35.12	32.77	35.76	44.43	26.94

Main sources of sediment yield in the basin are numbered as 1, 2 and 6. These sub basins are generally consist bare land and some of the agricultural used areas.

EİEİ Equation

Sediment measurement made by EIEI (General Directorate of Electricity Studies) in Sakarya river catchment, which also include Güvenç was obtained a sediment equation.

$$\text{Log } Q_s = -0{,}97688 + 1{,}10309 \text{ Log } A \quad (3)$$

where *Qs* is the sediment yield (in tonnes); A, area (in sqkm)

Basin sediment yield was calculated as 1.42 ton/km^2 yearly using EIEI equation.

Conclusion

In this study, actual sediment delivery ratio of a rural basin based on USLE result was compared to proposed equations by the researchers. USLE or RUSLE does not give actual sediment yield. They give the potential soil erosion from the basins. The sediment delivery ratio (SDR) is used to adjust the gross sediment estimate to compensate for deposition along the path traveled by the runoff

water as it moves from fields in the watershed to a continuous stream system. How much sediment is deposited (sediment yield) can be estimated by computing the gross erosion and multiplying by the sediment delivery ratio if a sediment delivery ratio is known or can be approximated from known parameters. SDR is a result of catchment drainage characteristics also including soil, vegetation, land use types and especially rainfall intensities. For that reason, if anyone wants to use any equation for estimation of SDR, developed conditions of these methods should be evaluated first of all. Moreover, SDR is also dependent to soil erosion processes. Existing technologies, like Geographic Information System offer an opportunity to find the potential source areas of soil erosion. Consequently, most of the attentions will condense on physical conditions like soil, land use, various conservation practices etc. in the future. In addition to that, abundant of the effective factors on soil erosion also effect the rates of SDR. The SDR for many agricultural watersheds have been estimated at 25 percent, plus or minus 15 percent, depending more on size of the watershed than any other factor. SDR_s vary widely for any given size drainage area, but limited data have shown that they generally vary inversely with the size of the drainage area.

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Management of Drainage Water Quality: The Impacts of Different Irrigation Water Salinities and Leaching Ratios

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Abstract

In this study, the effects of different irrigation water salinity and leaching ratio on drainage water quality changes were investigated in the field condition with PVC lysimeters, 115 cm in long and 40 cm in diameter. Alfallfa (*Medicago Sativa*) was grown and irrigated depend on the TDR readings. Three irrigation water salinity (0.25, 1.5 and 3.0 dS/m) and four leaching ratios (%10, 20, 35 and 50) levels were used in a randomized factorial design experiment with three replications, totally 36 lysimeters. The experiments were carried out from the spring until the last harvest in the autumn. After the irrigation drainage water were collected from the bottom of the lysimeters after the each irrigation. The EC, Cl^-, Na^+ and Ca^{+2} concentrations of drainage waters were determined throughout the experiments and chances were evaluated for these parameters. In general, total salinity and salinity parameters of drainage waters varied by the irrigation water quality and leaching ratios used. Increasing irrigation water salinity were also increased the drainage water salinity. Similarly, salt in the soil profile was leached effectively by increasing leaching ratio. Consequently, the drainage water quality was decreased.

Key words: leaching ratio, drainage water quality, irrigation water quality, lysimeter, alfalfa

Introduction

The volume of drainage water at irrigated areas may affect groundwater; it may be directed to surface water or reused at irrigation. Under all circumstances, the volume and quality of drainage water are important factors and must be considered during drainage water management. The quality of drainage water has a strong influence when discharged to surface water resources. It has detrimental contaminant effect on ground water. Re-use of drainage water is a factor which has to be planned very carefully.

Key factors which affecting the volume and quality of drainage water in the irrigated areas are irrigation water quality and used amount. The quality and amount of irrigation water is important due the amount of water returned from irrigation and the negative effects on water quality of environment where the drainage water discharged. In the case, water conservation, and re-use, it is important due to negative impact on agriculture and environment

Agricultural production in arid and semi-arid regions is mainly based on irrigation. The soil at irrigated areas usually has a higher salinity as compared to irrigation water salinity. The reason can be explained as salinity increases after evaporation of water and separation of soil minerals (Rhoades et al., 1973). As a result, due to irrigation water salinity and sodium levels the soil, salinity reach high levels where it adversely affect plant growth (Maas and Hoffman, 1977) and soil structure can be disrupted (Ben-Hur, 1998).

In terms of sustainable irrigated agriculture, leaching is a compulsory practice in order to prevent the accumulation of soluble salts in the root zone. Leaching out salts at the root zone means that, salinity level in drainage water has been increased. For this reason, reducing the rate of leaching and improving irrigation efficiency increases salinity level at and under the root zone and reduction in drainage water salt level (Oster and Rhoades, 1978). As a result, the control of irrigation management under certain conditions means drainage water salinity control. Suarez and Rhoades (1977) examined the effect of improvement of irrigation efficiency in a closed river basin on salinity of groundwater. In some circumstances, depending on the chemical composition of water, downstream water flow quality can be affected by the steady flow of water, salt and the differences in the efficiency of irrigation. Water coming from drainage systems generally contains agricultural chemicals and other pollutants (Banuelos, 1996, Goldberg et al., 2003) and drainage water can become a significant problem for irrigated agriculture (Letey et al., 2002; Schoups et al., 2005).

If any low quality water, which is to be removed from a certain area as drainage water, is discharged to a water source, whose properties will worsen. Usage of high salt content drainage water during irrigation will cause accumulation of salts in the soil (Yurtseven and Orta, 1992). Primary requirements for a successful water management are to reduce the amount of irrigation water applied and re-use of drainage water. It is known that a large portion of irrigation water applied (usually 50%) not absorbed by the plant, but removed as drainage water (Frederiksen, 1992).

There are three application practices in the use of drainage water for irrigation. The first is diluting saline drainage water by mixing with less salty water. The second is using the different quality water interchangeably. Saline water can be applied as aid either in pre-determined order not at seeding and germination, when the plant is sensitive to salt or at dry periods when there is insufficient water supply. The third is using the saline drainage water directly in salt-resistant crops or forestry (Hanson, 1990; Yurtseven, 1993; Büyükcangaz and Miller, 2002).

In the world, there are many examples of applications of irrigation by drainage waters. For many years, saline water has been used for cultivation of cotton, sugar beets and alfalfa in various regions of the U.S. In Israel, water which has value of EC 2-8 dS/m has been used in sprinkler and drip irrigation. In Tunisia, saline drainage water has been used for irrigation of clover, rye, barley. In Egypt, drainage water which has EC of 4.5 dS/m was mixed with the Nile waters and used in agricultural production (Rhoades et. al, 1992). In our country, it is encountered various forms of usage of drainage water in irrigation applications in Konya, Bafra plain, Harran irrigation.

In this study, we aimed to analyze the relationships between the irrigation water salinity and leaching efficiency and the quality of the drainage water in lysimeters.

Materials and Methods

In this study, the impacts of different irrigation water salinity and leaching ratio investigated on drainage water quality changes. The experiments were conducted in PVC lysimeters (115 cm in long and 40 cm in diameter) cultivated with alfalfa in field conditions. Three different irrigation water salinity (S1, S2, and S3, and 0.25, 1.5 and 3.0 dS/m respectively) and four leaching ratio (LR1, LR2, LR3, LR4 and %10, 20, 35 and 50, respectively) levels were used in an randomized factorial design experiment with three replications totally 36 lysimeters. Lysimeters are located in the experimental fields of Ankara University, Faculty of Agriculture, Dışkapı; Ankara. Pods were put under the lysimeters to collect the drainage waters leaching from the lysimeters and wood blocks are inserted beneath the pots.

The irrigation system is set with 80 liter plastic barrel placed on a high platform, connected by the dripper laterals to distribute the irrigation water to the plants. Only one dripper was used for a lysimeter. Irrigation times were determined in relation to plant vegetative development and harvest dates. Averagely, irrigation water was applied 2-3 times in a month depending on the climatic conditions. Leaching ratio was calculated from both soil samples collected from a spare lysimeter and TDR probes inserted in the middle row lysimeters. In fact, before the application of leaching ratio, irrigation water of the %60 of field capacity were determined in control lysimeter and this amount was applied firstly to the lysimeters of LR1. After, drainage water output were controlled, the other leaching ratios (20%, 35% and 50%) were applied to the all lysimeters correspondingly. Then, the drainage water was sampled for further analysis. Leaching ratio was defined in this study as the ratio of the volume of drainage water to the volume of irrigation water (Ayers and Westcot, 1989).

Ankara municipality tap water with the salinity level of 0.25 dS/m, and SAR value is 0.45 was used in the experiments (Table 1). SAR values the other saline irrigation water tried to kept lower than <1 (Yurtseven and Baran, 2000). Experiments carried out during April to October in 2010. During the vegetation period, 10 irrigations and 5 harvests were performed.

Table 1 –Water quality of Ankara tap water

pH	EC	Cations, me/l					Anions, me/l				SAR
	dS/m	Na^+	K^+	Ca^{+2}	Mg^{+2}	Total	HCO_3^-	Cl^-	SO_4^{-2}	Total	
7.11	0.25	0.43	0.07	0.70	1.14	2.34	1.60	0.50	0.24	2.34	0.45

For the preparation of saline irrigation water (1.5 and 3 dS / m), NaCl and $CaCl_2$ salts were used. These salts were selected because they are common in for salt stress in natural and artificial rearing environments (Levitt, 1980; Delesalle and Blum, 1994, Turhan and Baser, 2001). A BASIC based computer program used for calculation of salt amounts in Irrigation water (Yurtseven, 1989).
The soil, which is used in the experiment, is taken from the experimental fields of Faculty of Agriculture by excavation of upper 40 cm. After sieving the soil form 0,5mm sieve they placed to lysimeter according the undisturbed soil bulk density value. Test soil is sandy-clay-loam (SCL) with 58 % sand, 21 % silt and 21 % clay. Soils filled the lysimeter partially and with the care to ensure the same bulk density along the lysimeter.
After the each irrigation, drainage water samples collected and measured salinity measurements (electrical conductivity, pH, Na^+, K^+, Ca^{+2} Mg^{+2}, Cl^-) were determined. Total salinity (EC), is determined by the procedures described by Richards (1954), according to procedures set forth in, 25°C, with electrical conductivity instrument (YSI 3000) were performed. Laboratory measurement of pH was made with glass electrode pH meter (Martini Mi 151). And, all the cation and anion analysis was performed by ion chromatography (Dionex ICS 1600).

Results and Discussion
In the trials, the amount of leaching ratio calculated from the irrigation and drainage water volumes was 11%, 15%, 18% and 20% for LR1, LR2, LR3 and LR4, respectively (Figure 1).
The amount of irrigation water, calculated from the drainage water, among the treatments varies according to salinity level (Figure 2). The difference between the irrigation and drainage water was the lowest in S1, but increased in S2 and S3 levels as 12 and 23 %, respectively.

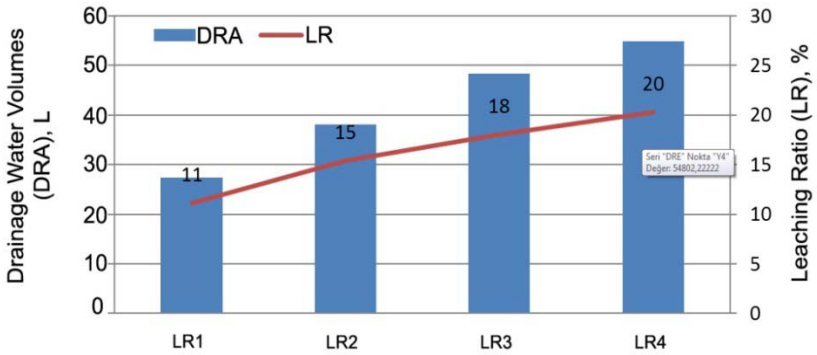


Figure 1 Experiments (Y) for subjects with the actual leaching ratio of the total volume of drainage water volumes (LR) ratios.

EC of drainage water for the first year of the experiment, variation of EC values do now show significant change for the first 4-5 irrigation (Figure 2). However, after 5th irrigation significant change of EC in drainage water is observed according to the salinity level of the irrigation water from S1 to S3 ($P<0.01$). From the 6th irrigation on, LR considerable affected the drainage water salinity. Increasing leaching ratio was increased the drainage water salinity as well. This is due to the leaching of the salt more in the soil profile with the increasing amount of the applied water. Increased drainage water salinity is due to the increased irrigation water salinity and later leaching of salt added to the profile with the increasing volume of leaching water. Irrigation with saline water cause to increase drainage water salinity was reported by Hake et al., (1996) and Choudhary et al., (2001).
Chlorine (Cl^-) in drainage water:
When variations in the Cl^- concentrations in drainage water are examined, from the first irrigation up to end of third irrigation, there was no apparent correlation between the irrigation and drainage water (Figure 3). From the fourth irrigation on, in the high-salinity irrigation water applications (S2 and S3),Cl^-content of drainage water was significantly increased($P<0.01$) due to the high of Cl^- content of water .After the sixth irrigation, in the LRI1 affected significantly the Cl^- concentration of the drainage water. Increased LR were also increased the Cl^- of drainage water.

Sodium (Na^{+}) in drainage water :

The irrigation water was significantly affected to the Na^{+} content of the drainage waters only after the sixth irrigation ($P<0.01$)(Figure 4). On the other hand, the effect of LR on Na^{+} of the drainage water is limited. Only after the 6, 8 and 9 irrigation application, LR began to affect the Na^{+} content of drainage water. This is due to the reason that the difficulty of Na^{+} leaching from soil. The most of Na^{+} added to profile, retained in the soil and small portion can be leached out from the profile.

Calcium (Ca^{+2}) in drainage water

Depending on the of irrigation water salinity, drainage water content of Ca^{+2} showed significant changes at level of 1% from the fifth irrigation on (Figure 5). Ca^{+2} content of drainage water influenced by the increasing salinity of irrigation water LR was not affected the Ca^{+2} content in drainage water. In the sixth irrigation, this relation was significantly important, but this is more remarkable after the, 8 and 9th irrigation ($P<0.05$). In general, excess of leaching is not effective for Ca^{+2} movement to drainage water.

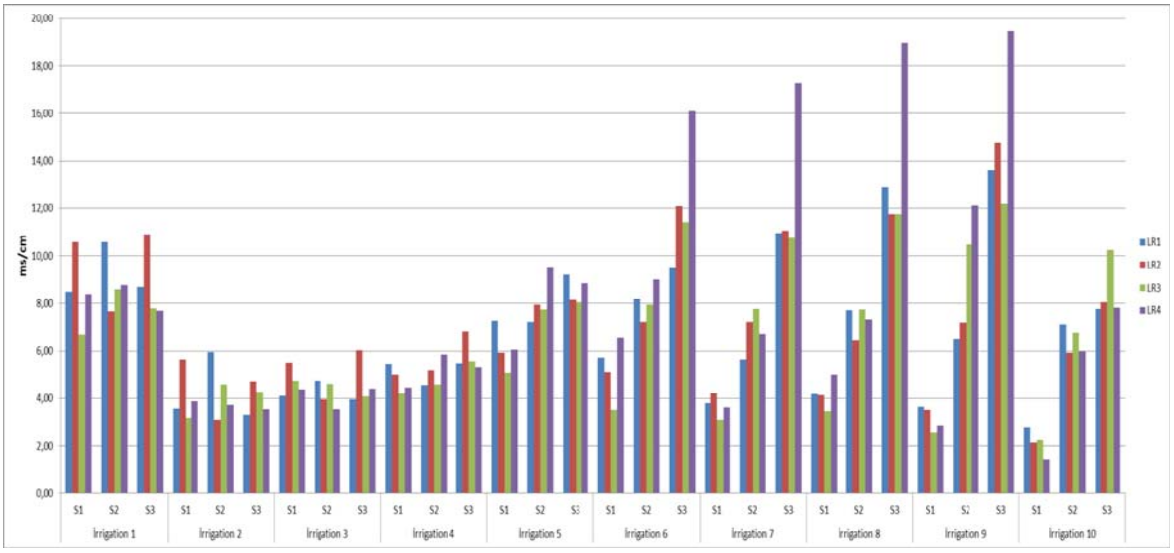


Figure 2. The results of analysis of drainage water EC (mS / cm)

Conclusions

Irrigated by the amount of drainage water quality in areas affected by irrigation practices. As the volume and quality of waste water discharged must keep in mind as they affect the environment negatively. Salt accumulationed in the root zone is very important when they are not removed by leaching. In this study, as evidenced by an increase in the amount of leaching in the frequency of the salts are washed with a profile. The quality of irrigation water applied, affects directly the quality of drainage water. Irrigation water applied is the most important source of soil salinity in irrigated areas. Excess use of irrigation water, even in sandy soils contributes to the formation of the root zone saline.

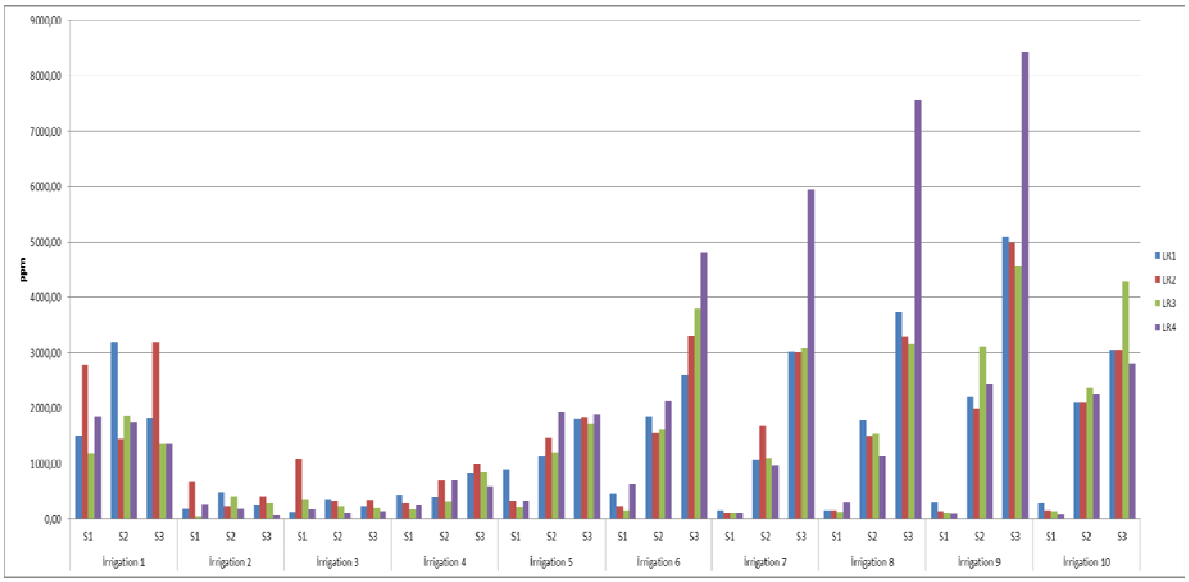


Figure 3. The Cl^- content of the drainage water (ppm)

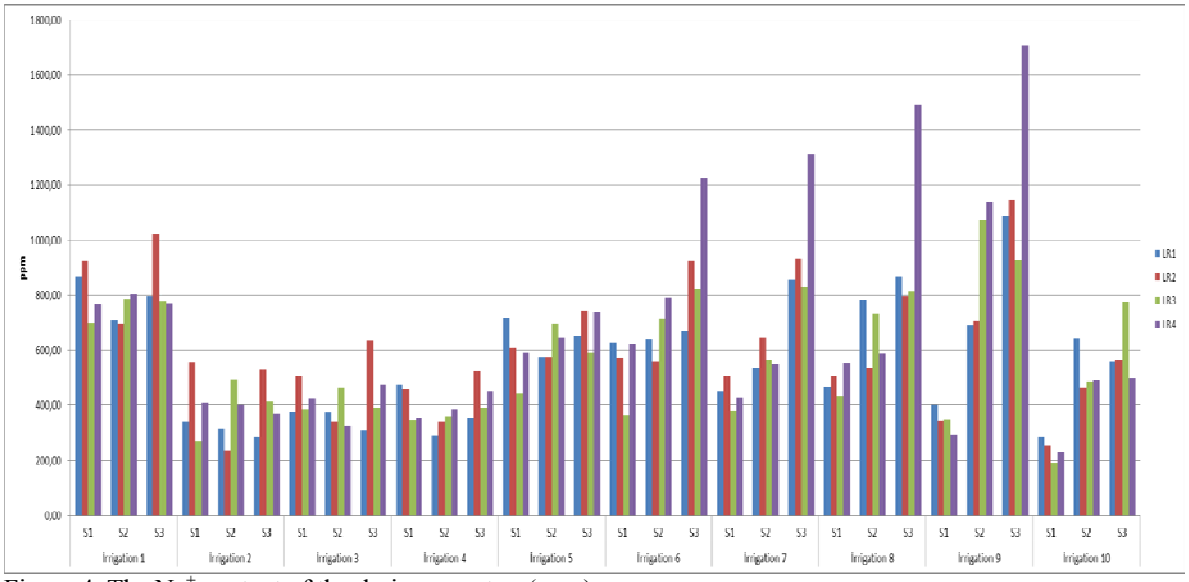


Figure 4. The Na^+ content of the drainage water (ppm)

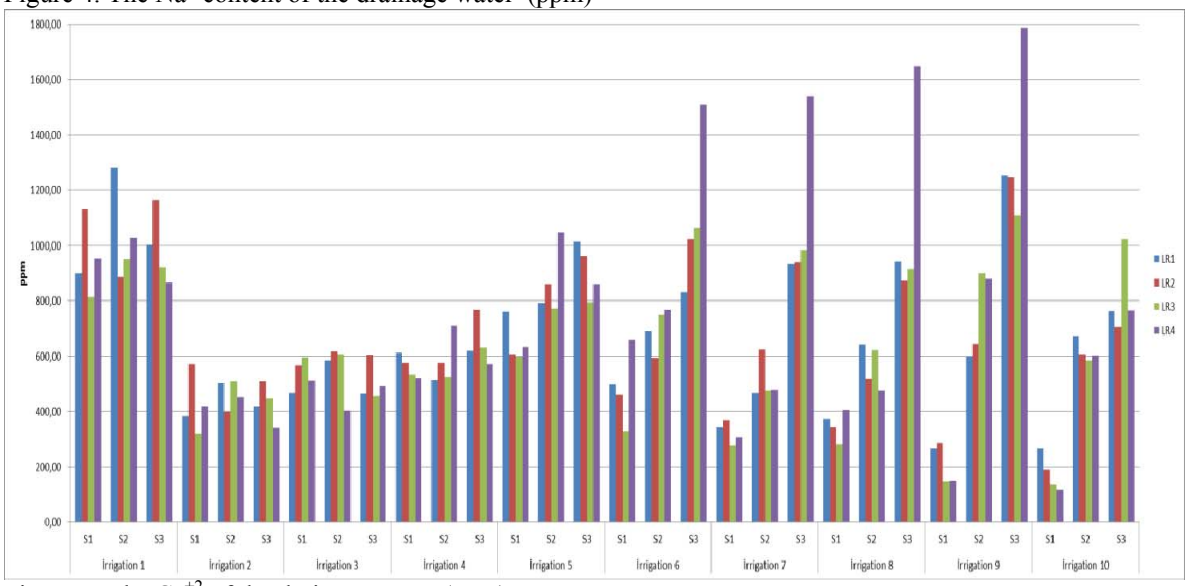


Figure 5. The Ca^{+2} of the drainage water (ppm)

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Numerical investigation on the gully erosion and sediment yield of the Khiyav Chay watershed in Meshkin shar: using GIS (Ardabel-Iran)

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Abstract

The Khiyav Chay river watershed with an area of 338/945 km^2, 410 mm annually precipitation and with average gradient of %17/3792 is located on the north east of the Meshkin city. According to the high gradient slops active tectonic, impacts and thunder storms rainfalls, has important role in fertilizer soil erosion. The average rainfall and altitude of basin respectively is 410 mm and 2375m, and due to the many interrelated factors, high soil erosion occurred. According to the E.P.M model the amount of sediment yield in the basin evaluated 234241.43 $m^3.km^2.y$. The amount of erosion in per ha of basin is estimated 769.85 m3.km2.y.So the intensive of erosion due to E.P.M model Z=0.43 evaluated and indicated this basin are located in the three class erosion.

Keywords: Gully erosion, Khiyav Chay watershed, E.P.M model**,** sediment yield

Introduction

The soil is the fundamental of world growthing resource and basic recourse for underpinning all terrestrial ecosystems (Nyle & et al .2000).Also soil erosion caused to filling dam reservoir and hydraulic channels and loosing topsoil with organic materials,(Kummu et al (2010). Gully is the depth channel with unstable walls development form of rill erosion by runoff concentration under effect of various factors on slopes, plains, valleys banks and cutting slopes (katibi.2000-Tolfflemire,& Mersey, 2005-Abedini, 2005, 2006,2008 and 2011).As the topmost layers soil ,rich in organic matter and nutrients, are removed, the long term productivity of the land is degraded(Tofflemir & Mrrsey 2005).Therefore conservation and protecting of soil formation is very necessary. Review and analysis of published investigated resource until today in the study.

Methods and materials

In order to studding and soil wasting by gully erosion via Khiyav Chay watershed and sediment yield, we obtained used from geology and 1:100000, Topographic 1:50000, aerial photos 1:55000, 1:20000 and some field work. For determining and analysizing potential of basin to gully genesis and some proprieties of soil formation investigated. We utilized from data average of climatic and laboratory experiment of sampling soil from basin. Also some parameters of gullies such as, Length, Slope%, wide, depth morphomerty work have been figure out. Then several equations and formula we applied for calculating and analysis the rate of sedimentary yield. Ultimately the distribution of gully map in the study watershed drowned.

Lithology and hydrology of watershed.

Geology study In the watershed indicated lithologicalyy outcrops from Eocene to quaternary. The structure of watershed mountains includes, Andesite, ,proclastic, lahars and tuff formations. But in the plain of study area alluvial, morns, and quaternary deposition and sedimentary formation such as clay, silt, sand and conglomerate are dominated,(fig 1).

Due to the weathering under relative humid climate and phenomena of melt and thawing (gelifractain) the out crop resistant formation distracted and converted to soil formation. According high gradient of watershed, active tectonic, impact and thunder storm rain fall occurrence soil erosion ratio by rill and gully is high. As you con see in the lithology map in the (fig 1).There are many Cully in the unresistant formation especially in the pediment and plain area due to decries of slope and deposited of alluviums. Derange density in unresistant soil formation are very prone for gullyfication so derange stream (order 1) almost formed in the lithologicaly unresistant soil formation.

Nivation and piping

Usually on the Khiyav Chay watershed 6 to 7 months in any year snowfall occurred. Hence process of thaw and freezing caused destruction of rock formation. Therefore by thaw and freezing process accumulated snow, and water yield, unresistant fine soil materials in the channel bed and walls transported to the downward of slopes. By sequences of this phenomena some runoff streams, tectonic fractures or cracks and etc..., enlarged and expanded width gully with rounded walls form due to nevation phenomena in cool months by thaw. In the sleepiness' slopes genesis of developing rill erosion in the soil formation led to badland forming and in low gradient surface gully (Ahmadi, 1998, 221).In the study area extensive of marl, Alluvial, colluviums and regolithes with composed rock fragments, gravel, sand, loamy clay, silt clay and silt prepared potentially for soil formation erosion by genesis under grand small channel or piping. Piping is involved in channel enlarging through roof collapse, gully development and mass movements particularly in semi-arid areas (Holden & Jones, 2005).In deed, the water of rainfall or melting snow penetrated in unresistant superficial soil formation then moved solved and suspend materials toward the slope by creating pipe or small hidden.

Morphometeri of gullies

To numerical analysis we have done morphometric work in the some parameter of gullies. So statically analysis determined correlation coefficient between study variables (as you see in the Table 1 and Figs (1, 2 and 3). After doing morphometry and fieldwork, according to length parameter (Ahmadi, 1998:263), the gullies of Khiyav Chay classified of study watershed.

Table 1. Morphometric some parameter of gullies

Classification of gully due to length	Topographic unit	Average deep(m)	Average width(m)	lengths	Gradient%	Average height	Slope number
small	mountain	4/30	3/5	110	24	4000	1
small	mountain	1/70	2/5	85	20	1800	2
small	mountain	3	6	85	18	2400	3
medium	mountain	2/60	2/5	160	20	3500	4
large	Plain area	2/30	7/5	320	7	1980	5
small	mountain	1	1	60	25	2300	6
small	mountain	./85	1/80	75	17	2200	7
medium	mountain	1/40	2/5	130	18	1880	8
large	Plain area	2/20	4./5	240	8	2000	9
medium	Plain area	2/5	3	200	12	2400	10
large	Plain area	3/2	4/80	280	10	2360	11
small	mountain	2	1/5	70	20	3100	12
small	mountain	1/5	1/70	88	18	1900	13
small	Plain area	2/6	2/5	105	10	3000	14
small	mountain	1	1	45	20	1850	15
medium	mountain	2/40	3	150	25	2000	16
small	mountain	1/80	2/5	65	16	4500	17
small	Plain area	2/30	2/5	50	9	1750	18
small	Plain area	4/5	2/5	100	28	4200	19
small	mountain	3	2/5	45	23	3400	20

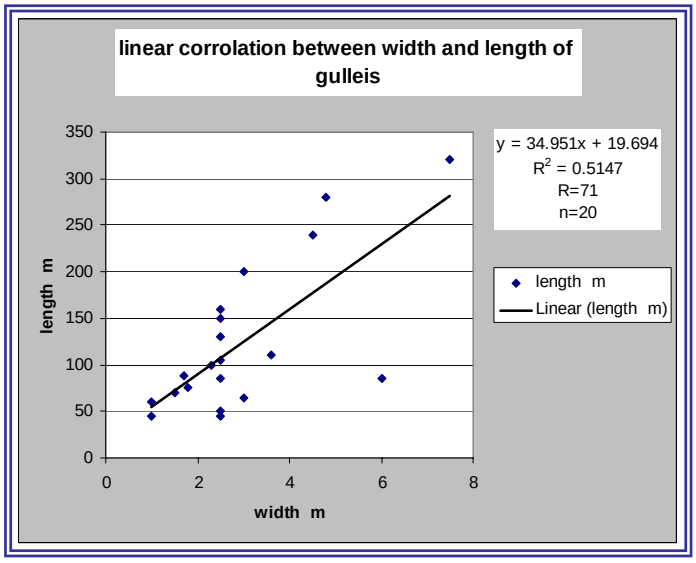


Fig 1. shows linear correlation between width and length of gullies

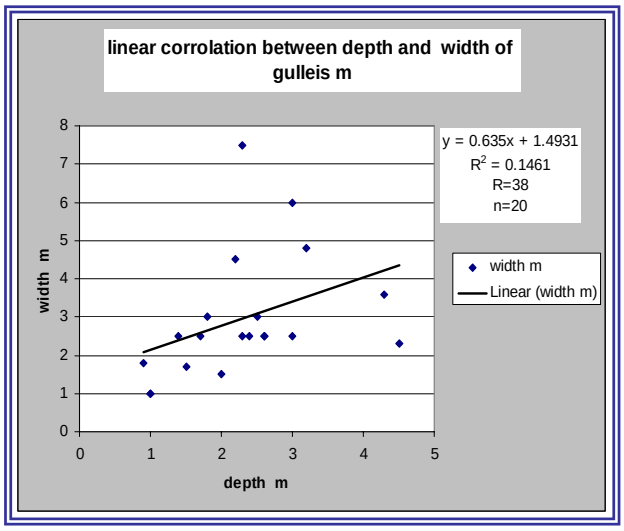


Fig 2. shows linear correlation between gradient and length of gullies

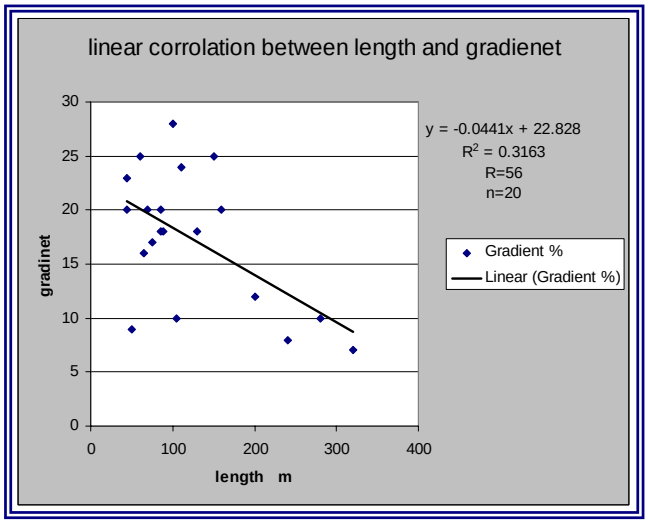


Fig 3. shows linear correlation between width and depth of gullies

In the study area 6 to 7 month's in any year snowfall occurred. Therefore process of Gelifraction (thaw and freezing) caused destruction of rock formation. Mostly heavy snow accumulated in the some stream channel, tectonic fault cracks. So by thaw and freezing process accumulated snow, and water yield, unresistant fine soil materials in the channel bed and walls transported to the downward of slopes. By sequences of this phenomena some runoff streams, tectonic fractures or cracks and etc..., enlarged and expanded width gully with rounded walls form due to nivation phenomena in cool months by thaw. To the study watershed the amount of sediment yielded (235.8 ton/ha/y), at the per km^2. Also the ratio of total annually sediment yields for this watershed given up about 555309 ton/per ha/year. Therefore according to the E.P.M model the amount of sediment yield in the basin evaluated 234241.43 $m^3.km^2.y$. The amount of erosion in per ha of basin is estimated 769.85 m3.km2.y.So the intensive of erosion due to E.P.M model Z=0.43 evaluated and indicated this basin are located in the three class erosion high soil erosion via gully caused almost top layer with organic maters and fertilizer soil wasting in the study watershed. Gully erosion creates deep channels that cannot be erased by cultivation. Although gully erosion looks more catastrophic for more total soil is lost by the less obvious sheet and rill erosion (Nyle &ray, 2000:482). Due to statistical results of calculated data from (table 1), there are positive relationship with %71corroletion and with discernment coefficient 0.55 between the length and width of gullies. This subject indicated the role of topography factor in increasing gradient gully bed and extensive soil losing. Also there is significant relationship with %56corroletion and %32discrimination coefficient in confident level of %95 diagram (2) between depths and width of gullies. It is mean's illustrated increasing gradient rate of gully bed average depths of gully obviously reduced. There are positive relationship with %71corroletion and with discernment coefficient 0.55 between the length and gradient of gullies. In other word with increasing the slope heights (increasing gradient %) decrease of soil diameter and length of gullies in the study watershed. Due to the morphometric result (table 1), from viewpoint of length, depth and density on Plaines in contrast with mountain area, consequence of soil loosing by runoff is very high. Because in plain area mostly composed fine sensitive alluvial deposited. Therefore concentrated rainfall were high and accelerated linear runoff soil formation losing via rill and gully erosion.

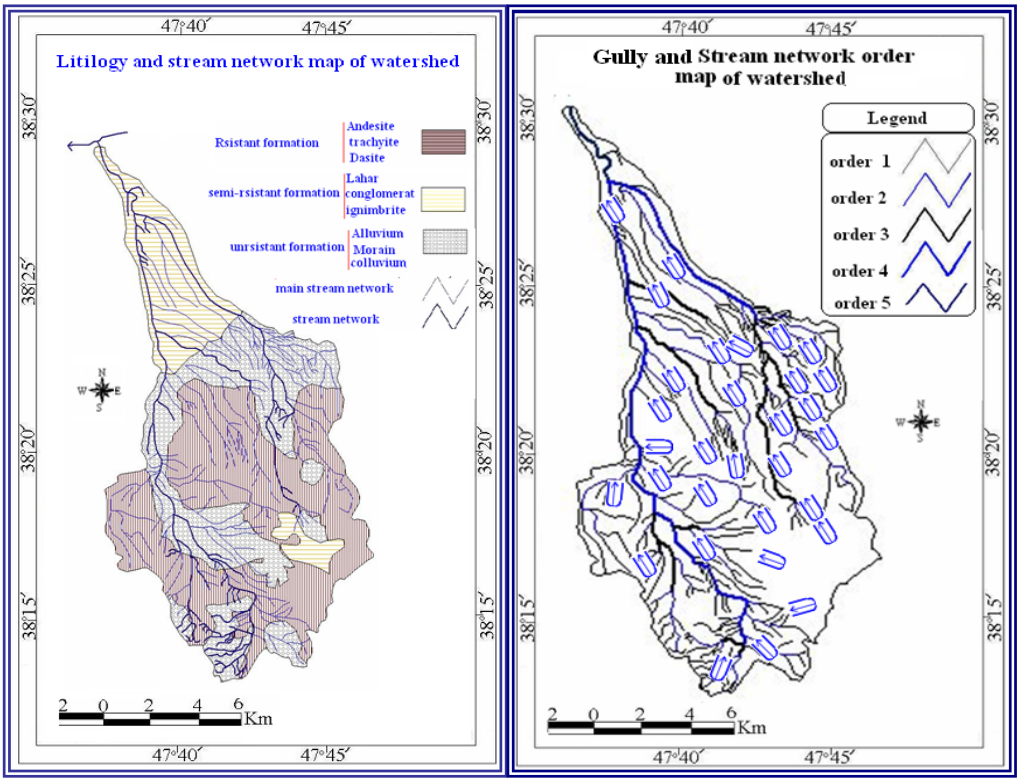


Fig 1: This map shows distribution of gully and stream and Fig 2 this lithology map shows distribution of stream network system on the study watershed

Conclusion

Vast extension of soil formation according to tectonically uplifting (especially in mountain area) created background for genesis typical Gully .In the study area, gully erosion not only caused the soil and green cover destruction, but also created some problems for using agricultural machines. According to the E.P.M model the amount of sediment yield in the basin evaluated 234241.43 $m^3.km^2.y$. The amount of erosion in per ha of basin is estimated 15869.85 $m^3.km^2.y$. So the intensive of erosion due to E.P.M model Z=0.43 evaluated and indicated this basin are located in the three class erosion. The statistical correlation results showed with increase of height of gullies the length of then decreased. Because associated thickens of soil formation in low gradient slopes and plains runoff with linear erosion led to gully forming. Ultimately some suggestion for controlling soil erosion proposed as below:

-Avoiding in over grazing and excessive cultivation and retain remnant vegetation along gullies and areas of recharge.

-Construction of dam gully to controlling flow with due spillway is possible in the study basin.

-According to the climatic condition control and managing any human activities also over grazing and fire so that pasture is not damaged.

-from erosion prone areas using diversion banks to divert water away is a suitable technique in the Khiyav Chay watershed.

-To minimizing the erosion power of water runoff, maintaining tracks and culverts can be better methods.

-To controlling of rain eroding sheet flow, rill and gully geneses establishing and maintain vigorous deep rooted perennial pasture are necessary.

-Controlling and managing for reduce the topsoil erosion via force of water, building gully structures.

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Controlling soil loss using polyvinyl acetate (PVAc) in a highly erodible marl soil in NW Iran

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Abstract
Application of polymers is one of the effective methods in reducing runoff and controlling soil erosion, particularly in soils prone to water erosion. Polyvinyl acetate (PVAc) is one of the polymers which may be properly applied in the soil conservation due to lack of the environmental dangerous. The study was conducted to investigation of the effect of this polymer in reducing runoff and sediment in a susceptible marl soil in 2010. Polyvinyl acetate was applied in soil in five levels consists of zero (control), 50, 100, 150 and 200 kg ha^{-1} at three replications. The PVAc solution was sprayed to soil boxes (0.5m × 1m) placed in 9% slope. The soil boxes were affected by five simulated rainfall events with 40 mm h^{-1} intensity and 30 min duration. Results indicated that the PVAc treatments significantly ($p<0.05$) affected the soil erodibility. With an increasing the PVAc, the soil erodibility remarkably ($p<0.05$) decreased. The soil erodibility in 50 kg ha^{-1} treatment was 38% lower than zero (control) treatment. This treatment was the most effective level of the polymer in controlling soil erosion due to its main role in increasing soil infiltration rate. The soil loss significantly ($p<0.001$) varied among rainfall events. Based on the results, the highest soil loss value (1.863 ton ha^{-1} yr^{-1}) was occurred in the forth rainfall event. In the fifth rainfall event, the soil loss was negligibly decreased rather than the forth event.
Keywords: Polymer, Soil conservation, Rainfall event, Soil erodibility

Introduction
Marl is defined as a soil or rock-like material containing about 35–65% calcareous material as well as varying percentage of clay content (Netterberg, 1982). The formation of marl soils is believed to be the result of the physical and chemical weathering of the parent carbonate rocks (e.g. lime stones, dolomites, carbonate sandstone, etc.) (Aiban et al., 1998). The carbonate material present in the marl tends to be soluble, chemically reactive and easily recrystallizable. The behaviour of marl is complex and its formation defies any satisfactory geologic, chemical or pedological definition (Ahmed, 1996). Consequently, marl generally exhibits a wide variation in terms of its characteristics, engineering properties and definitions (Al-Amoudi et al., 2010).
Since vegetation cover density in the marl soils is mostly low and return plant residues to virgin marl soils is not possible, the use of materials which can stabilize soil surface is the first step in controlling soil erosion in this area. Various soil amendments can be used to reduce soil erosion and improve soil quality. It is believed that the soil amendments can increase soil porosity, increase infiltration (Gal et al., 1992), enhance soil aggregation (Wallace, 1986), decrease plash detachment and enhance aggregate stability (Sutherland and Ziegler,1998), reduce soil sealing, reduce soil crusting, and reduce soil erosion (Gal et al., 1992; Brandsma et al., 2001). Polymers have been known to be effective flocculants when added to soils. For example, acrylate, polyacrylamide (PAM), polysaccharide polymer, polyvinyl alcohol (PVA) and polyvinyl acetate (PVAc) have been commonly used to amend soil properties (Wu et al., 2010). PAM is the most common polymer in improving the physico-chemical properties of soils (Jhurry, 1997).
Polyvinyl acetate (PVAc) is a rubbery synthetic polymer with the formula $(C_4H_6O_2)_n$. It belongs to the polyvinyl esters family with the general formula -[$RCOOCHCH_2$]- (Murray, 1997). PVAc is a water-soluble, biodegradable and non toxic polymer which can be used to soil conservation aims. Efficiency of this polymer in improving soil properties and reducing soil erosion has not been quantitatively investigated. Therefore, the objectives of this study were to determine the effects of different rates of PVAc on soil loss in a high erodible marl soil under a rainfall simulator.

Methods and materials
Experiments were conducted in a marl soil with five polyvinylacetrate levels using a rainfall simulation under laboratory conditions. The soil sampling area was located in Azarpey in the west of the Zanjan province in N.W. Iran. The climate is semi-arid with an average annual precipitation

of 255 mm, concentrated in the spring and winter months, and a mean annual temperature of 20.6 ºC. Soils located in marl formations with a high level of carbonates and low level of organic matter. Soils based on Soil Taxonomy classification system (Soil Survey Staff, 1975) were classified as Typic Calcic Xerepts. Soils were mostly under virgin pasture with a low density of plant covers. Water erosion is a major factor influencing land degradation in this area. This area is the most important region with regarding to sediment production in Sefidroud watershed in northwest of Iran.

Soil samples from 0 to 20 cm depth were collected from a marl virgin soil located between 36° 56′ 21″ latitude and 48° 6′ 27″ longitude in May 2010. Soil samples were sieved from a 2 mm sieve and transported to the laboratory within 15 big bags 65 kg for using in the PVAc experiment. To determine aggregate stability, several soil samples also passed through a 8 mm sieve. To determine some soil physicalochemical properties was used of the samples passed by a 2-mm sieve. The pH and electrical conductivity (EC) of the soils were measured in 1:2.5 soil: water suspension (Nelson, 1982). The total soil organic carbon was measured by the Walkley–Black wet dichromate oxidation method (Nelson and Somers, 1982). Calcium carbonate ($CaCO_3$) content was determined using acid acetic volume consumed to neutralization of carbonates (Goh et al., 1993). Gypsum content was determined using acetone methods (USDA Soil survey Staff, 1972). The moisture content of soil samples at field capacity (-0.033 MPa soil water pressure) was determined with a pressure plate apparatus (Klute, 1990). Hydraulic conductivity of soils was measured by the constant-head method in saturated samples (Klute and Dirksen, 1990). The aggregate stability was determined using the wet-sieving method based on the mean weight diameter (MWD) as proposed by Angers and Mehuys (1993).

Soil samples were packed over a 3 cm thick layer of sand placed on the bottom of the 50 × 100 × 15 cm sized experimental flumes with a bed drainage system. Soil surface in experiment flume was smoothed. Polyvinylacetate (PVAc) solution was sprayed on soil surface three times with 1-day interval. Before polymer treatment, soils wetted till 15% FC to make suitable condition to affect the polymer. PVAc was applied to the soil surfaces at concentrations of 0, 50, 100, 150 and 200 kg ha^{-1} as a completely randomized design with three replications. The experiment flume was sloped at a rate of 9% and placed under the rainfall simulator from a nozzle type with a rainfall surface of 100 × 120 cm. A collector container was placed under the outlet of the experimental tray for measuring eroded soil particles and runoff water during rainfall applications. The trays were exposed to a simulated rainfall with a 50 mm h^{-1} in intensity for a period of 1 h after the 24 h from PVAc applications. Three replication of each treatment were affected by five simulated rainfall events. Runoff water and sediment in the collecting container was weighed and then was separated using Watman 42 filter paper. A homogeneous sample was taken from the collecting container. Soil loss data were obtained by weighting of soil particles that dried at 105°C in oven. Infiltration rate data was obtained by subtracting the total amount of runoff from the total amount of rain fallen on the soil surface during to 1 h time.

All data were subjected to analysis of variance for each variable using SPSS (Version 18) software. The statistical significance among different application rates of PVAc on soil loss was determined at the 0.05 and 0.01 probability levels using appropriate F-values. The Duncan's test was used for multiple comparisons (Steel and Torrie, 1980).

Results and discussion

Soil analysis (Table 1) showed that the study soils are loamy with a low amount of organic matter a high amount of carbonates (lime). Aggregate stability of the soils was very low likely due to a low amount of organic matter.

Table 1. Some physicochemical properties of the study soil

Soil properties			
Physical properties	Mean	Chemical properies	Mean
Sand (%)	34.9	pH	7.66
Silt (%)	39.7	EC (dS/m)	1.52
Clay (%)	25.4	Organic matter (%)	0.29
Aggregate stability (mm)	1.16	Carbonates/ Lime (%)	51.20
Hydraulic conductivity (m/hr)	22.1	Gypsum (%)	2.01

Results of the effect of the PVAc on some physical soil properties have been shown in Table 2. Application of the polymer to the soil considerably affected water content ($p< 0.05$) and hydraulic conductivity ($p< 0.01$). Soil porosity did not affect by the PVAc applications. The largest improvements of the hydraulic conductivity compared to the control occurred in 50 kg ha^{-1} PVAc treatment.

Table 2. Variance analysis of the effect of the PCA application on some soil properties

Soil properties	df	Mean Sum of Squares	F	Significant level
Water content	4	1.01300	3.67	0.043
porosity	4	0.00018	0.36	0.834
Hydraulic conductivity	4	2.66300	7.83	0.004

Results indicated that both rain water infiltration and soil loss at the boxes significantly ($p< 0.05$) affected by consumed level of the PVAc (Table 2). Treatment of 50 kg ha^{-1} of the PVAc had the highest effect on increasing rainwater infiltration (9.1%) and declining soil loss (16.6%) as compared with the control treatment. Effect of other levels of the PVAc on water infiltration and soil loss was negligible rather then the control treatment.

Table 2. Mean rain water infiltration and soil loss as affected by the PVAc.

PVAc level	Mean rainwater infiltration (mm)	Mean soil loss (kg ha^{-1})
Zero (control)	25.84 ^{bc}	1255.3 ^{a}
50 kg ha^{-1}	28.19 ^{a}	778.9 ^{b}
100 kg ha^{-1}	27.21 ^{ab}	760.0 ^{b}
150 kg ha^{-1}	27.56 ^{ab}	557.3 ^{b}
200 kg ha^{-1}	24.90 ^{c}	620.9 ^{b}

The soil loss significantly ($p<0.001$) varied among rainfall events (Fig. 1). Based on the results, the lowest (0.022 ton ha^{-1} yr^{-1}) and highest soil loss values (1.863 ton ha^{-1} yr^{-1}) were occurred in the first and forth rainfall event. In the fifth rainfall event, the soil loss was negligibly decreased rather than the forth event.

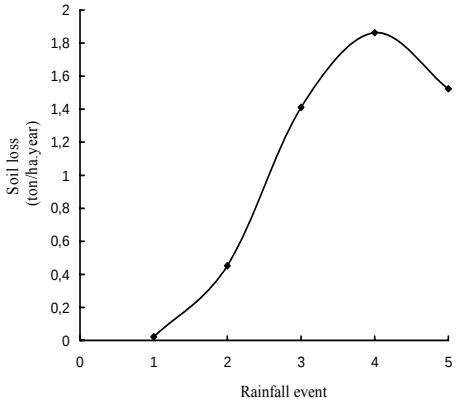


Fig.1 . Temporal variations of soil loss in the marl soil trated with the PVAc at five rainfall events.

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Effect of polyacrylamide (PAM) on physical properties related to germination in an agricultural marl soil in north west of Iran

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Abstract
Polyacrylamide (PAM) can increase cohesion among soil particulates, improve soil microstructure and soil aggregate stability against water, and consequently depress soil sealing formation and soil erosion, and enhance seed germination and plant growth. The study was conducted to investigate of the effect of the PAM on some physical properties and wheat grain germination in a marl soil suceptible to water erosion. The PAM solution was sprayed on soil surface at four levels/treatments (0.00, 33.34, 66.67, 100.00 kg ha^{-1}) with four replications in 16 soil boxes. Wheat grains were planted in 3-cm depth with a spacing 5cm × 5cm in the soil boxes. The boxes were affected by four simulated rainfall events with an intensity of 40 mm h^{-1} and 4-day interval. Aggregates stability, compaction and surface resistance were measure in the boxes soils at germination stage. Results indicated that PAM application significantly improved soil structure ($p<0.001$), so strongly declined soil compaction ($p<0.001$) and soil surface resistance ($p<0.05$). In this reason, wheat grain germination also significantly increased by PAM application ($p< 0.05$). Level of 100 kg ha^{-1} PAM was recognized to be the effective level of the polymer to improve soil physical properties and enhance wheat grain germination in the marl soil.
Keywords: Aggregate stability, Rainfall events, Soil compaction, Surface resistance, Wheat grain

Introduction
Marls are the most sensitive stalented geological formation of erosion and produce large amount of sediments that annihilate fertile soil and deduct the capacity of dams (Ramezanpour et al., 2010). Poor crop emergence is a wide spread problem in structurally unstable soils such as marl soils (Nabi et al., 2001). The instability of soil structure in these soils is a common problem leading to topsoil crustability and erodibility. Farming in these area results to degrade physical soil properties, decline plant growth, and accelerate soil erosion. Soils with low aggregate stability tend to be more susceptible to disruption and so soil sealing and crusting than those with high aggregate stability. Soil structural degradation accelerates the high soil strength, poor infiltration, increased runoff and soil erosion problems (Tisdall and Oades, 1979). Soils with unstable structure are also subject to compaction, degrading soil conditions for optimal crop growth. In thse soils, grain seedling, root development and soil aeration are restricted due to effects of natural factors (rainfall and etc.) or anthropogenic activities (cultivation etc.). Although in most agricultural lands, organic matter can be added to improve soil structure, increase infiltration rate, reduce penetration resistance, and increase water holding capacities, in marl areas, vegetation cover is mostly low and so returning plant residues to soil is very low. Thus, the use of materials which can improve soil physical properties is the first step in enhancing plant growth and controlling water erosion. As reported by some authors, amendments should can reduce soil's high penetration resistances (Busscher et al., 2002) and increase its low water holding capacities because these factors can retard root growth and stress plants (Busscher et al., 2009).
Polyacrylamide (PAM) is a water–soluble and biodegradable polymer which is commonly used as soil conditionr in agriculture (Liang-Hsing et al., 2012). PAM is attracted to the surface of the soil via van der Waals and coulombic forces, where it increases particle adhesion through flocculation (Sojka and Surapaneni, 2000). So, it can improve soil microstructure and the stability of soil aggregates against water force (Zhang, 2006). There are many studies concerning utilization of PAM as a soil conditioner in agriculture. The studies indicated that applying PAM can improve aggregate stability (Asghari et al., 2009), reduce soil surface sealing/crusting (Sojka *et al.*, 2007), increasing soil infiltration rate thus, reducing runoff and soil loss (Ajwa and Trout, 2006), enhance water holding capacity (Uz et al., 2008) and improve seedling emergence rates (Rubio et al. 1989) in the soils. Some studies showed that applying PAM with irrigation water reduce runoff and soil loss (Bjorneberg and Aase, 2000). Although considerable information is available regarding the use of PAM as a particles bonder and anti-erosion soil additive, relatively little has been known about

the effects of PAM treatment on the soil properties related to seedling, particularly in susceptible soil to water erosion. The objectives of this study were to investigate of the effect of the PAM on some physical properties and wheat grain seedling in a suceptible marl soil.

Methods and materials

The study was conducted in a marl soil treated with PAM application in the lab conditions. Soil samples were taken from 0-30 cm depth from Sardehat area (36° 57′ 41″ latitude and 48° 5′ 30″ longitude) in the west of the Zanjan province in northwest of Iran in May 2010. The climate of the study area is semi-arid with an average annual precipitation of 255 mm and a mean annual temperature of 20.6 ºC. Soils have high amount of carbonates and low amount of organic matter and were classified as Typic Calcic Xerepts based on Soil Taxonomy classification system (Soil Survey Staff, 1975). The predominant land-use is weak pasture with some cultivated lands plant covers. Field observation showed that due to instability of the soil structure and low fertility, crop yield particularly in dry years is mostly low and uneconomic. Moreover, agricultural practices accelerate water erosion due decline soil organic matter and disturbance soil structure particularly in sloped lands.

To application of PAM, 16 big bags were filled with about 65 kg soil sieved from a 2 mm and transported to the laboratory. Three representative soil samples (d< 2 mm) with about 3 kg in weight was also used to physicochemical analysis in the lab. Soil properties consist of particle size distribution using hydrometer method (Gee and Bauder, 1986), particle density using pycnometer method (Hao et al., 2006), pH using a glass electrode pH meter (McLean, 1982), electrical conductivity by EC-meter (Nelson, 1982), organic matter using the Walkley–Black wet dichromate oxidation method (Nelson and Somers, 1982), carbonates/lime using acid acetic titration method (Goh et al., 1993), gypsum using acetone methods (USDA Soil survey Staff, 1972), exchangeable sodium percentage (ESP) using the ammonium acetate method (Thomas, 1982), Calcium and Mg were analyzed using atomic absorption spectroscopy, and the soium adsorption ratio (SAR) was accordingly calculated using the square root of the ratio of Na^{+} to Ca^{2+} and Mg^{2+} (Lesch and Suarez, 2009) were determined in three soil samples.

Soil bags were separately spread on 16 plastic sheets as four treatments with four replications. PAM solution was sprayed at four levels (control, 33.33%T 66.66% and 100%) on soil surface at three times with 1-day interval. In 100% PAM as resulted Sojka et al (2006), there was applied 100 kg per hectare PAM. After spraying PAM solution in second stage, about 70% of treated soils were transported to boxes with 30 × 40 cm area and 25 cm depth. A sand layer with a depth of 3 cm was used in the boxes bed as a drainage layer. Soil surface in the boxes was leveled and wheat grains were planted in 3 cm depth. Then residual parts of the treated soils were transported to the boxes. Four soil boxes of each treatment as a completely randomized design were affected by four rainfall events with 4-day interval using a rainfalls simulator (40 mm h^{-1}- intensity and 30 min-duration).

After 15-day from the last rainfall event and finishing emergence, seedling was accounted in each box and accordingly germination/ seedling percentage was computed. In germination stage, some soil properties including bulk density, porosity, compaction and surface resistance were determined in the treated soils. Soil bulk density was determined using core method (Blake and Hartge, 1986). Soil porosity was calculated using particle density and bulk density and accordingly soil compaction was calculated. The aggregate stability was determined using the wet-sieving method based on the mean weight diameter (MWD) as proposed by Angers and Mehuys (1993). The effects of different application levels of PAM on the soil properties and grain germination was analyzed at the 0.05 and 0.01 probability levels using the Duncan's test.

Results and discussion

As shown in Table 1, the study soil was silty clay loam, calcareous (36.2% carbonates/lime) and gypsic (15.2% gypsym) with low amounts of organic matter (0.75%). Due to instability of soil structure (MWD=0.54 mm), soil porosity was relatively low (0.27). Due to having high concentration of soluble salts and a low amount of exchangeable sodium, soil was classified as saline.

Table 1. Physicochemical properties of the marl soil

Physical properties	Mean
Sand (%)	32.0
Silt (%)	40.0
Clay (%)	28.0
Bulk density (gr cm^{-3})	1.07
Particle density (gr cm^{-3})	1.47
pH	7.6
EC (dS/m)	4.0
Organic matter (%)	0.75
Carbonates/ Lime (%)	36.2
Gypsum (%)	15.2
ESP	1.7
SAR $(meq/l)^{0.5}$	0.4

Soil compaction and soil surface resistance significantly affected by PAM application at statistical level of 0.001 and 0.05. Soil compaction and soil surface resistance strongly decreased as PAM amount increased (Fig. 1). The lowest level of the soil compaction (0.29) and soil surface resistance (3.75 kg cm^{-2}) was observed at 100 kg ha^{-1} PAM. Soil compaction and soil surface resistance decline by 33% and 51% compared with control treatment. Treatment 100 kg ha^{-1} PAM was recognized to be the most effective level to decline the soil compaction and soil surface resistance. Contrary to findings of Steinberger and West (1991), the considerable effect of PAM on declining soil compaction was associated with declining soil bulk density and enhancing soil porosity. Steinberger and West (1991) also observed significantly greater penetrometer resistance following the PAM addition.

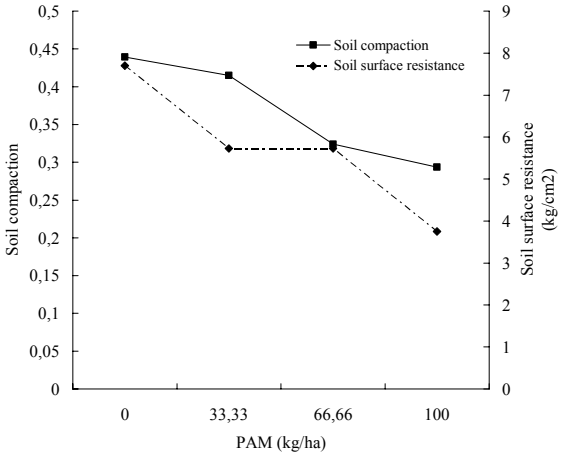


Fig. 1. Effect of PAM application on the compaction and surface resistance in a marl soil.

The effect of PAM on declining soil compaction and soil surface resistance was related to the stability of soil structure. Aggregate stability positively correlated with PAM application ($p< 0.001$). There was significant correlation between both soil compaction and soil surface resistance and aggregate stability with an R^2 of 0.99 and 0.77 (Fig. 2). Sivapalan, (2002) reported that application of synthetic organic polymers, such as polyacrylamides (PAM) to soils prevents degradation in soil hydraulic and physical properties due to improving aggregate stability. Dode et al. (2004) resulted that PAM application to the soil increased the percentage of water stable aggregates, and increased infiltration and soil hydraulic conductivity. Mamedov et al. (2010) showed that adding anionic polyacrylamide (PAM) to soils stabilizes existing aggregates and improves bonding between and aggregation of soil particles.

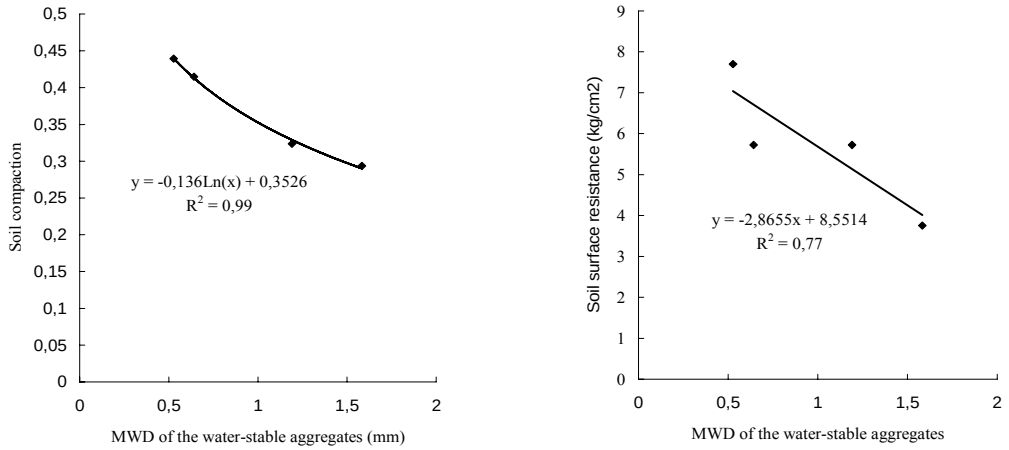


Fig. 2. Correlation between soil compaction and soil surface resistance, and aggregate stability.

Wheat grain germination significantly affected by PAM application ($p< 0.05$). With an increasing in PAM amount, wheat grain germination increased. The highest and lowest germination rates values were observed at 50 kg ha^{-1} PAM (96%) and control treatment (88.2%), respectively (Fig. 3). Application of PAM, as a soil amendment, effectively developed the soil aggregates (Ajwa and Trout, 2006) and reduced soil surface resiostance to rainfall impacts (Levin et al., 1991). The improved germination percentages were attributed to the PAM treatment's ability to reduce the surface crusting of soil after rainfall events (Rubio et al., 1989; Liang-Hsing et al., 2012).

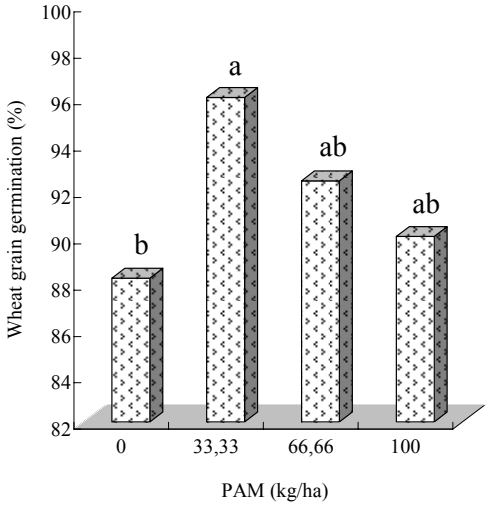


Fig. 3. Effect of PAM application on the wheat grain germination in a marl soil.

As shown in Fig. 4, a significant positive correlations was observed between wheat grain germination and the soil structure stability as affected by PAM ($R^2= 0.97$, $p<0.001$). In fact, application of the PAM developed soil structure and so improved physical properties related to germination e.g. soil compaction and soil surface resistance.

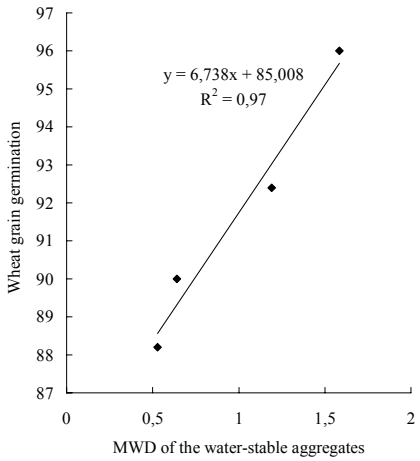


Fig. 4. Correlation between wheat grain germination and the soil structure stability as affected by PAM.

This study indicated that the physical properties of a seedbed had a major influence on the germination of wheat grains in the marl soil. The addition of PAM to the marl soil was a suitable method of overcoming the impacts of instability of soil structure on the soil physical properties related to germination e.g. the soil compaction and surface resistance.

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Rainfall Erosivity Factor (R) Values Determined from Daily Rainfall Data and Its Annual Distribution in Balikesir-Bigadiç Kocadere Creek Watershed

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Abstract

Rainfall and runoff has an important role in the process of soil erosion. It is acknowledge that R factor value (which) is a parameter defined erosivity effect of rainfall and runoff, explain of 80 percent of the variation in soil loss (Wischmeier et al., 1958).

In this study, rainfall erosivity factor values of Balıkesir-Bigadiç Kocadere Watershed and its annual distribution was determined, and R factor map was formed.

Rainfall erosivity factor was calculated for three geographic areas in Kocadere Watershed represented in terms of geological and topographical structure, natural resources and land use pattern. Rainfall which has erosive character (rainfall ≥12,7 mm and maximum 15 minute rainfall intensity >24,0 mm/h) within rainfall occured in 10-year period (1999-2008) was determined from daily rainfall records, and there were on average 15 erosive rainfall events in the watershed. The average annual rainfall in the watershed was 578,7 mm, annual total rainfall ranged from 327,7 mm to 843,5 mm. Average annual R factor calculated from erosive rainfall events was 64,37, and annual peaks ranged from 5,73 to 135,89. According to the average monthly erosivity values of the research area, R factor value in October is the highest (15,34 MJ.cm/ha.h).

Monthly distribution of the rainfall erosivity is needed to determine time-varying cover-management factor (C) and erodibility factor (K) in Revised Universal Soil Loss Equation (RUSLE). With this study, average monthly erosivity index values and erosivity index distribution as percentage of annual values was obtained.

Keywords: rainfall erosivity (R) factor, erosive rainfall, Balıkesir-Bigadiç, Kocadere Creek Watershed, RUSLE

Introduction

Rainfall erosivity (R factor) is one of the main parameters for Universal Soil Loss Equation (USLE) (Wischmeier and Smith, 1978) and its revised version (RUSLE) (Renard et al., 1997) methodologies that most commonly used in estimation of soil loss that may occur in agricultural land or large-scale areas.

R factor value refers to the value of erosion index (EI) for the period of calculation. The annual and monthly value of erosion index are being used as primary guide for desing of soil conservation measures in many countries (Renard et al., 1997; Hu et al., 2000).

Turkey is among the countries highly exposed to soil erosion. About 78.78% of the total area is exposed to moderate, severe and more severe water erosion (Taysun et al., 1995).

Approximately 70 years ago, equation development studies for determination of soil loss was took a new dimention with USLE equation. RUSLE technology has been developed with the revision of the USLE.

Since the publication of Agriculture Handbook No. 537, additional research and experience have resulted in improvements in USLE. The improvement on rainfall factor include new and revised isoerodent maps; a time-varying approach to reflect freeze-thaw conditions (Renard et al., 1997).

Both USLE and RUSLE compute the average annual erosion expected on field slopes as

A= R. K. L. S. C. P (Wischmeier and Smith, 1978)

Where;

A= the rate of soil loss (ton. acre^{-1}. yr^{-1}),
R= rainfall-runoff erosivity factor,
K= soil erodibility factor,
L= slope length factor,
S= slope steepness factor,
C= cover-management factor,
P= support practice factor

The first research project was carried out in natural and artificial rainfall conditions to determined of USLE factors in Turkey conditions in 1965. This was followed by the researches have been conducted in the standart USLE parcels to determine of USLE factors in seven different location (Konya, Tokat, Turkey, Eskisehir, Results, Samsun, Şanlıurfa, Erzurum Province) between the years of 1972-1993 in Turkey. USLE-Soil Loss Equation Guide containing the results of these researches for Turkey was prepared (Oguz et al., 2002).
In the scope of the determination of USLE/RUSLE rainfall factor in conditions of Turkey, average annual erosivity factor values was calculated using 13 yearly (1957-1969) precipitation data of 55 center included Balıkesir Province. The average annual erosivity factor value of Balıkesir Province for the named period has been determined as 45,35. In the same study, the first three month with the highest erosive potential have been June, September and July. Erosion index value for the month of June with the highest value has been 11,07. In this study, In order to determine of erosive rainfall, the criterias which envisaged by Wischmeier and Smith (1958) have been used (Gücer, 1972). In another study, monthly and annual erosion index values have been calculated with 8-32 yearly data taken from 96 different observation stations spanning across the Turkey. In scope of this, erosion index value for Balıkesir Province has been determined as 53,92 (Doğan, 2002).

Materials and Methods

Kocadere Creek Watershed defined as research area is located in Bigadiç District of Balıkesir Province. Kocadere Creek Watershed carried out the research is located in Susurluk Great River Basin. Kocadere Creek Watershed which is a representative water storage basin has 11.366 km^2 areas (Figure 1). As research material, rainfall that recorded during 10 year in three rainfall stations established in three villages within the watershed were evaluated. Rainfall stations were numbered as R1 (Yağcıbedir Village), R2 (Kargın Village) and R3 (Durasılar Village).
The average rainfall of Kocadere Creek Watershed for long year periods (1987-2008) was 567.8 mm, The distrubution of rainfall according to the seasons was 26.2% in autumn, 38.7% in winter, 29.7% in spring and 5.5% in the summer (Acar et al., 2009).

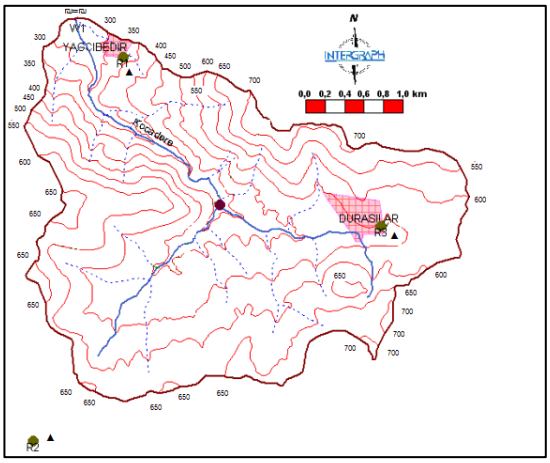


Figure 1 Kocadere Creek Watershed topographical map

R factor value of the research watershed was calculated on the basis of soil conservation planning guidelines of RUSLE for 10-yearly period covering the years of 1999-2008. Individual rainfall which has erosive character (rainfall ≥12,7 mm and maximum 15 minute rainfall intensity >24,0 mm/h) within rainfall occured in 10-year period (1999-2008) was determined from daily precipitation records. This selected rainfall has been evaluated in R factor calculation. Sensitivity of daily rainfall diagram was 10 min and 2.5 mm.
Unit kinetic energy value and the intensity of rainfall were calculated using the following formulas. Erosivity value of the each one individual rainfall was estimated with multiplied of maximum intensity of 30 minutes of precipitation with the obtained energy values. Annual R value was obtained by summing of EI values of erosive rainfall taken into consideration throughout the year (Wischmeier and Smith, 1978).

E=1099 [1-0,72 exp (-1,27 İr)]
E= rainfall energy (MJ cm/ha.h)
İr=rainfall intensity (cm/h)

İr=ΔV_r / Δt_r
ΔV_r= rainfall depth (cm)
Δt_r= rainfall duration (h)

Results and Discussion

Rainfall occuring in a 10 yearly period covering the years of 1999-2008 in Kocadere Creek Watershed was examined, and rainfall which has erosive character was identified. Accordingly, average 15 units erosive rainfall were determined per year in the watershed. In this period, the average number of rainy days has been 94 (Table 1).

The distribution of the average monthly rainfall for 10 year period (1999-2008) and for long years (1987-2008) were given in Figure 2. In both periods, rainfall has been lowest in the summer months and highest in the winter months. In both period, respectively, 3,7% to 5.5% of the total rainfall was recorded in summer months and 40.7% to 38.7% was recorded in winter months. The average rainfall of the research watershed was 578,7 mm for 10 year period (Table 2) and 567,8 mm for long year period.

Table 1. The number of erosive rainfall and rainy days recorded in the Watershed

	Years										10- year max.	Average
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008		
The number of erosive rainfall	21	18	11	17	15	12	11	24	11	15	24	15
The number of rainy days	103	81	85	109	99	90	106	104	74	93	109	94

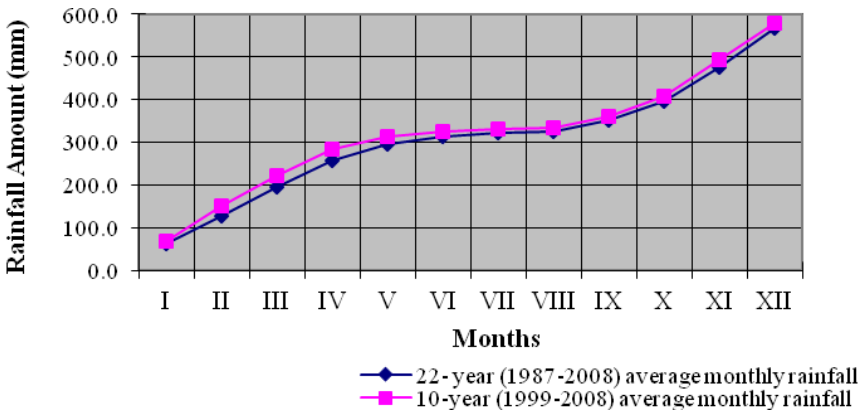


Figure 2. Annual rainfall distribution for long year period and 10-year periods of Kocadere Creek Watershed

According to average values of the watershed for 10-year period, the most rainy year was 1999 with 820,0 mm and the driest year was 2007 with 365,4 mm. Difference in rainfall between the rainy year with the driest year was 454.6 mm (Table 2).

The annual total rainfall, erosive rainfall and rainfall erosivity factor (R) values determined for 3 rainfall stations (R1, R2, R3) in the research watershed are given in Table 2. Average annual rainfall erosivity factor values for the stations of R1, R2 and R3 have been, respectively 66.39; 61.24; 65.49 MJ.cm.ha^{-1}.h.$^{-1}$ The average annual R factor value for the watershed has been 64,37 MJ.cm.ha^{-1}.h.$^{-1}$ Annual peaks in the watershed ranged from 5.73 (R3, the year 2000) to 135.89 (R1, the year 1999). Rainfall erosivity factor map of the watershed was created using R factor values determined for each of the three rainfall stations (Figure 3).

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Table 2. Total annual rainfall, erosive rainfall and rainfall erosivity factor (R) value determined for each three locations in Kocadere Creek Watershed.

Years	Rainfall Stations										
	R1			**R2**			**R3**			**Watershed average**	
	Total rainfall amount (mm)	Erosive rainfall amount (mm)	Rainfall erosivity factor values (MJ.cm.ha^{-1}. h.$^{-1}$)	Total rainfall amount (mm)	Erosive rainfall amount (mm)	Rainfall erosivity factor values (MJ.cm.ha^{-1}. h.$^{-1}$)	Total rainfall amount (mm)	Erosive rainfall amount (mm)	Rainfall erosivity factor values (MJ.cm.ha^{-1}. h.$^{-1}$)	Rainfall amount (mm)	Rainfall erosivity factor values (MJ.cm.ha^{-1}. h.$^{-1}$)
1999	823,1	565,9	206,56	793,4	509,5	172,21	843,5	582,9	172,42	820,0	183,73
2000	509,1	387,3	52,26	491,6	335,0	36,83	549,3	413,2	56,34	516,7	48,48
2001	489,9	250,8	73,49	497,9	245,3	74,52	530,5	281,1	93,54	506,1	80,52
2002	749,6	525,9	89,88	765,4	480,6	73,90	765,9	452,5	69,55	760,3	77,78
2003	611,7	313,3	53,78	630,5	256,3	26,60	635	297,7	44,12	625,7	41,50
2004	482,4	247,8	23,63	550,8	286,8	35,85	596,6	317,6	44,23	543,3	34,57
2005	499,3	240,6	38,96	513,3	246,5	46,78	546,6	297,5	36,21	519,7	40,65
2006	570,1	301,7	24,13	627,7	296,3	20,07	622,4	338,0	46,61	606,7	30,27
2007	327,7	215,9	44,26	410,3	253,9	30,50	358,3	210,8	43,86	365,4	39,54
2008	503,2	297,7	56,90	527,3	337,9	95,14	537,4	304,3	47,99	522,6	66,68
Aver-age	**556,6**	**334,7**	**66,39**	**580,8**	**324,8**	**61,24**	**598,6**	**349,6**	**65,49**	**578,7**	**64,37**

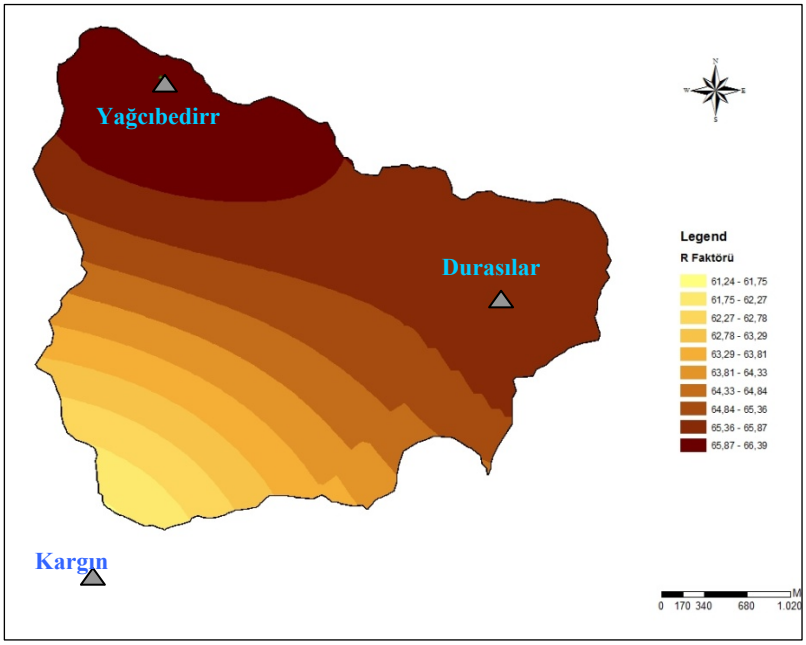


Figure 3. Rainfall erosivity factor map (R factor) of the research area

Monthly distribution of the rainfall erosivity is needed to determine time-varying cover-management factor (C) and erodibility factor (K) in Revised Universal Soil Loss Equation (RUSLE). With this study, average monthly erosivity index values and erosivity index distribution as percentage of annual values were obtained (Renard et al., 1997; Lu and Yu, 2002). In the research, average monthly, half-month erosion index (EI) values and the EI values as a percent of average R value of the watershed were obtained (Table 3). When the Table 3 was examined, the month of October with the average monthly EI value of 14.91 was the highest, and it was followed by the months of November (7.57) and September (7.04). Cumulative annual erosion index distribution curve of the watershed has been created using the values of average monthly EI (Figure 4).

Table 3. Average monthly and half-month erosion index (EI) values of research area

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
Aver. Monthly EI	3,88	4,67	5,39	4,45	5,28	3,98	1,16	0,73	7,04	14,91	7,57	5,30	64,37
%EI	6,03	7,25	8,38	6,92	8,20	6,18	1,80	1,14	10,93	23,17	11,77	8,24	100,00
1st period (half-monthly) EI	2,00	2,14	2,73	2,24	2,71	2,62	0,78	0,24	1,92	7,32	4,69	3,08	32,48
2nd period (half-monthly) EI	1,88	2,52	2,67	2,22	2,57	1,35	0,38	0,50	5,11	7,59	2,89	2,22	31,90
1st period (%EI)	3,11	3,33	4,24	3,48	4,22	4,08	1,21	0,37	2,99	11,37	7,28	4,78	50,45
2nd period (%EI)	2,92	3,92	4,14	3,44	3,99	2,10	0,59	0,77	7,94	11,80	4,48	3,45	49,55

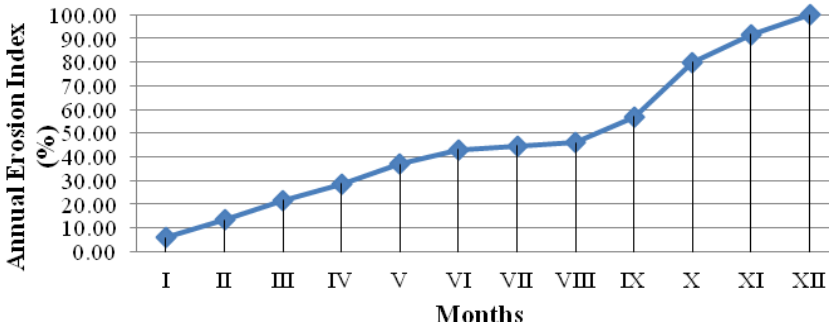


Figure 4. Erosion index distribution curve for the Kocadere Creek watershed

The results of this investigation suggest that the average value of the erosivity factor R=64,37 and average monthly and half-month erosion index (EI) values should be taken in application of USLE/RUSLE in the region.
Future research should be directed to predict of the R factor and its monthly distribution for RUSLE using alternative methods based on daily precipitation.

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Soil Erodibility Evaluation by Splash Cups under the Simulated Rainfalls

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Abstract
Soil erodibility is an important parameter to determine the sensibility of soil to the erosion and there are many methods to specify the erodibility. Until today, many methods were improved and the "Universal Soil Loss Equation (USLE), which has the most common use in worldwide, is one of them. In this prediction technology, the soil susceptibility to the water erosion is represented by a multiplier factor together with those for climate, topography, vegetation and conservation practices. This study aimed to determine a soil erodibility factor by the laboratory simulated rainfall tests under the specified kinetic energy and rainfall intensity values using the splash cups. For test soils, a total of 256 surface samples were taken from the fallow-crop system in the Asartepe Dam Basin and the splash erosion rate was found with the units compatible with the USLE. However, since the USLE predicts soil losses from not only splash erosion but also sheet and rill erosions, the measured splash values should be mathematically related to the erodibility equations commonly employed in the model in order to meet the model requirement.
Key words: Splash erosion, rainfall simulation, energy flow, soil erodibility

Introduction

Until today, some researchers tried to make relations between soil characteristics and physical rainfall parameters to explain the soil erodibility process. Hence, there are many studies about the relationships between soil erodibility and rainfall (Ellison 1947, Young and Wiersma 1973, Morgan 1978, Poesen and Savat 1981, Ghadiri and Payne 1981, 1986, 1988, Poesen and Torri 1988, Sharma and Gupta 1989, Salles and Poesen 2000, Ghadiri 2004). Bubenzer and Jones (1971) studied on the sensibility of soil to the splash erosion under the different rainfall intensities by using different drop size and drop velocity distribution. Kinnell (1973) related soil loss to the rainfall intensity. Park et al., (1983) and McIsaac (1990) calculated the rainfall energy with the rainfall intensity distributions. A study underlying the mathematical correlation between erosion and rainfall physics was done by Meyer (1981). After this, Park et al., (1983) and Gilley and Finkner (1985) showed that physical impact parameters (size, impact frequency and impact velocity) and splash erosion rates of rainfall were closely linked. McIsaac (1990) suggested rainfall intensity (*I*) and kinetic energy (*KE*) equations by using drop size distribution of rainfalls for any area. Especially, Gilley and Finkner (1985) intended to determine functionality of the erodibility equations statistically, defining an erodibility equation by using raindrops at terminal velocity and conclusively proposed a "rainfall detachment factor" under the natural conditions as a function of rainfall intensity. Another group of researchers developed a splash cup method to understand the sensibility of the soil surface to erosion and raindrop erodibility under either natural precipitations or simulated rainfalls. A raindrop threshold energy value for the soil detachment was presented by Sharma and Gupta (1989), and then, an equation for the total rainfall *KE* was developed by Sharma et al., (1993). To explain the raindrop-induced interrill erosion processes, Sharma et al., (1995) used the approach of the USLE. Parallelly, this research made an attempt to obtain the soil erodibility in the units of the USLE by the experimental splash cup technique.

Material and Method

Study area

Asartepe dam basin is located in the catchment-area of the İlhan creek sub-basin in the Sakarya Basin, within the boundaries of the Ayaş district of the Ankara province, approximately 47 km northeast of Ankara in Turkey.

The region has a semi-arid climate with the average annual precipitation of 350 mm and average temperature of the region is 11,9°C and ranges from -20,6 to 42 °C. A wide range of *Entisol* soils represents the study area, which is mostly sandy and shallow.

Study Methods

Soil sampling

Soil samples were taken from an arable land under the fallow-crop system in the Asartepe Dam Basin. The grid-based 231 soil samples by a square-mesh method and 25 soil samples, totally 256 surface soil samples (0-10cm), were sampled systematically and randomly from a plot in the study area, respectively. The sizes of the sampling plot and grid sizes are 50 x 100m 5m x 5m (Figure 1), respectively.

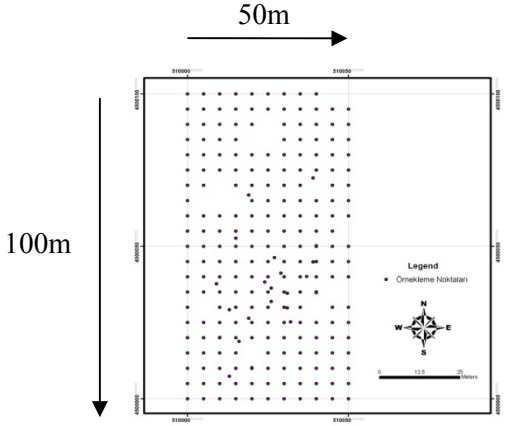


Figure 1. A combined grid-based and random sampling method

Determining rainfall energy and rainfall intensity

Rainfall simulations were carried out in the rainfall Simulation Unit at the Department of Soil Science and Plant Nutrition, Faculty of Agriculture, Ankara University (Erpul and Çanga 2001).
To assess the rainfall energy, mass (m, kg), volume (V, m^3) and surface area (A, m^2) of the drops were calculated by the drop size (d, mm). For this study, these were 5,79 x 10^{-5} kg, 5,79 x 10^{-8} m^3 and 1,809 x 10^{-5} m^2, respectively, with a drop size of 4,8 ± 0,07 mm. The obtained KE for the uniform-sized raindrops falling 3m height was 1.491x10^{-3} kg m^2 s^{-2} or "joule". Also, to determine the total KE flow of the artificial precipitation (E_T, J m^{-2} s^{-1}), rainfall intensity measurements (I, m s^{-1} or m^3 m^{-2} s^{-1}) or the determination of raindrop number (Ξ, # m^{-2} s^{-1}) were implemented in the precipitation basin of the rainfall simulator.
Splash measurements
Soil splash tests by rainfall simulations were carried out with the air dried samples and the determination of moisture analysis were done for each soil sample. Bottom of the splash cups were covered with the porous fabric material for free drainage. Splash cups with the known weights and filled with the air-dried soils (W_{SK+HKT}) were exposed to the simulated rainfalls with the specified rainfall kinetic energy and rainfall intensity for 10 minutes (Figure 2a and 2b). After the rainfall simulations, the soil splash cups were dried in stoves for 24 hours at 120°C ($W_{(SK+WFKT)2}$, gr) and soil losses (W_T, gr) were calculated by Eq. (1):

$$W_T = W_{(SK+FKT)1} - W_{(SK+FKT)2} \quad (1)$$

$W_{(SK+WFKT)1}$ and $W_{(SK+WFKT)2}$ show oven-dry weights with the splash cups, respectively before and after rainfall. Soil loss (D, gr m^{-2} s^{-1}) from a splash cup surface per unit time was calculated by Eq. (2):

$$D = \frac{W_T}{A \cdot T} \quad (2)$$

A and T are splash cup surface area (m^2) and duration of rainfall simulation (s), respectively. In this research, the splash erosion was calculated with the USLE – K unit (Renard et al., 1997) (Eq. (3)):

$$K_s = \frac{D}{ET \cdot I} = \frac{gm^{-2}s^{-1}}{Jm^{-2}s^{-1} \cdot ms^{-1}} = \frac{gm^{-2}}{Jm^{-2} \cdot ms^{-1}} \quad (3)$$

K_s, E_T and I are respectively raindrop splash erosion, rainfall energy and rainfall intensity. Finally, the unit of Eq. [3] was converted into the USLE - K unit ([ton ha^{-1}/(MJ ha^{-1} mm h^{-1})]).

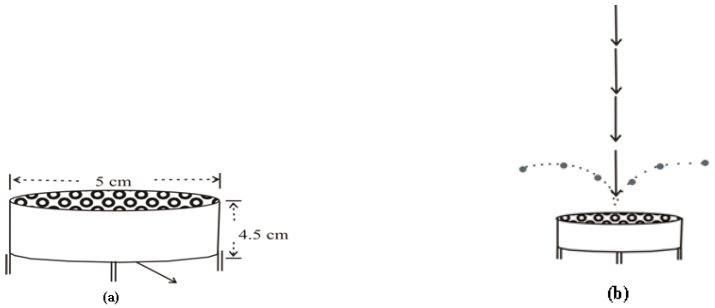


Figure 2. Splash cup and radial soil particle splash movement by vertical drop impact

Physical and chemical soil analyses
Aggregate stability, organic matter (OM), hydraulic conductivity (HC) and particle size distribution (PSD)

Aggregate stability analysis was conducted by the wet sieving method with only one diameter size suggested by Kemper and Rosenau (1986). Soil samples were sieved from the 1 mm diameter sized sieve and the soils which remained on the sieve were used for the analysis. The sieve of 0,5 mm diameter was used for the wet sieving and a stability index was calculated by Eq. (4).

$$AS = \frac{mb}{ma + mb} \quad (4)$$

AS: aggregate stability index; *ma*: the amount of the dispersed soil in water; and *mb*: the amount of the dispersed soil in sodium hexametaphosphate (pH > 7) or NaOH (pH < 7).

Before the rainfall simulations, the soil samples were air-dried without crushing in the laboratory in order to introduce the natural conditions of the soil samples and to be a reference point. Particle size distribution (Bouyoucus 1951) and hydraulic conductivity (Klute et al., 1986) analyses were also performed. Organic material content of the soils was determined according to the revised Walkley - Black method (Walkey and Black 1934, Walkley 1947, Peech et al., 1947, Greweling and Peech 1960, Nelson and Sommers 1982 and Tüzüner 1990).

Statistical methods

Descriptive statistics was obtained using MINITAB 14.0. "*Pearson correlation coefficient*" (Eq. (5)) was calculated with a significance level of "$p < 0,05$" among K_s and research soil properties.

$$\rho = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{(n-1)s_x s_y} \quad (5)$$

$\bar{x}$, average sample for first variable; s_x, standard deviation for first variable; $\bar{y}$, average sample for second variable; s_y, standard deviation for second variable; n, number of sample.

Results and Discussion

The values of the descriptive statistics were given in Table 1.

The descriptive statistics were done for particle size distribution (PSD), hydraulic conductivity (HC), organic material (OM), aggregate stability (AS) and K- value (K_s).

Table 2. "*Pearson correlation coefficients*" between K_s and research soil properties using ***ln-transformed data***

K_s: RUSLE – K factor, AS: aggregate stability, OM: organic material, S: sand, Si: silt, C: clay, HC: hydraulic conductivity, VFS: very fine sand, S-VFS: revised sand, Si+VFS: revised silt, ** p <0,01, *p<0,05

Descriptive statistics	**S**	**Si**	**C**	**HC**	**OM**	**AS**	**K_s**
Ave.	38,7 ± 0,406	29,54 ± 0,318	31,87 ± 0,377	2,706 ± 0,142	0,06± 2,8019	0,44± 0,767	0,0282 ± 0,001
St. deviation	6,429	5,031	5,968	2,277	0,9624	4,88E-02	0,0151
Variance	41,327	25,308	35,615	5,184	0,9263	0,00285	0,0002
Coef. of Variation	16,61	17,03	18,72	84,13	34,35	6.94553	53,45
Min.	27,5	7,4	4,1	0,17	0,72	0,60134	0,01
Max.	96,6	56,5	56,2	13,84	8,04	0,93099	0,141
Skewness	3,17	0,63	-1,33	1,72	1,64	0,58	2,94
Kurtosis	25,32	5,4	6,68	3,46	5,01	0,692	14,82
KS*	0,075	0,064	0,103	0,036	0,065	0,662	0,1
**KS: Kolmogrov-Smirnov*							

Variable	**K_s**	**AS**	**OM**	**S**	**Si**	**C**	**HC**	**VFS**	**S+VFS**	**Si-VFS**
K_s	1									
AS	0,209	1								
OM	0,237	0,009**	1							
S	0,711	0,266	0,946	1						
Si	0,995	0,038*	0,788	0,000**	1					
C	0,934	0,009**	0,552	0,000**	0,000**	1				
HC	0,421	0,792	0,000**	0.000**	0,022*	0,406	1			
VFS	0,088	0,510	0,020*	0,001**	0,007**	0,336	0,186	1		
S+VFS	0,818	0,294	0,672	0,000**	0,000**	0,000**	0,001**	0,625	1	
Si-VFS	0,792	0,024*	0,442	0,000**	0,000**	0,000**	0,026*	0,876	0,000**	1

"*Pearson correlation coefficients*" are shown in Table 2, there were no significant correlations between K_s *– OM,* K_s *- AS* and *OM – AS* with the original data set. However, when the original variable values were *ln*-transformed, better correlations were found (Table 2). The correlations of *OM – AS* ($P \leq 0{,}009$**), *OM – HC* ($P \leq 0{,}000$**) and *OM – VFS* ($P \leq 0{,}020$*) were found statistically significant. Besides, *AS – C* ($P \leq 0{,}009$**), *AS – Si* ($P \leq 0{,}038$*) and *AS – Si-VFS* ($P \leq 0{,}024$*) correlations were significant. Although HC did not show any significant correlation with *C* ($P \leq 0{,}406$) its correlations with S and Si were found significant and the values were $P \leq 0{,}000$** and $P \leq 0{,}022$* respectively. The corrected sand and silt values (S+VFS and Si-VFS, respectively) also indicated statistically significant relations with *HC (*$P \leq 0{,}001$** and $P \leq 0{,}026$*, respectively).

There was no statistically significant correlation between K_s and other soil characteristics with the analysis carried out by both original data set and transformed data set although expected strongly. The reason was attributed to the fact that the soil samples were taken only from the arable land under the fallow-crop system in the Asartepe Dam Basin. Especially, in terms of OM and physical parameters soil sampling may not reveal enough variability, resulting in very confined data. Since OM content is closely associated with the land use type, most probably a satisfying range for statistical analysis to account for the diversity in the soils of the research area could not be obtained in data set. This situation particularly caused an inability to generate a regression model between K_s and the tested soil physical characteristics. Only the correlation between K_s and VFS happened to be significant at the level of ($P \leq 0{,}088$).

Conclusions

The research indicated that the USLE-K factor could be experimentally obtained under the laboratory simulated rainfall conditions by the splash cup technique provided that it could be mathematically related to the erodibility equations, and once this is built with a wide range of data set, it could be more direct and easier method that those using the empirical equations with some independent soil property parameters.

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Investigation of Water Requirement of Wheat on Different Soil Types Using RS and GIS

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Abstract

In water resources and hydrological studies, transpiration from plants and evaporation from the underlying soil is an important factor for estimating irrigation water requirements when planning irrigation systems, especially in arid and semi-arid conditions of South-Eastern Anatolia in Turkey. The aim of the study is to investigate the water requirement for wheat fields cultivated on different soil types by estimating the actual crop evapotranspiration of wheat crop by using Remote Sensing (RS) and Geographical Information System (GIS) techniques. Data used in this study have been obtained from selected real-time monitoring areas for wheat in the area of South-Eastern Anatolia Region. SPOT 5 images acquired on growing season were used to determine the Normalized Difference Vegetation Index (NDVI), Modified Soil Adjusted Vegetation Index (MSAVI) and to generate the crop coefficients for each month of wheat crop season. The results have shown that water demands may vary for cultivated wheat fields on different soil types having different land use capability classes.

Keywords: Crop Coefficient, Evapotranspiration, Spot 5, Ground Stations and Remote Sensing.

Balancing Vermicomposting Benefits with Conservation of Soil and Ecosystems at Risk of Earthworm İnvasions

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Abstract
Vermicomposting has become an alternative to windrow composting of agricultural and municipal wastes. In farming and horticultural systems it serves as a source of nutrients and organic matter. With fertilizers becoming more expensive a cost-effective method of recycling organic materials can help make food systems more sustainable. Yet, there are some environmental risks associated with vermicomposting. The same traits that make worms good composters might make them good invaders. Earthworms, including some composting worms, are exclusively exotic in the formerly glaciated areas of northern North America and some are invasive causing forested land degradation. Regional climate and earthworm life history traits should be taken into account when composting facilities choose a composting worm. We studied the phenology of *A. agrestis*, a potential composting worm, in the field to assess its ability to invade Vermont's forests. Biomass developed as a quadratic function of growing degree days base 5 (GDD_5, r2 = 0.8048, P< 0.001), with biomass increasing to its maximum of 152 g fresh weight/m^2 after 1004 GDD_5, 280 GDD_5 after the first mature worm was collected. *A. agrestis*' maturation time was 88 days, shorter than the frost free period for most of Vermont. Thus, it can persist in Vermont, even though this earthworm is often regarded as subtropical. We found this worm in several forested ecosystems in Vermont where they had caused soil and ecosystem degradation. In severe cases, the A and O horizons were reduced to a 5 cm layer of castings directly above the B horizon. In some ecosystems understory vegetation was entirely absent or dominated by invasive plants.
Keywords: vermicomposting, invasive earthworms, soil degradation, life history traits

Introduction

In the northern tier of the USA and Canada, earthworms are relatively recent additions to the postglacial ecosystems and some taxa are regarded as invasive. Ecosystem-wide changes caused by invasive earthworms are most visible in hardwood forest (Hale et al., 2006, Bohlen and Groffman etc.). Notably, earthworms accelerate decomposition and/or mixing of organic with mineral horizons (Hale et al., 2005a). The loss of the organic horizons in hardwood forests results first in a loss of herbaceous plants that rely on the Oe and Oi horizons as a seed bank and germination medium. This in turn may increase browsing pressure on some woody species (Hale et al., 2006). The overall effect of this soil degradation is a loss in understory biodiversity.

This negative assessment of the effect of earthworms is contrasted by the public's perception that earthworms renew soils, increase soil fertility and aerate soils. The presence of earthworms is also still part of USDA-NRCS soil quality system.

The potential of earthworms to accelerate decomposition has made composting with earthworms, so called vermicomposting, an attractive proposition. Vermicomposting is practiced both industrially and at home and differs from windrow composting in that high temperatures are not reached. It can be argued that vermicomposting is a component of windrow composting as high earthworm densities persist on the periphery of the windrow piles even during the thermophilic phase of composting (Gorres, pers. observation; Gilbert, Highfield Center for Composting, priv. comm.). Depending on the operation, vermicompost is either screened to remove earthworms, which are then sold for home operations, or applied by home owners with the worms present. In either case, there is a chance of earthworm invasions primarily through application of compost containing the worms.

Vermicomposting makes use of earthworm species that have high reproduction rates, consume resources fast and are adaptable to different environmental conditions (Domínguez, 2004). Interestingly, these coincide with some of the characteristics that increase the invasiveness of earthworms (James and Hendrix, 2004).

There are environmental characteristics that limit the ability of earthworms to establish populations in the wild. Some earthworms require calcium for respiration and digestive functions (Piearce, 1972) suggesting that soils with low base saturation have less of a potential to support large

populations of invasive earthworms (Bernhard et al., 2010). Low temperatures may also kill the earthworms (Richardson et al., 2009) and reduce the viability of cocoons, although some species produce cocoons that are cold hardy to – 40 C (Holmstrup and Westh, 1994; Leirikh et al., 2004). The length of the frost free period of a region may limit the ability of populations to persist (Görres and Melnichuk, 2012). Resource availability may further inhibit earthworms. For example, *Amynthas* spp. survived controlled burns but died in the fire's aftermath as a result of low resource available (Blackmon,).

Amynthas agrestis is a epi-endogeic species that lives mainly in the litter layer or close to the soil surface. It is sold for composting in the southern US (US National Park Service, 2012) and is associated with horticulture (Reynolds, R.W. 1978). To our knowledge it is not a common industrial vermicomposting worm in the northeastern USA, but it is found in compost heaps. It has similar effects on forest floor degradation as *Amynthas hawayanis* which is a vermicomposting organism. We were interested in the length of real and phenological time it takes *A. agrestis* from hatching to reaching maturity as this would be one limiting factor for successful colonization of woodlands by vermicomposting worms in cold-winter, short growing season climates.

Materials and Methods

We recorded the phenology of a population of *A. agrestis* at the Horticultural Research Center (HRC) of the University of Vermont In South Burlington, VT, from April 2011 to November 2011. The dominant tree species at our study site was *Acer saccharum* (Sugar Maple) with little understory or *A. saccharum* regeneration. *A. agrestis* may have invaded the site from an adjacent townhouse development which receives horticultural care. The soil was a fine sandy loam (Duane-Deerfield complex). The depth of castings and the A horizon were measured to the nearest 1 cm at three locations where we had found *A. agrestis* in the past. In addition to the South Burlington site, a flood plain in Quechee, VT, and a hill slope in Shelburne, VT, were investigated. In Quechee the soil was a find sandy loam (Rumney series). The canopy was dominated by *A. saccharum* and *Pinus strobus*, the understory by *B. thunbergii*. The Shelburne site had a silt loam soil (Palatine series) and a canopy of *A. saccharum*. There was no understory vegetation.

We sampled the *A. agrestis* population at the HRC on 20 days during the study period. On each sampling day we excavated five randomly distributed 50 X 50 cm quadrats to a depth of 20 cm in increments of 5 cm. Earthworms were extracted by hand sorting. We counted the earthworms, measured their length and classed them into either adult or juvenile by the presence or absence of a clitellum, respectively. Very small specimens found in April and May were incubated at 12°C until they could be identified. Identification of sample specimens was by internal characters after dissection in accordance with a key in Reynolds (1978).

150 specimens were collected from the field to establish an allometric equation that describes fresh biomass as a function of length. Prior to weighing the earthworms were washed and dabbed dry with paper towels. Biomass, B, was measured to the nearest 0.01 g and length, L, to the nearest 0.5 cm. A quadratic was fitted to the data

$$B = 0.00268L^2 + 0.324L + 1.31 \qquad \textbf{(1)}$$

Goodness of fit for this relationship was $r^2 = 0.888$ with a $p < 0.001$.

Soil temperature was logged every half an hour at 5 cm depth using Thermochron iButtons (Embedded Data Systems, Lawrenceburg, KY, USA) with a resolution of 0.5^{o} C. We computed Growing Degree Days (GDD) with base temperature of 5°C using the formula

$$GDD = \sum_i D_t \begin{cases} Dt = 0 \; if \; \frac{Tmax - Tmin}{2} - 5 < 0 \\ Dt = \frac{Tmax - Tmin}{2} - 5 \; if \; \frac{Tmax - Tmin}{2} - 5 \geq 0 \end{cases} \qquad \textbf{(2)}$$

where Tmax and Tmin are the maximum and minimum daily temperatures. The base temperature was chosen because mortality of *A. agrestis* in lab experiments was shown to be 100% at 5°C (Richardson et al., 2009)

Results and Discussion

The soil profiles at all sites differed from the profiles given in the official soil series descriptions. In particular, a substantial layer of casting had formed at all sites. At the HRC and in Shelburne, the Ap horizon deviated greatly from soil survey descriptions of the original soils. In Shelburne the Ap horizon was absent. At the HRC it was almost half the depth recorded by the soil survey. At both the HRC and Shelburne there was no O horizon whereas in Quechee there was a 2 – 3 cm-deep O horizon. The difference might be due to vegetation type. The forest type in Quechee was a mixed deciduous/coniferous forest. At the other two sites the forest was deciduous dominated by *A. saccharum*. Coniferous litter may not be as palatable as deciduous litter (Addison, 2009) and thus some O – horizon material was still present.

Table 1: Castings and A/Ap Horizon depth at three sites with A. agrestis.

	Layer Depth Range and (Median) Depth [cm]		
Location	Castings	A/measured	A/Soil Survey
HRC	2- 5 (4.5)	10 – 15 (12)	22.5
Shelburne	3 – 5 (4.0)	0	25
Quechee	2 – 3 (2.5)	15 – 20 (18)	22.5

The first earthworms and the first juvenile *A. agrestis*, that could be cultured to a size where it could be identified, were collected on April 12, the second sampling day (GDD_5 = 12). This was shortly after soil temperature briefly increased above 10°C (Fig. 1), which may be a potential cue for hatching (Richardson et al., 2009).

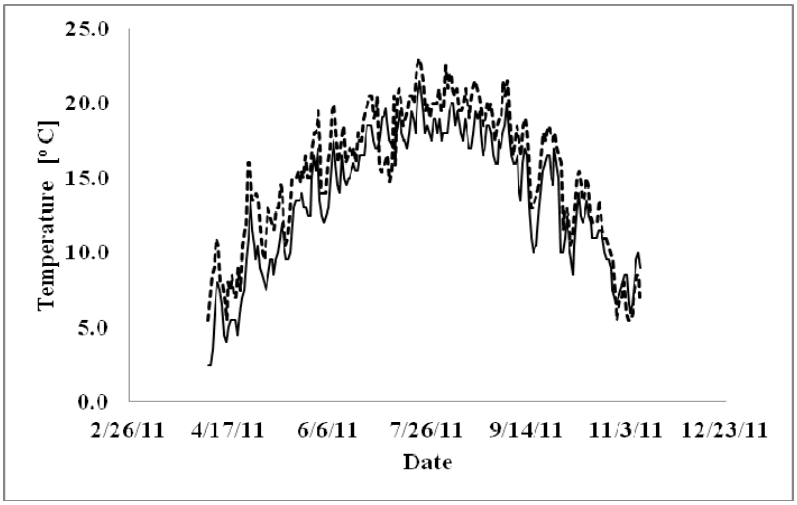


Figure1: Minimum (solid line) and maximum (broken line) temperatures from April 7, 2011 to November 11, 2011

The first adult *A. agrestis* were collected on July 9, 2011, 88 days after the first hatchling (GDD_5 = 724). The first date on which a sample of *A. agrestis* comprised only adults was on October 5, 2011 (GDD_5 = 1816). On the previous sampling date (September 16, 2011, GDD_5 = 1642) the population still had 22% juveniles. These late juveniles might have been hatchlings from previous year's cocoons or they may have been propagules of the adults that matured in early summer. The number of days between first observed adult and last observed juveniles was 59 days, and 79 days between the first observed adult and the time all earthworms in a sample were adults. If one assumes that juveniles on September 16 were part of a second cohort and that some of the adults on October 5, 2011 were second cohort adults, then the development from hatchling to adult is shortened in the summer. Some credence is given to this by that the maturation peiod in phenological time, i.e.

GDD_5, is actually longer for the second cohort (GDD_5 = 1092) than for the second cohort (GDD_5 = 712).

The overall development of clitellated versus unclitellated specimens observed here agrees with Reynolds (1978) who summarizes phenological information for *A. agrestis* for the northeastern USA: adults are found from June to November. However we observed unclitellated worms as early as April whereas Reynolds (1978) cites Gates (1953) who found unclitellated *A. agrestis* only in June.

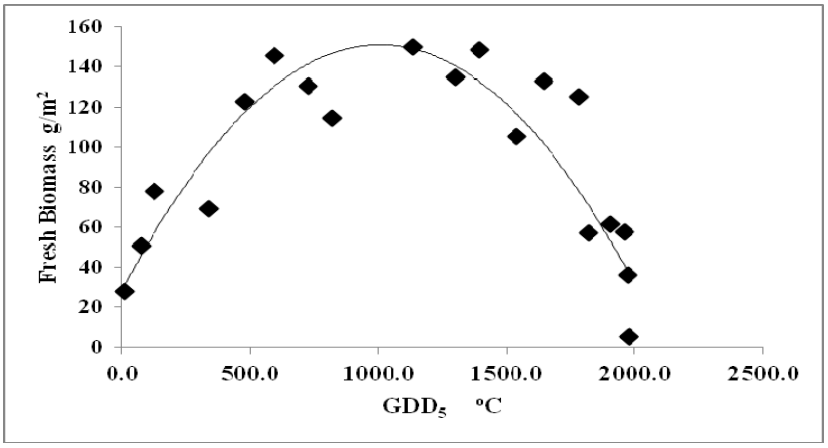


Figure 2: Biomass variation of *Amynthas agrestis* from April 12, 2011 to November 11, 2011 as a function of Growing Degree Days to base 5 °C, GDD_5

Fresh field biomass, B_f, followed a quadratic function of GDD_5 with a maximum of 152 g/m2 on GDD_5 = 1004 ($B_f = -1.215\ 10^{-4}\ GDD_5^2 + 2.45\ 10^{-1}\ GDD_5 + 27.99$, r2 = 0.805, $p<0.001$, Fig. 2). The decline of biomass after GDD_5 = 1004 (estimated occurrence on July 21, 2011) might have been due to both a drought early in the summer (Snyder et al., 2010), cooler temperatures towards autumn, fewer resources and predation. We did not measure the amount of leaf litter left in late summer when the decline began but we noticed that some areas in the forest were devoid of leaf litter at that time. Thus, *A. agrestis* may have limited itself by consuming the available resources. Other earthworms have been reported to consume a year's litter within a season (Hale et al., 2005b). Blackmon (2007) observed that the lack of resources after a prescribed burn increased *A. agrestis* mortality. Fast consumption of fresh litter by *A. agrestis* may account for the absence of other earthworm species at the study site. Lack of other species is not uncommon at sites invaded by *A. agrestis*. For example, Reynolds (1978) reported that at 4 out of 17 field collection sites in Tennessee, *A. agrestis* was the sole species present.

Our data suggests that even in cold climates with a sufficiently long frost free period, *A. agrestis* and presumably other vermicomposting species can persist in forested ecosystems.

There are still many questions related to reconciling vermicomposting and conservation biology. For example, how effective is the selection of compost species based on their intolerance to environmental factors such as frost or low pH? *Eisenia fetida* is a common composting species thought to be of low invasion risk because they are deemed intolerant to frost and the low pH of forest litter (Addison, 2009). Yet, they are found in cold climates such as the Himalayans (Blackmore, 2002), the White Sea Region in northern Russia (Tiunov et al., 2006), or the upper Midwest (Keller et al., 2007). Are there genetic variations in this species that would allow them to persist in colder climates? Could mutations make them more frost tolerant?

Changes in soil structure can occur quickly as a result of invasion by early colonizers such as epigeic species that are generally followed by deeper burrowing species (Hale et al., 2005b). Is persistence of epigeic and epi-endogeic species over multiple years necessary to degrade the forest soil? Or can a voracious, but frost-intolerant, vermicomposting species consume enough of high organic matter to damage a forest floor in a single season or in consecutive years of application? Can such an event bring about a cascade of other deleterious effects?

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Detailed Investigation of Relationships between Aggregate Breakdown Mechanisms and Soil Organic Carbon Contents under Rainfall Simulation Conditions during Certain Time Periods

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Extended Abstract

Soil susceptibility to detachment and transport sub-processes of erosion is generally controlled by aggregate breakdown mechanism. In this study we aimed to investigate to relationships between aggregate disintegration and soil organic carbon content (OC) in laboratory conditions using the soils of three different land uses (agricultural land, grassland and forest), taken from a semi arid catchment, located in Ankara, Turkey. The rainfall simulations were conducted with the slope degrees (9, 15 and 20 per percents) under two rainfall intensities (80 and 120 mm h^{-1}). Splashed and transported sediments were collected every 5 min during 60 min rainfall simulations. Soil aggregate breakdown was evaluated by the mean weight diameter values (MWD, mm) of the collected sediments. The relationships between MWD values and OC contents of soil aggregates obtained from experiments were investigated in Sigma Plot 12 statistic-mathematic computer program. OC was selected as dependents variable (y) and MWD was independent variable (x). For all sub-conditions, performances of all 105 equations were evaluated and the equation shown best fit was selected. It is "$\mathbf{y=a+b[(lnx)/x^2]}$". And then, equations were compared to their slopes with variance analysis technique. Obtained results indicated that interactions between OC and MWD values in some of sub-groups were found statistically significant. These were; splashed sediments of grassland for 9 and 15 per percent slope degrees in 80 mm h-1 rainfall intensity; splashed sediments of agricultural land for 9 per percent slope degree in 120 mm h-1 rainfall intensity; splashed sediments of grassland for 15 per percent slope degree in 80 mm h-1 rainfall intensity; and transported sediments with runoff of agricultural land for 20 per percent slope degree in 120 mm h-1 rainfall intensity; transported sediments with runoff of forest for 15 per percent slope degree in 120 mm h-1 rainfall intensity conditions. Additionally, interactions between slope degrees, rainfall intensities and land uses were found statistically significant for splashed and transported soil aggregates for MWD values and OC contents (**P <0.01). Forest soils mostly differed from other land use types for all conditions opposite of agricultural and grassland usages. This situation can be explained that forest soils having higher soil organic carbon content than those of agricultural land and grassland had more stable soil structure under destructive rainfall conditions (*P < 0.05). The differences in the soil organic carbon content played a very crucial role in protecting the soils of the semi arid ecosystem against the aggregate breakdown by erosion processes.

Key words: aggregate breakdown, soil organic carbon, rainfall simulation, mean weigth diameter (mm)

Effect of Landuse and Slope Steepness on Erosion Risk Level in Cisangkuy Sub Watershed, Pangalengan, Indonesia

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Abstract
The aim of the research was to investigate the effect of landuse and slope steepness on erosion risk level. The research was conducted from June to July 2011 in sub watershed of Cisangkuy, district of Pangalengan, Bandung, Indonesia. The study was carried out using physiographic free survey method, comparative and descriptive, it was a survey based on land physiographic appearance. Soil sampling was carried out into transect on the similarity of slope without calculating the range between points of observation. Soil samples were carried onto three classes of land use such as: forest, plantation and dry cultivation area. Each land use consists of three slope classes such as: 8-15 %, 16-25 %, and 26-40 % class. Three samples of soil were taken from each of them, resulting 27 points of observation. The result of the research showed that type of land use and slope classes gave different effect on erosion risk level. The lowest erosion risk level was found on forest with slope 8-15%.
Keywords: land use, slope, erosion risk.

Introduction
Citarum Hulu watershed as part of the Citarum watershed is included as one of the largest watershed in West Java. It is located in the upper of Citarum watershed which covers Citarum spring water to dam of Saguling with an area of 1771 km2. Citarum Hulu watershed is divided into five sub-watershed such as : Cikapundung, Citarik, Cisarea,Cisangkuy and Ciwidey (Perum Otorita Jatiluhur, 1990). The topography is dominated by mountains along the boundary and plains in the middle of the watershed area .The monthly rainfall average measured in 2001 ranges from 45 to 352 mm with annual rainfall of 2200 mm (Poerbandono et al, 2006).
Citarum Hulu watershed is geomorphologically a basin of Bandung where city of Bandung as the capital of West Java province and other cities exist. Rapid population growth increases the need for land, thus resulting imbalance of land and other natural resources. Over seven years (1994-2001) forest area decreased by almost 60%, whereas the agricultural land area increased by 40%. Decreasing of Forest area, pollution and soil erosion become the core problem in Citarum Hulu watershed
Upper watershed is often become the focus of watershed management planning as important water catchment area (water catchment area). It is also supported by its role associated with middle and lower watershed. Any kind of physical damage in the upper watershed will not only impact on the upper watershed, but ultimately also have an impact on the middle and lower watershed.
There are three main factors causing the degradation of watersheds In Indonesia: (1) the natural state of geomorphology (geology, soils and topography) is prone to erosion, flooding, landslides, and droughts, (2) climate, particularly high amount of rainfall which produce potential power to destruct soil, or causing high erosivity, (3) human activity without the implementing soil and water conservation rules (Hutabarat, 2008).
In the field of soil science, land use and slope steepness are considered as important aspect because the effect on the erosion, soil formation and soil properties (biology, physic and chemistry of soil). Soil properties which are influenced by the slope are the thickness and content of organic matter, the depth of solum, the amount of the water content, the development of acidity, base saturation (Hardjowigeno et al., 2001). Soil properties are influenced by land use are organic carbon, nitrogen, phosphor, cation exchange capacity (Maranon et al., 2002), permeability, porosity, infiltration (Arifin et al., 2003), as well as soil erosion. Slope steepness and slope length are two of the most influential elements of topography on runoff and erosion (Arsyad, 1989).
The strength of a watershed against erosion depends primarily on land cover (Poerbandono et al., 2006). Vegetation above soil surface may improve the ability of soil to absorb and reduce the destructive power of the splash and dispersion effect of the raindrop and runoff carrying

capacity. Dense cover crop not only reduces the runoff velocity, but also inhibit the transport of soil particles (Arsyad, 1989).

Materials and Methods

Location and time of study

The study was conducted from July to September 2011. Area of study was the catchment area of Cinyiruan as a part of Cisangkuy sub watershed, Citarum Hulu, District of Pangalengan, Regency of Bandung , located between 07°07'00" S to 07°18'00" S latitude and 107°30'00 E to 107°38'00" E longitude (Figure 1).

Method

The study was carried out using physiographic free survey method, which is a survey based on land physiographic appearance, and soil sampling was carried out into transect on the similarity of land use without calculating the range between points of observation.

Land unit map was created by analyzing the same geological , soil (order) and climate map, hence resulted the physiographic units, then it was classified by land use and slope. This land unit map will be used as a guide to collect soil sample. The number of soil sample were 27 (figure 1). Those were collected from 3 different land use such as forest, plantation and dry cultivation area and 3 different slope such as 8-15%, 16-25% and 26-40% (Christian and Stewart,1968). Samples were collected to obtain the data of texture, organic matter and permeability. Field observations were carried out to obtain the data of structure and depth of soil (solum). Rainfall data for 10 years (2001-2010) was taken from the Pusat Penelitian dan Pengembangan Sumber Daya Air (PUSSAIR), where the data was recorded in Ciparay and Nanjung climate stations, PLTA Plengan and Saguling.

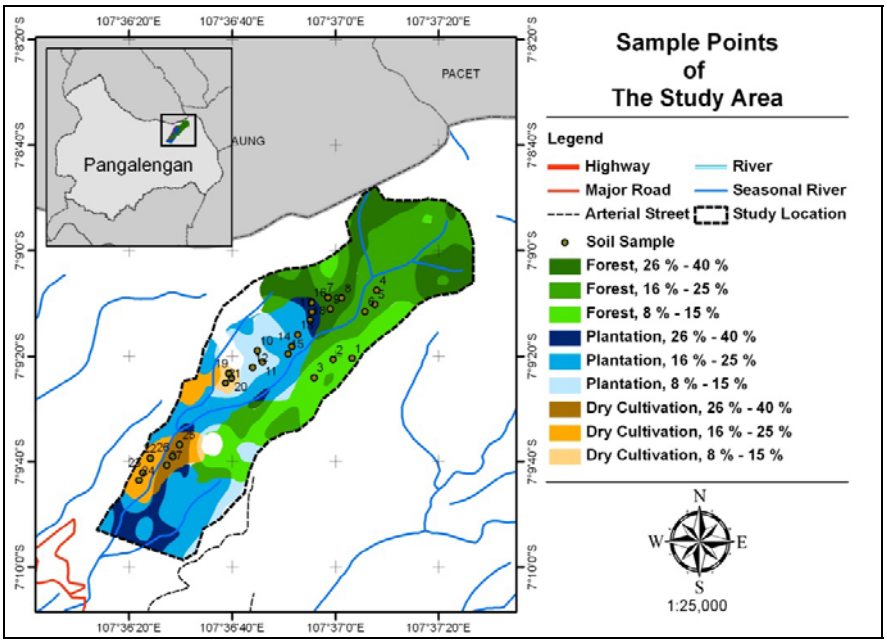


Figure 1. Study area and sample points of the study area

The survey was intended to obtain the data of land use and slope steepness. Land use observations was done based on land use maps. The slope steepness observations were done by using clinometer based on map of slope. Prediction of erosion risk level determined by method in table 1.

Table 1. Method to determine erosion risk level

Depth of	Erosion (A)-ton/ha/year				
Solum	<15	15-60	60-180	180-480	>480
>90	VL	M	M	H	VH
60-90	L	H	H	VH	VH
30-60	M	VH	VH	VH	VH
<30	H	VH	VH	VH	VH

VL = Very low, L = low, M = Moderate, H = High, VH = Very high

Erosion rate was calculated using Universal Soil Loss Equation (USLE) (Weischmeir and Smith, 1978), as follow:

$$A = R \times K \times LS \times C \times P$$

Where A refers to erosion (ton/ha/year), R refers to erosivity factor, K refers to soil erodibility factor, LS refers to slope length and steepness, C refers to land use factor (crop) and P refers to practice management.

Results and Discussion

Climate

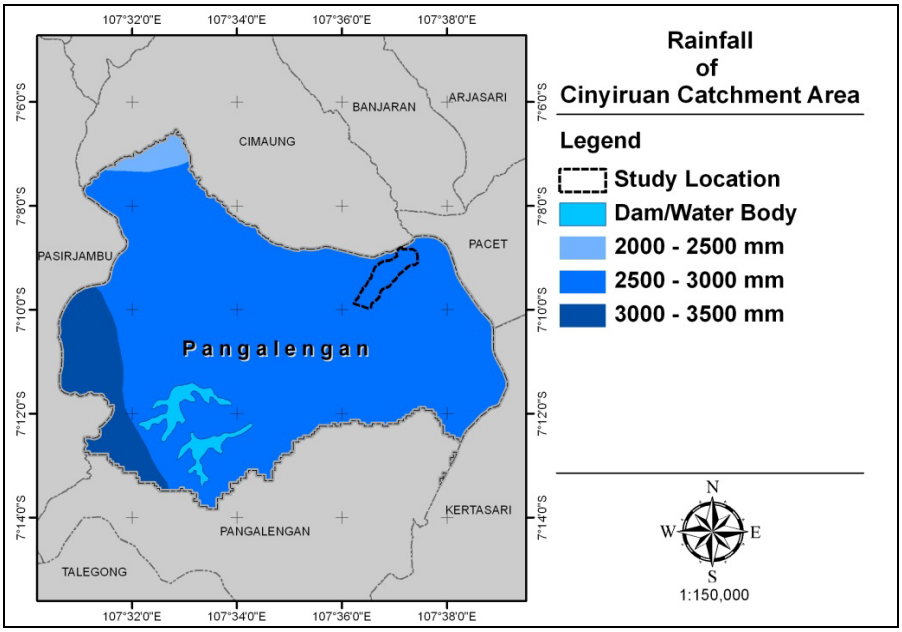


Figure 2. rainfall amount of the study area

Amount of rainfall in the study area was 2500-3000 mm (figure 2). Dry season occurred on July to September with average monthly rainfall of less than 100 mm, and the rainy season occurred on November to April. Average number of dry months of 1.4 while the wet months of 9.8. Based on those data, study area is classified as a type of precipitation that is very wet according to Schmidt-Ferguson classification with Q value of 0.142 or 14.2%.

Soil Type

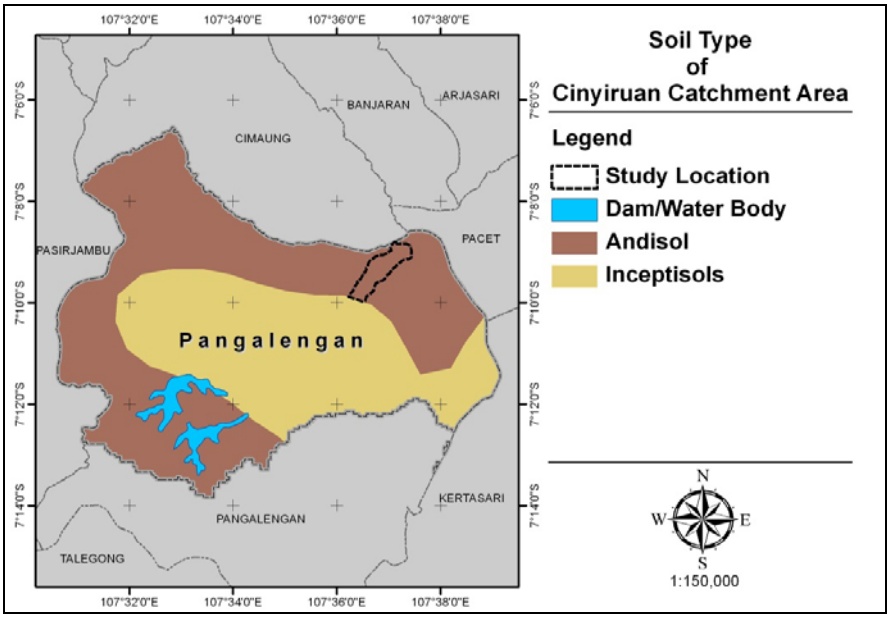


Figure 3. Soil type of the study area

Based on the results of profile description, the study area belong to Andisols because it has mollic epipedon (figure 3). Typic Hapludands are identified as soil subgroup in the study area.

Topography

District of Pangalengan possess flat, undulating, hilly and mountainous for topographical condition.

Land use

Land use of Pangalengan district was dominated by the plantation area of 4249 ha (45%), which is occupied by tea plantation of PTPN VIII, spread from the northern to the southern part of Pangalengan. Primary forest is the second dominant land use of the Pangalengan district with coverage area of 3038 ha (33%). Primary forest is still preserved in the Tilu and Wayang mountains. Dry cultivation area occupies of 2070 ha (22%). Total area of study is 173.26 ha. Forest has 169.5 ha, plantation has 0.22 ha and dry cultivation area has 0.10 ha. The area was planted by onions, potatoes, peanuts, etc.

Effect of land use and slope steepness on erosion risk level

The results of one way parametric test showed that the value of the sig. (p) less than 0.05. It means slope of land use affect the rate of erosion. Because of significancy effect by above test, then it is necessary further to perform the Tukey test to identify significant differences between each independent variable on the rate of erosion.

Table 2. Effect of land use and slope steepness on erosion risk level

Independent Variabel	Solum of soil (cm)	Erosion (ton/ha/year)		Erosion Risk Level
Hutan, 8-15 %	140	2,42	a	Very low
Hutan, 16-25 %	143	7,25	a	VeryLow
Hutan, 26-40 %	154	21,91	a	Moderate
Perkebunan, 8-15 %	120	198,97	b	High
Perkebunan, 16-25 %	141	971,15	cd	Very high
Perkebunan, 26-40 %	115	2392,98	de	Very high
Tegalan, 8-15 %	120	498,04	bc	Very high
Tegalan, 16-25 %	136	1300,22	d	Very high
Tegalan, 26-40 %	120	4549,41	e	Very high

Based on USLE calculation, forest land use possesses erosion risk level rates from very low to moderate (figure 4). This condition is supported by low erosion rate and deep solum. Tukey test results showed that different slope steepness on forest was not significantly affect the erosion rate. This condition is presumable by the existence of forest vegetation which is able to reduce the influence of slope steepness on erosion rate. The lowest erosion is acquired by forest land use with 8-15% of slope steepness. Forest with 8-15% and 16-25% of slope steepness are still in a tolerable erosion condition. It shows us that erosion is not a problem on both locations (table 2).

Plantations and dry cultivation area possess high and very high erosion risk level. From the Tukey test, it is showed that slope steepness 8-15% of plantation is significantly different from 16-25% and 26-40% of plantation, 16-25% and 26-40% of dry cultivation area, but not significantly different from dry cultivation area with slope steepness 8 - 15%. This indicates that the plantation and dry cultivation area were not able to reduce the effect of slope on erosion significantly. On the other hand, slope is highly impact the occurrence of erosion. The highest erosion rate was possessed by dry cultivation area with slope steepness 26-40% and significantly different from the other variables. This is presumable of dry cultivation area has a very high C value. It causes the soil surface will always open from rain attack and it leads to poor soil aggregate stability. Beside that, slope of 26-40% increases the amount of erosion rate, the flow rate and amount of surface runoff.

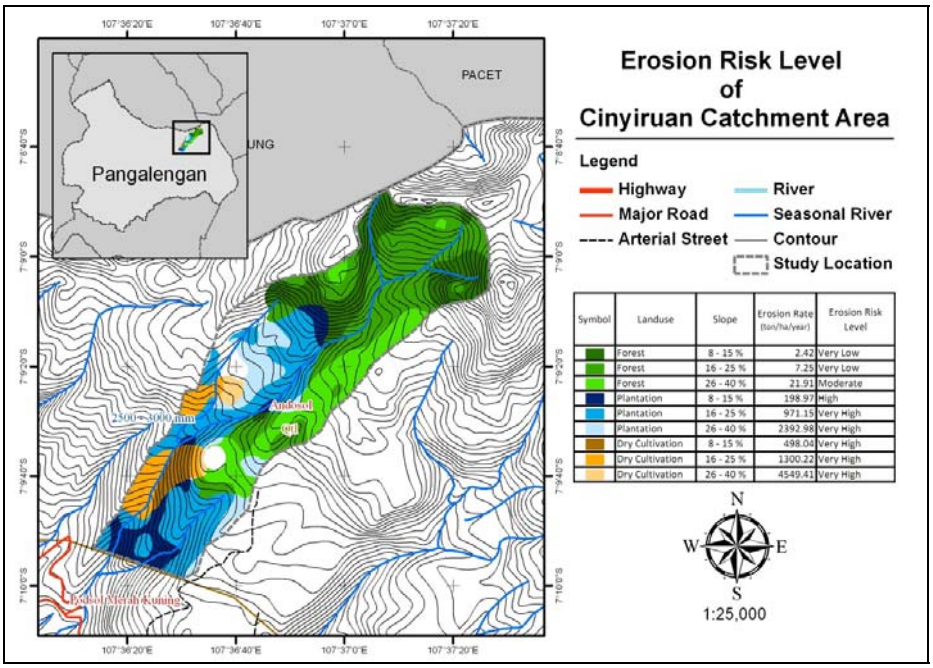


Figure 4. Erosion Risk Level of the study area

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Soil Conservation and Land Use Act, Content, Process of Preparation and Implementation

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Abstract

Topographical structure in Turkey is a rugged, arid, semi arid and semi-humid climate are seen. For this reason, soil and water resources are more sensitive to human activities and natural events. The effects of climate change, loss of biodiversity and desertification may experience the most intensive way. Beginning with the Rio process conducted by the United Nations agreements, related to climate change, biodiversity conservation to combat desertification taking into account, soil conservation and land use act efforts was accelerated. Soil conservation and land use regulated within the different subjects of law. It was not practical. The first time regulatory requirements in integrity discussed in the seventh five-year development plan covering the years 1995-2000.

Act studies were not completed during the seventh plan. It took part in the eighth development plan covering the years 2001-2005. At the end of a long participatory studies the Soil Conservation and Land Use Act came into force in 2005.

Objective of this act is to determine the procedures and principles which will provide planned land use in accordance with the development principle which puts environment on the foreground and takes the protection and improvement of soil through preventing it from losing its necessary features and preventing soil erosion as the basis.

This act covers the procedures and principles concerning the determination and classification of land and soil resources according to a scientific basis; preparation of land use plans; evaluation of social, economic and environmental aspects in the protection and improvement process; prevention of improper usage; definition of responsibilities and authority for establishing methods which will provide protection.

During the preparation and taking the parliamentary agenda of the act, TEMA Foundation made important contributions. At the implementation of act, TEMA Foundation representatives are attending the soil conservation boards which are created at the provincial level. The act has brought important innovations suited to market and nature of the reform, which are different from current soil conservation and land use approach. However, it seems to be difficult to succeed in implementation without a strong public opinion, political and economic support. For success in Turkey, it has still needed more awareness, participation, partnership of public, private and NGO, by taking organizational and fiscal measures.

Introduction

Land degradation based on human activities and natural events have been increased and prevailed all over the world, because of the effect of climate change, desertification and loss of biological diversification which are speeded up by uneven population growth, unsustainable social and economic development, unbalance sharing.

Degraded land is not able to sustain well economic, ecological and social functions. The most important land degradation components are:

Soil degradation: Degraded soil loses some economic, ecological and social functions, goes into a decline in agricultural productive capacity as a result of losing its hydrological, biological, chemical and physical functions. Main soil degradation types are soil erosion, organic matter decline, compaction, salinisation, contamination, sealing and biodiversity decline.

Vegetation degradation: When vegetation has been degraded, the quality and quantity of natural biomass has declined and the vegetative ground cover has decreased.

Water degradation: Water degradation causes a decline in quality and quantity of both surface and underground water resources, and raises soil moisture problems. Soil is the largest water store which can be used by plants. Water and soil degradation can adversely affect each other.

Climate degradation: As a main part of the land, climate has a huge effects on vegetation. A little changes of the climatic condition increases the risk of crop failure.

Sealing: Arable land losses for sealing are urban sprawl (housing, industry, tourism...est.), increased transport, movement of population. Conversion of the high agricultural production potential lands to urban, industrial and infrastructure uses causes many economic, social and ecological problems.

Some land degradation figures with numbers in the world and in Turkey (Million hectares/%)				
Type	World *	%	Turkey**	%
Water erosion	1093,7	55,6	57,15	63
Wind Erosion	548,3	27,9	0,47	0,5
Chemical degradation	239,1	12,2	3.8	4.8
Physical degradation	83,3	4,2	4,8	6,06
Totals	1964,4	100	63,95	74,36 (25% other degradation types excluded, gravelly and sand...est.)
	*:Source: Oldeman et al,1991 **:TOPRAKSU, 1978			

There are many interactions and interdependencies between these components. Unless all those components take in to consideration together, all measures to combat land degradation and promote sustainable land management will not be succeeded.
By keeping in mind all those approaches, new legal regulation had been dealt with.
In Turkey soil conservation and land use measures were being seen in the different regulations which were related to agriculture, forest, environment..est. It was not pratically applicable. For those reasons and after the Rio conference process conducted by the United Nations agreements, related to climate change, biodiversity conservation to combat desertification taking into consideration. Firstly The idea of land use and soil conservation act took part In the Seventh Five Year Development Plan. According to this plan ‘’A land law of framework nature shall be enacted with a view to improving all institutional and legal difficulties like allocation, conservation (against erosion, disaggregation, pollution, aridity), classification, sectoral and inter-sectoral utilization, planning for production and covering all loopholes.’’
Act studies were not completed during the seventh plan. It took part in the Eighth Five Year Development Plan covering the years 2001-2005 as well. According to the eighth plan ‘’A Law on Land Use and Soil Conservation of framework nature shall be enacted with a view to eliminating all the shortcomings like allocation, conservation (against erosion, parcel fragmentation, pollution, salinisation and non-purpose use), classification, sectoral and inter-sectoral use, planning for production and covering all loopholes.’’ At this point TEMA organized many meeting in which many experts took part from different branch of knowledge, engineer, jurist, economist from different related ministries, universities and institutions. At the end of a long participatory studies the Soil Conservation and Land Use Act (SCLUA) came into force in 2005. The new act has brought many new approaches in land use and soil conservation by taking into consideration participation of all related public and private organizations, market orientation and reform nature.

Content of the Act

SCLUA consists of 33 articles of which are 29 main, 3 temporary and 1 additional articles. It has brought forward some newness in soil conservation and land use.
Objective of SCLUA is to determine the procedures and principles which will provide planned land use in accordance with the development principle which puts environment on the foreground and takes the protection and improvement of soil through preventing it from losing its necessary features and preventing, sealing, soil erosion, mismanagement as the basis.
Scope of the act covers the procedures and principles concerning the determination and classification of land and soil resources according to a scientific basis; preparation of land use plans; evaluation of social, economic and environmental aspects in the protection and improvement process; prevention of improper use; definition of responsibilities and authority for establishing methods which will provide protection.
Some terms related to land, soil and their usages, which are known and given different meaning in different regulations, have clarified and defined in the scientific way in SCULA. The procedures and principles for setting up a standard on the determination, classification, study and analysis of soil and land properties; preparation of maps and database and putting them into service are

specified by a regulation which will be prepared by the ministry. It gives responsibility to the ministry for all these studies.

Other important newness in the act is forming a soil conservation committee at the province level, under the presidency of province governor. In these committees, related public, private, universities and NGO's have taken part.

The responsibilities of the Board are:

a) Carrying out examination, evaluation and monitoring for the protection, development and productive use of lands; defining the negative aspects, soil protection and taking measures against the problems related to this and setting up an opinion for the development and implementation of this measures.

b) In order to steer all the enterprises requiring land use, monitoring the implementation of local plans and projects.

c) Setting up an opinion regarding the annual local-scale business programs in line with the oncoming soil protection and use plans and checking the implementation of them and also developing solutions.

d) Checking the harmonization between national, regional or local-scale plans.

e) Accepting the applications related to the matters in this act and convey it to the relevant authorities.

f) Carrying out other responsibilities determined by the act.

The committees have completely been organized local level to work locally and to help central authorities activities on land use and soil conservation.

According to the judgments of the act; soil conservation and protection of land degradations in every enterprise and investment process which requiring land use, prevention of the loss of soil due to natural and artificial effects can be achieved by putting into practice the land use plans, agricultural land use plans and projects and soil protection projects.

Land use plans are the main backbone of the Act. This plan is not a physical planning, but it is a decision based on soil and water potential by participatory approaches. This has been forced the decisions-makers to follow in planning the physical plans. Land use planning adds new directions to the physical planning in environmental sustainability, economic viability, socially acceptability.

Land use planning is defined as an instruments to set land use policies to implement these policies for location of the various land use and for the improvement of the spatial and physical conditions of the rural areas for an optimal use and protection of the natural resources (especially soil and water resources) on the long term while meeting the needs and aspirations of the present generations. In this way defined, the optimal use and protection refer to the environmental sustainability while meeting the needs of present generations refers to the socio-economic sustainability.

Differences of Physical Planning and Land Use Planning are defined by FAO Land and Water Bulletin 2: ''Physical planning is normally carried out by the state, or by local government organizations for the general good of the community. The purpose is to take a more nearly holistic of overall view of the development of an area than can or would be taken by individuals. Physical planning has two main functions: to develop a rational infrastructure, and to restrain the excesses of individuals in the interests of the community as a whole. This latter function usually leads to physical planning being associated with a system of laws and regulation.

Land use planning should be a decision-making process that ''facilitates the allocation of land to the uses that provide the greatest sustainable benefits'' (Agenda 21, paragraph 10.5). It is based on the socio-economic conditions and expected developments of the population in and around a natural land unit. These are matched through a multiple goal analysis and assessment of the intrinsic value of the various environmental and natural resources of the land unite. The result is an indication of a preferred future land use, or combination of uses. Through a negotiation process with all stakeholder, the outcome is decisions on the concrete allocation of land for specific uses (or non-uses) through legal and administrative measure, which will lead eventually to implementation of the plan''

The logic of the SCLUA is also suitable with this approach and mainly based on soil and water potential in quality and quantity aspect.

It is essential to protect soil in its place where it formed, in order that it can maintain its natural functions properly, no meter where it is located, field, grass, pasture, forest, protected area…and so on. One of the aims of SCLUA is that ecological, economics and social functions of soil are kept in balance without damaged.

Chemical, physical and biological degradation of agricultural land is protected by preparation of agricultural land use plans and projects, including erosion control measures, proper irrigation method, proper fertilization, chemical use, crop rotation, plot size and shape ... and so on. These plans are making agricultural systems more sustainable and viable. SCLUA, except for the purpose of use of agricultural land also tied to strict rules and under certain circumstances, conversion of prime farm land to the other uses have been prohibited.

In order to prevent the loss of soil due to the natural events such as, landslide, flood, surface runoff, wind etc, and human activities, soil conservations projects have been made. Soil conservation projects include manufacturing and cultural measures, such as terracing, plant rotation, protection wall, planting, drainage which are essential for the prevention of land degradation and loss of soil.

The plains with high agricultural production potential may come across with soil losses and land deterioration as a result of erosion, pollution, misuses of land and using the land out of purpose, etc. These plains are determined as ‘’Big Plain Protection Area,’’ to take urgent measures and to stop degradations.

Determination and preservation of erosion-susceptible areas are also given priority by the same way to take urgent measures, due to severe soil erosion risks. These areas called as ‘’Erosion-susceptible Area’’. Due to high erosion risks, erosion control measures have to be taken urgently for these areas.

Act brings a new approach on land consolidation practices in line with the market and reform nature, by selling and buying land to make a bigger parcel of land for beneficial agricultural activities. It is completely different from current consolidation practices.

Agricultural areas which are in the private property of Treasury and remain in possession and judgment of government in consolidation field and which may be utilized within consolidation purposes are allotted to Ministry of Agriculture by Ministry of Finance without taking into consideration characteristics and current utilization manner of these areas based on Ministry demand.

The areas which are allotted in the scope of consolidation can be distributed in return for its price to farmers who don’t have any agricultural areas or don’t have enough areas by Ministry in order to establish agricultural enterprises or to develop current enterprises.

Implementation

Creating a work of relevant sub-legislation has been largely completed with the application. Physical protection practices, and planning is underway for the establishment of the technical details and standards. Formation of committees at the provincial level was completed, for the purpose of agricultural land use changes, especially during the physical planning processes, on the boards started to produce decisions, but other physical infrastructure, projects, plans will form the base of soil conservation, water and other studies could not enter in to force, still being undertaken for the completion of some sub-legal regulations and technical standards.

Before SCULA came into force, by-laws to protect agricultural land was made. By-laws are the weaker legal arrangement than physical plans. Because of this, prima farm land was not protected enough. After SCULA entered into force, farm land gained an important legal guarantee to sustain their agricultural production functions. According to the SCULA rules, prime farm land protection activities are going well, with the cooperation between ministry and committees, except for emergency situations and special conditions, do not allow the use of prime agricultural areas to non-agricultural aims.

Land use planning approaches is a new instrument for the planning procedure in Turkey. Excluding some meetings held to assist in decisions, nobody has touched land use planning works which is the most important part of the act up to now as public offices. But TEMA has made some meetings with the related institutions including ministry. Unfortunately an improvement has not been seen yet. When we look at the contents of the act, it is clear that there are more works to be done by public, private, NGO' at the local and central level.

Main difficulties in implementations are lack of public and private organizational structures, and lack of technical and legal experts on soil and water in quality and quantities, as well as planning that mentioned in SCLUA, at the central and local level. TEMA has been making some educational programs for the members whom are the member of soil conservation committees on land use changes from agricultural to nonagricultural use.

Result and Discussion

Although many legal arrangements have made, many problems have been still going on in land use and soil conservation issues in Turkey. When additional organizational and financial measures have been taken at the central and local level, SCLUA applications have produce special key solutions in soil conservation and land use, particularly land use planning activities .

According to the FAO guidelines, at the land use planning, two conditions must be met if planning is to be useful:

- The need for changes in land use, or action to prevent some unwanted change, must be the people involved;
- There must be political will and ability to put the plan into effect.

Where these conditions are not met, and yet problems are pressing, it may be appropriate mount an awareness campaign or set up demonstration areas with the aim of creating the conditions necessary for effective planning.

For success in Turkey, it has still needed more awareness, participation, partnership of public, private, professional organizations and NGO, by taking organizational and fiscal measures and political will. For success in Turkey, it has still needed more awareness, participation, partnership of public, private, professional organizations and NGO, by taking organizational and fiscal measures, strengthening political and public will.

The act on soil conservation and land use, central and local level gives broad legal powers to ministries and committees. However, a very small portion of these powers are used, the preparation of plans on land use is clearly more work to be done.

It is a urgent necessity to speed up SCLUA applications to avoid desertification, climate change and the loss of biodiversity, to ensure economic development. Due to common and strong traditional productions patterns, when the envisage measures of SCLUA are not taken it is not possible to strengthen the agricultural holdings in Turkey as well.

Finally SCLUA has brought significant innovations on prevention of land degradation and soil loss, in addition to strengthen the agriculture holdings structure. However, in practice the institutional and financial problems, the limitations in the other capacity building activities have still remained. Unless these limitations urgently are dealt with by the authorities, the development of the socio-economic and ecological problems will be going on in land degradation.

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Relations Between Erosion and Water and the Case of Eskişehir

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Abstract

Turkey has come to a point that the foreign scientists call it "the museum of erosion". Behind this scary, thought provoking and sad situation lies the negligence of many centuries on the Anatolian ecosystem. More and more every year, the erosion, with all its power and cruelty, continues its destruction particularly to the forests, to meadows used as grazing land and the inclined fields used for agricultural purposes after cultivation.

Keywords: erosion, water, soil conservation

Introduction

Erosion is the abrasion and carryover of the soil by rain water and wind. There are two types of erosion classified in the nature, which are geological and human-*induced accelerated* erosion. Geological erosion, which is also described as normal erosion, is caused by the effect of natural powers, occurs very slowly. Therefore it is a type of erosion that exists as a natural process. There is a balance between the formation or the dissolution and the process of abrasion and carryover and the result of this kind of erosion is not significant. The type of erosion that comes to mind with the word "erosion" and which is more emphasized is the accelerated erosion which occurs as a consequence of negative human interferences and that occurs quickly as can be understood from the name. We can classify the accelerated erosion in two main categories: water erosion and wind erosion.

The relations between the erosion and the water are identified with the amount of rainwater that starts surface flow and the flow rate.

According to the findings obtained in the studies conducted, on a precipitation area, there is a direct proportional relation between the amount of soil carried over and the surface flow and the flow rate. The factors that affect the water erosion are the climatic factors, the features of the soil, the relief features and the biotic factors.

Among the climatic characteristics, especially the average precipitation, the intensity of precipitation, type of precipitation and seasonal distribution of precipitation play important roles on water erosion.

Water erosion affects 82.55% of the overall area in Turkey. When we add into this the areas that are under slight effects of water erosion, this rate is nearly 90%. Every year, a significant amount of forest land is destroyed because of fires, illegal cutting and clearing for agricultural purposes and for urban development. Besides, the intense destruction of meadows continues. The loss of sediment due to water and wind erosion is abnormal huge since there are nearly no precautions taken in agricultural areas in general in Turkey. The loss of sediment increases more and more especially due to the fact that no precautions are taken in the inclined agricultural areas in the drainage *basins*. People who live on the lands that lose productivity, have no other choice than immigrating to cities from their villages and lots of social and economical problems emerge as a

consequence of this. Furthermore, many important and high cost facilities including the dams complete their economical lives much sooner (Taysun and Uysal, 1996; Taysun et al. 1996).

In terms of Land Use Capability the 1st class lands cover 6,4%, the 2nd class lands cover 8,7%, the 3rd class lands cover 9,7% and 4th class lands cover 9,3% of the amount of land in total. For the first four classes which constitute the arable lands, It is obligatory to take the precautions required for each class. The lands that are not arable, which are 5th, 6th and 7th class lands constitute respectively 0,2%, 13,2% and 46,6% of total. The lands which are not arable constitute 60% of total area. The 8th class lands, on which it is not possible to do agricultural activities cover a 5,9% of the total area. When we have a look at the situation of the erosion problem in agricultural areas, erosion is the principle problem for 11.416.396 ha of the arable lands and the lands which have erosion as a secondary problem cover an area of 2.749.471 ha. Of the lands that are not arable, the amount of cultivated land that has erosion as principle problem is 5.009.563 ha and the amount of land that has erosion as a secondary problem is 1.004.487 ha. This situation clearly shows that erosion is the most important problem of cultivated lands. Turkey has a very undulating structure in terms of geography. The lands that are inclined by more than 12% cover 60% of total area of Turkey. This situation reveals how careful we should be in terms of water erosion. Unfortunately, we could almost never be completely successful in application. (Taysun et al., 1995a; Taysun and Uysal, 1996).

In the inclined regions which have a rocky layer beneath the surface of the soil, the farmers have to leave their lands after the top layer is carried over and look for alternative means of livelihood. Also in the case of cultivated areas which have a parent material that is soft underneath, As the fertile soil on the top is carried over with intensive erosion the agricultural activities are done on the infertile layer beneath, therefore the level of production is very low, which results in increasing number of problems for the farmers and worsens their economical situation (Taysun, 1984) .

Material and Method

In this study we have assessed the research conducted and concluded in abolished *Eskişehir Bölge TOPRAK SU Araştırma Enstitüsü* (Eskişehir Regional SOIL AND WATER Research Institute) and reviewed the work done in relation to this subject in general in the country.

Findings- Erosion in the City of Eskişehir

The subject of prevention of erosion in our country was first included in the Forestry Law numbered 3116 enacted in 1937. However no significant work has been done regarding this subject because of the difficult conditions then. The Irrigation and Draining Branch Office that was founded in 1952 as part of the Ministry of Agriculture and the Soil Preservation and Agricultural Irrigation Works founded in 1960 and then the General Directorate which got the name SOIL AND WATER carried out some work on the basis of field and catchment area. This institution was integrated into the General Directorate of Rural Services which was formed with General Directorates of Roads, Water, Electricity and Land Settlement in 1984. The other institutions which are responsible for soil preservation works in our country are General Directorate of Forestry for the higher catchment basins and General Directorate for State Hydraulic Works for the stream beds and dam catchment basins. Both of these directorates have carried out very successful work for erosion control.

The distribution of eight soil groups which were found throughout the city of Eskişehir is as given in the Table 1.

The major soil groups which are under the effect of moderate, severe and very severe levels of erosion are the brown soil, brown forest soil, reddish brown soil, non-calcareous brown soil and non-calcareous brown forest soil.

Table 1: Groups and Rates of Soil in the city of Eskişehir

Alluvial	92501 Ha	6.78%
Colluvial	3624 Ha	0.26%
Hydromorphic alluvial	16856 Ha	1.23%
Brown	611494 Ha	44.80%
Brown Forest	359787 Ha	26.36%
Non-calcareous Brown	173187 Ha	12.70%
Forest		
Reddish Brown	6307 Ha	0.46%
Non-calcareous Brown	19616 Ha	1.43%
Other Lands	79756 Ha	5.82%
Water Areas	2300 Ha	0.17 %
TOTAL	1365248 Ha	100%

The rates of erosion of various levels and the percentages occurring on these soil types are presented in the Table 2.

Table 2: The Severity of Erosion in Eskişehir in Accordance with the Soil Groups

Soil Group	The Soils with Moderate Level Erosion Ha %	The Soils with Severe Level Erosion	The Soils with Very Severe Level Erosion Ha %
Brown Soils (611494 Ha)	203811 33	176895 29	104581 17
Brown Forest Soils (359787 Ha)	34940 10	68961 19	245199 68
Reddish Brown Soils (6307 Ha)	4650 74	907 14	- -
Non-calcareous Brown Soils (19616 Ha)	4440 23	2440 12	12047 64
Forest Soils (173187 Ha)	173187 3	5220 20	34851 76
Total (1170391 Ha)	253061 22	284054 26	494400 29

As can be seen in the table above, the soil erosion in the city of Eskişehir is very intense. Erosion of different levels continue on 88% (1.031.515 ha) of the brown, brown forest, reddish brown, non-calcareous brown and non-calcareous brown forest soil which constitute 86% (1.170.391 ha) of the total surface area of the city of Eskişehir which is 1.365.248 Ha. The area that is under the effect of

various severity levels of erosion that is 1.031.515 Ha constitutes 76% of the surface area of the city of Eskişehir.

There is moderate and severe erosion on 350.936 ha of the total 589.917 ha of land in Eskişehir which is suitable for agriculture with cultivation. This area constitutes 59% of the land for cultivation in the city of Eskişehir. In addition to this, there is moderate, severe and very severe erosion on 682.540 Ha (89%) of 763.373 ha of land which is not suitable for agriculture with cultivation.

Following suggestions were made taking into consideration all the data that were obtained and interpreted as a result of the study conducted in the city of Eskişehir, where the erosion is very severe, in natural precipitation conditions for four years starting from 1973 and named *''Eskişehir Yöresi Kuru Tarım Koşullarında Bazı Tarımsal Uygulamaların Su Erozyonuna Etkileri''* (Effects of Certain Agricultural Practices in Dry Farming Conditions on Water Erosion in Eskişehir Region) (*Tokat Bölge TOPRAKSU Araştırma Enstitüsü Müdürlüğü Yayınları* (Publishing House of Tokat Regional SOIL AND WATER Research Institute), General Publication No:58, Report Series No:36, Tokat- 1983).

- It was established that the mixed grazing crops are the most effective means for the protection of soil and water in the conditions that the study was conducted. Therefore the perennial grazing crops with hairy roots which cover the surface of the soil very well should be included in the crop rotation. This should be practiced constantly in the places which have a higher level of inclination.

- It was seen that in the months of March, April, May and June, during which there is intensive erosive precipitation, much less erosion occurs on the lands under cultivation. The plants which are planted in winter provide coverage on the surface of soil and an important protection due to the root penetration on the top soil until the months of spring. There should be overseeding in winter and pulses as alternative to grains should be included in the current crop rotation.

- The fallowing preparation and plantation should definitely be done in parallel direction to the levelling curves. This condition applies for all kinds of agricultural practices.

- Burning stalks with the purposes of making the cultivation of the soil easy and weed management had many negative consequences in terms of both the humidity location and productivity. It was seen that in certain precipitation conditions and years the parcels that are ploughed and planted parallel to the levelling curve after burning stalk gave worse results than the parcels that are ploughed and planted in the direction of the inclination but the stalk of which was not burned. Due to these reasons, the stalk left after the harvest of grains must definitely not be burned and if possible, the stalks of the grains should be chopped up with additional equipment assembled on harvester-threshers and dispersed across the field, which will provide great benefits in terms of prevention of erosion and soil fertility.

- It was seen that the erosion was accelerated even more on the fields which had been exposed to extremely severe erosion and the top soil of which had been carried over to a significant extent. In such fields, the cultivation of the soil in the direction of inclination has even worse consequences. Therefore in order to enable formation of a good structure in the top soil, to increase fertility and resistance to erosion, such fields should be kept under meadow vegetation

for long years before the field is opened to agriculture with machinery. Or other managerial precautions that are fit for this purpose should be taken.

- If it is possible to find the opportunities to benefit from meteorological data that cover long years, the months and days that have high erosive potential should be followed or if there is a high possibility that the erosive precipitation occurs on the fallow fields during the time that grass grows, the doubling or tripling activities should at least be done after this precipitation. A very heavy precipitation that occurs during the activities such as doubling, tripling or weed management sometimes causes the amount of erosion that might occur in a year. However, if the soil is covered with even a small amount of grass, the harm that erosion gives may decrease to an important extent. It is beneficial to keep a fallow with its weeds on the day or the hour that a downpour is expected and not do the cultivation until the right time after the precipitation. It was established that the resistance of the soil to erosion increases in the fields that are under meadow vegetation and that are rich in organic materials. Farm manure should be used in order to improve the soil structure, to balance the heat, to improve the C/N rate and enrich the soils in terms of organic materials that are known for many benefits.

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A Result-Oriented Approach on Land Use Planning and Conservation of Large Plains in Turkey: Concerns and Solutions Proposed by TEMA Foundation

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Abstract

Conserving the soil as a natural asset becomes more urgent as the increase of food production is getting systematically slower yet the food demand is in constant increase. Together with the problems related to land degradation, high levels of erosion, uncontrolled urbanization and industrialization, the urgency of implementing sustainable, holistic and strict measures for soil conservation through well-planned land use process is obvious. For this, TEMA Foundation suggests basic principles, a well-structured schema and participatory process in order to conduct national, regional and local land use plans that do not allow the usage of agricultural lands for other purposes. Following the definition and envisaged frames in the related legislation, TEMA also puts its focus on the conservation and/or preservation of large plains and proposes a 4-step action plan to bring the issue to the highest decision-makers level, the Council of Ministers.
Keywords: Soil conservation, Large Plains, Land use planning

Introduction

The world seems to be in the edge of repeating global food crisis in relation with the increasing demand from consumers. On the other hand, we know that the average total amount of productive land is not increasing any more: It is actually decreasing[1]. Together with food distribution problems and inequalities on accessing food, we witness a fundamental problem that reflects on global food prices as well: FAO reports an average of 150% increase on real food prices between 2000 and 2011 (2012)

When we consider the strong and fast urbanization in many countries leading to the loss of productive land and other factors causing loss of soil fertility, there is a clear need to emphasize the crucial importance of ecologically-sound land use based on sustainability, food security and soil conservation. This also reveals the need for a paradigm change towards perceiving the soil not as a resource but a natural asset that cannot be "re-created" once it's lost. Such a paradigm change would mean conservation, improvement and finally sustainable use of soil becoming the framework of policies related to land use.

With 34% of its territories defined as "to be used only for agricultural use" (I., II., III., and IV. classes) (Cangir et al., 1996), and 82.17% of its lands considered to be too steep for agriculture (Atalay 2000), Turkey is defined as a country where "utmost care must be shown to protect the agricultural areas" (Koç, 2002). Rapid and uncontrolled urbanization and industrialization "misusing" 600.000 hectares (%10 of productive lands), and high volumes of soil erosion effecting %75 of agriculture lands of Turkey (TEMA, 2012) are the major reasons for the urgency of this need for "utmost care", beside the topographical and climatic characteristics of the country.

This paper thus presents the solutions that Turkish Foundation for Combating Soil Erosion, for Reforestation and the Protection of Natural Habitats (TEMA) proposes in order to develop and implement appropriate policies to ensure conservation and sustainable use of soil assets through land use approaches and specific regulations and action plans regarding the "large plains".

Materials and Methods

[1] Tranquileye.com, based on FAO statistics, reports the loss of 1 hectare of productive land in average every 7.67 second. United Nation Convention to Combat Desertification (UNCCD) also reports 12 million hectares of productive land lost due to desertification (further details available online: http://www.unccd.int/media/pressrel/showpressrel.php?pr=press19_09_11)

This research is mainly based on a systematic analysis of different levels of current legislation in Turkey, together with a critical approach on how the legislation is implemented. It also proposes efficient and holistic approaches to land use planning and large plains' conservation.
The outcomes and outputs of previous workshops, seminars and working group sessions conducted by Scientifics' Committee and specialized advisors of TEMA Foundation are used as main material of the article, together with the official documents, legislation and regulations of Turkish state.
The author benefited of the reports and "lessons learnt" from previous sustainable land use and rural development projects of TEMA Foundation and other actors in Turkey. Meanwhile, share of experiences and written and/or oral reports from the TEMA's delegates in "Provincial Soil Conservation Committees" have been a valid secondary resource.
The research puts the focus first on the notion of land use planning as an approach to conserve soil assets and a share of responsibilities between defined stakeholders. The second half of the work tries to establish the link between the land use planning and conservation of large plains.
The inputs are analyzed with system thinking methods (Meadows, 2008).

Land Use Planning: Why and How?
Two main perspectives can be pointed out for the necessity of land use planning. First, there is a socio-economical need that is multiplied due to the increasing agricultural demand and decreasing total amount of productive lands and soil degradation, as explained above.
Second, the Turkish legislation gives a clear responsibility to the state in Constitution of 1982 (Article 44 and 45) to conserve and improve soil, to take necessary measures for constraining its degradation. This task is further detailed with the Soil Conservation and Land Use Planning Law (No: 5403) which cites "planned use of land" (article n: 1), "planning for soil conservation in land use" (article n: 9), and "rational land use plans for sustainability and stopping soil degradation and environmental impact" (article n: 10). The same law also imposes that "productive lands shall not used for other purposes, while there might be certain exceptions".
TEMA argues for a complete implementation of this law through a holistic planning process with national, regional and local plans based on basic principles taking social, political, economical and ecological dimensions into account. The planning process should also use technical inputs defining the capacity and characteristics of land and soil.
In this frame, the methodology should first focus on completing soil-water capacity analysis through international standards; and then comparative studies must be conducted to compare the lands' sustainable usage capacity with socio-economical needs and dynamics in the local level. Such process gives opportunity to categorize each land according to which extent the productive capacity of the land meets the social-economical demand and needs.
In this process, TEMA puts its basic priorities to take into account as following: Sustainable development with a special focus on environment, pluralism and participatory democracy on decision making processes, taking the national development plans and social-economical dynamics as main inputs. It also has to be underlined that special measures should be taken for wildlife protection areas, wetlands and similar natural preservation areas which have special characteristics of biodiversity.
According to the Soil Conservation and Land Use Planning Law, the State, The Ministry of Food Agriculture and Livestock and provincial governors have shared responsibilities and tasks for implementing the measures for soil conservation and land use planning. One of the used tool in this process is the "Provincial Soil Conservation Committees" that are established in all the 81 provinces of Turkey. These committees have the task to evaluate the demands for permission to use agriculture lands for non-agricultural purposes. TEMA Foundation have its delegates on 61 of these committees and our experiences show that the working methods of these committees depend substantially on the general perspective of high-level bureaucrats in the committees, government's (lack of) support on residential, commercial or industrial projects that are planned on agricultural lands, and especially the provincial governors' attitude and perception of the priority of soil conservation. In this frame, TEMA Foundation underlines the critical importance of standardized, well-managed and participatory work of Soil Conservation Committees in order to ensure the necessary measures envisaged by the mentioned law.

This brings the issue to another and final crucial point related to check and control mechanisms of the implementation of public institutions. In relation with its pluralism and participation principles, TEMA Foundation argues for a high level of and encouraged involvement of the civil society and professional organizations.

Highly Productive and Endangered: Importance of Large Plains

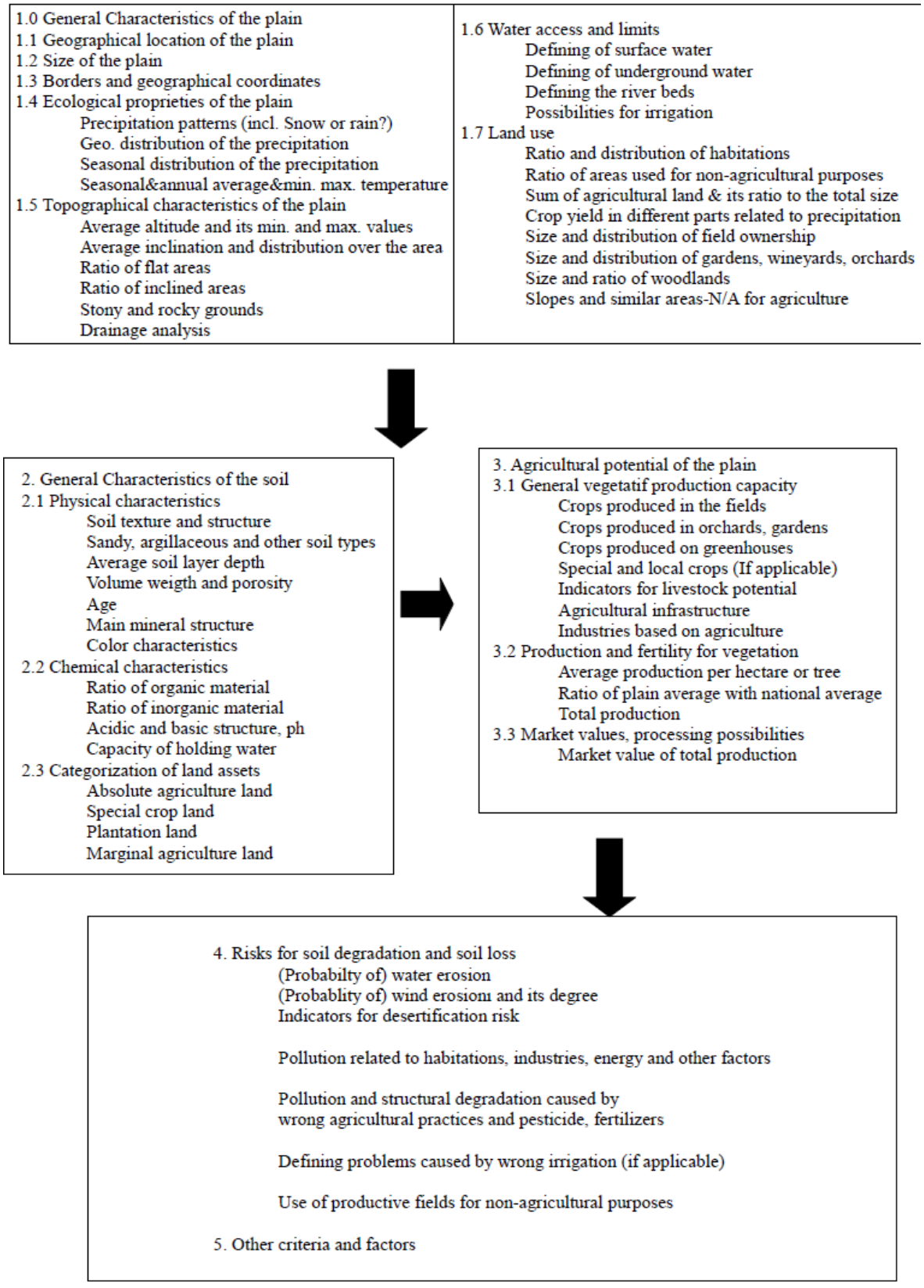
Land use planning gains a particular importance on the conservation and sustainable use of large plains. The definition of these lands have two reference points by law: The article number 14 of the Soil Conservation and Land Use Planning Law (N: 5403) cites "high potential of agricultural production" and the article number 12 of regulation related to this law mentions "plains that are highly endangered and subject to degradation because of reasons such as erosion, misuse, loss of soil fertility and pollution.

Through a holistic approach, these two factors of high production potential and endangered status produce the notion of "agricultural preservation sites" meaning that high level of protective measures should be taken in order to preserve these lands. This is the reason why the articles mentioned above impose that "large plains can be taken under protection by the decision of Council of Ministers."

TEMA Foundation suggests the following methodology for protection of large plains: First step should be to determine the proprieties of the plain such as its geographical location, size and borders, ecological and topographical characteristics, chemical and physical analysis of the soil, its up-to-date usage status and water capacity. This step should be realized by the provincial branches of Food, Agriculture and Livestock Ministry together with local institutions such as research institutes or universities. Civil society and professional organizations that are specialized on the issue can also contribute to this process.

The second step should focus on the determination of productivity for different species, agricultural practices, crop yields, involved stakeholders that are producing yield from the land. This step should also be conducted by the same actors as in the first step.

Table 1: Technical/Step-by-step scheme for defining large plains



The third step has to realize a risk analysis for the concerned plain: The wind and soil erosion, risk assessment for desertification, the soil and water contamination and pollution caused by non-agricultural industries are the major variants that should be taken into account.

The fourth and final step should be the decision making process: For this, the issue should be brought to the agenda of Provincial Soil Conservation Committees which can take an advisory decision in order to bring the question to the Council of Ministers in national level.
In this phase, the political dimension of the issue has a major role: Through the participatory democracy and pluralism principles, local and national campaigns based on a discourse that reveals the importance of soil in general, its relation with an independent and safe future for next generations, lack of fertile soils in the country and the increasing demand for high quality food production.

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TEMA, Turkish Foundation for Combating Soil Erosion, Reforestation and the Protection of Natural Habitats in the soil conservation processes as a CSO

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Abstract

TEMA, Turkish Foundation for Combating Soil Erosion, Reforestation and the Protection of Natural Habitats, a Turkish civil society organization which has been focused on soil phenomenon with its various aspects. There are several agents taking place in soil conservation process such as state units with legislative, executive and judiciary functions; universities with a R&D function and the international agencies and networks the main mission of which is to bring the issue to the international agenda. First section focuses on the state units, how they are organized in soil protection processes and how TEMA influences and contributes to the state units. Second section looks into the CSO-university cooperation and how TEMA contributes to the transfer the scientific knowledge to the field in this respect. The last section focuses on the TEMA's role in the international platforms regarding soil and soil conservation. Finally, the paper here argues that an active CSO, can influence, improve and accelerate the processes through strategic positioning and interaction with each single agent of that specific problematic.
Keywords: civil society organization, participation, desertification, sustainable land use management, soil conservation processes

Introduction

TEMA, Turkish Foundation for Combating Soil Erosion, Reforestation and the Protection of Natural Habitats, a Turkish civil society organization (CSO) which has focused on soil phenomenon with its various aspects. This paper aims to present how a civil society organization can actively take place in and impact soil conservation processes. First section focuses on the state units, how they are organized in soil protection processes and how TEMA interacts with state functions. Second section looks into the function of universities in soil conservation processes and TEMA-university cooperation in this respect. Finally, the last chapter takes up the international agenda regarding soil and soil conservation and TEMA's role and contribution within those platforms.

State agencies and TEMA in soil conservation processes

Turkish state units are composed of independently functioning bodies namely legislation making, execution and judgement bodies. There are over 100 laws and legislations regarding soil and land including incentives, organizational issues and development in Turkey. However, no specific law on soil protection and land improvement was existed until 2000s when TEMA brought up the issue. Soil embodies controversial aspects as being subject to ownership, as an input for production and a natural asset. Referring and considering the fact that the lack of such a juridical arrangement leads the attempts on finding solutions to threats on soil habitats as bootless. TEMA started drafting a law on soil protection and land improvement aiming to achieve planning the conservation of soil and land management in Turkey and in order to cope with the effects of desertification, prevent land degradation and ensure sustainable land management. Together with its volunteers from all parts of the society, TEMA Foundation actively lobbied for the approval of this law by the parliament. These activities include a petition campaign with over 1 million signatories, communication efforts to raise public awareness on the issue through media, seminars, and visits. The draft law passed to the parliament as public bill in 2004 and became a law in July 2005, after discussed in the plenary committee. Considering its controversial form of soil, the process was a challenging one, such as;

- The preparation process of the law started in 1998 and completed in 2000. After the law is written in 2000, face to face contacts started with ministers, parliament members, party leaders. Due to change in the government and coalition works during the period, there couldn't be a compromise on the draft law and these issues obstructed the process.

- Pursuant to articles 13-14 of the "Law on Soil Protection and Land Use", it is imperative to determine the big lowlands and erosion sensitive lands which haven't had a formal base until then.
- There is no umbrella association or governmental corps who is in charge of implementing the law practices. Even if there was a legislative framework, there was no structure that is in charge of execution or control of the laws priorities.
- Reactions against draft law coming from business and industry groups.

The main strategy to achieve to enact the law is the identification of the key partners to the discussions at national level and to involve them in the preparation of the draft law through;

- Workshops in collaboration with Chambers, Universities and directors on the draft law,
- Campaigns and country-wide petitions by local TEMA representatives for public opinion building,
- Broadcast events, such as draft law presentation on TV,
- Lobbying in the National Assembly and president of state levels, giving briefings to the groups in the National Assembly.

There have been significant achievements gained regarding soil conservation and land use practises with this initiative of TEMA such as;

- Identification of the factors contributing to soil degradation, desertification and misuse of the land,
- Identification of the practical measures necessary to combat and/or mitigate the effects of erroneous land use techniques,
- Setting up a specific body in charge of the conservation, expansion and improvement of soil, the Soil Conservation Councils, in the local government level within which NGO participation in the decision making process is ensured
- Empowerment of the local people –especially the members of TEMA Foundation- with relevant rights, duties and responsibilities to cooperate with the local government structures as stipulated in Article of the law,
- Raising awareness and ensuring the participation of local people in activities for the implementation of the law,
- Development of definitions for the boundaries and areas of big lowlands and erosion sensitive lands,
- Drawing the lines to rehabilitate and upkeep lands,

The legislation drafting process has been complete at a certain level; however attempts regarding the execution of the legislation are still in progress. On the other hand, at judiciary level, TEMA has been playing a fundamental monitoring role. Over 70.000 ha of agricultural soil were saved and the non-agricultural development on those soils was prevented thanks to the law cases that TEMA started over.

Academic institutions and TEMA in soil conservation processes

Secondly, academic institution is another agent of soil conservation and has three basic functions in soil conservation processes; research and development of the soil conservation techniques, training, and dissemination of scientific knowledge and monitoring the international literature. TEMA is in cooperation with universities to transfer the know-how generated in universities to the field and vice versa. CROP-MAL, Creation of Rational Opportunities for Conservation of Marginal Arid Lands, funded by Japanese MITSUI[i], is one of the projects which TEMA is working in cooperation with Cukurova University, Department of Soil. TEMA mobilized private sector funds to conduct the project.

The project aims to conserve the water and soil resources of the site, to introduce the tools for the sustainable use of those resources and, to combat and mitigate desertification with a multi-disciplinary approach in an area covering approximately 4100 km2 in Central Anatolia (Karapinar and the arid and semiarid zones of Eregli and Karaman)

The project is basically structured on 4 main components:

- Demonstration fields for the introduction of the good agricultural practices enabling direct contact with the locals
- Farmer trainings for awareness raising
- Exploration of traditional crafts and local products for economic diversification to decrease the human pressure on soil
- Data collection and analyses (water, soil, vegetation, climate) and production of a sustainable land management model

As stated above, project adopts an integrated perspective to the problem of desertification and land degradation in arid lands with a scientific sensitivity while taking into account the current political and social conditions. Throughout the project, various scientific outputs have been produced such as desertification sensitivity maps, crop pattern maps, anthrospace tables indicating the dependency of the crops and the zones, analyses of change in water resources, which all formed the basis for the sustainable land use model specifically designed for Crop-Mal site. For the next step what is aimed is to produce a community layer to complete the social and political dimension of the picture.
Expected final outcome of the project will be the sustainable land management plan of Karapinar. The plan will help the decision makers to adopt the most effective strategy to achieve a sustainable development in the site as a guiding reference paper.

International community and TEMA in soil conservation processes

The international community has long recognized that soil and land degradation is a major economic, social and environmental problem of concern to many countries in all regions of the world. In 1977, the United Nations Conference on Desertification (UNCOD) adopted a Plan of Action to Combat Desertification (PACD). Unfortunately, despite this and other efforts, the United Nations Environment Programme (UNEP) concluded in 1991 that the problem of land degradation in arid, semi-arid and dry sub-humid areas had intensified. As a result, the question of how to tackle desertification was still a major concern for the United Nations Conference on Environment and Development (UNCED), which was held in Rio de Janeiro in 1992. ***The Conference supported a new, integrated approach to the problem, emphasizing action to promote sustainable development at the community level***. It also called on the United Nations General Assembly to establish an Intergovernmental Negotiating Committee (INCD) to prepare, by June 1994, a Convention to Combat Desertification, particularly in Africa. The Committee completed its negotiations in five sessions and the Convention was adopted in Paris on 17 June 1994.
UNCCD has produced a ten-year strategy plan to implement for the years of 2008-18. However, it is obvious that to achieve soil conservation and to implement this plan without the participation of civil society is not likely. Therefore, 14 Civil Society Organisations (CSOs) from all over the world joined forces in 2007 in a programme called Drynet where TEMA is one of the partners. Drynet, as stated in its slogan "a global initiative giving futures to drylands" is a network ranging 4 continents and 18 countries worldwide[ii], almost competing with its government level counterparts.
DRYNET partners and their national CSO networks are expected to build the necessary instruments and capacity to participate in the political and budgetary mainstreaming of the aims of the UNCCD and its National Actions Plans. What is meant by mainstreaming is that the integration of the environmental dimension, especially related to the dryland ecosystem, into national development priorities, processes and frameworks such as Millennium Development Goals', 5-year development plans, Country Strategy Papers and Poverty Reduction Strategy Papers, and trade related frameworks. This conceptualization has been formalized in the joint publication of The Global Mechanism [iii] which is subsidiary body of the convention and DRYNET as follows:

"As countries develop strategic national development frameworks to prioritise and guide resource allocation and official development assistance, development aid actors are increasingly aligning their programmes to these frameworks. It is essential that dryland and land management issues be addressed at this level to raise the political priority of drylands, whether through the NAP or other institutional frameworks. Efforts to achieve this can be called 'mainstreaming,' a process that involves dryland issues and needs becoming integrated within all development-related decision-making processes, policies and laws, institutions and planning frameworks."

3 main targets of the network are;

1. Sharing of knowledge to disseminate the local know-how, research and experiences
2. Capacity improvement to strengthen national cooperation and integration
3. Advocacy to influence national and international decision making

DRYNET wants to create an operational and actively used structure for the exchange of positive project results and participatory methodologies to combat land degradation among CSOs, key stakeholders from science and key policy-makers. DRYNET aims to strengthen national NGO networks and cooperation in order to build capacities and to facilitate the exchange of knowledge. DRYNET which TEMA is an active member is a unique attempt to carry the international agenda to the local level and a platform where to build the link between community and the policy level.

Conclusion

In this context, the case of TEMA indicates that active participation of civil society in soil conservation matters since the issue requires 'integrated action'. What is achieved by TEMA as a CSO in Turkey is setting up the necessary links among agents and simultaneously taking action at the different platforms. Looking at the picture with a wide perspective will make the position of TEMA clearer. It has been facilitating and supervising government level via legislation drafting, soil conservation councils and law cases as well as mobilising community by volunteerism and capacity building. On the other hand, in cooperation with universities, knowledge generated at the academic institutions has been transferred to the field and reflected to the development plans and decision making mechanisms. While actively influencing and accelerating the processes at local level, TEMA keeps up with the international agenda and carries the global perspective to the community level. CSOs like TEMA are critical agents of soil conservation and sustainable land management since those have intrinsic conflicting aspects and require agents to fill in the gaps.

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i Mitsui & Co., Ltd. is a Japanese company headquartered in Tokyo, which maintains a global network of 154 offices in 67 countries, as well as nearly 450 subsidiaries and associated companies worldwide. Crop-Mal is funded by Mitsui & Co., Ltd. Environment Fund

ii Both ENDS Netherlands, CAREC Kazakhstan/Uzbekistan/Kyrgyzstan/Tajikistan/ Turkmenistan, CARI France, CENESTA Iran, DCG/DCG Mali, EMG South Africa, ENDA TM Senegal, GRET Madagascar, LPPS India, OLCA Chile, PROBIOMA Bolivia, SCOPE Pakistan, TENMIYA Mauritania and TEMA Turkey

iii Established by the First Conference of the Parties (COP1) held in Rome, in September 1997, the Global Mechanism (GM) of the United Nations Convention to Combat Desertification (UNCCD), is a subsidiary body of the Convention, mandated to "increase the effectiveness and efficiency of existing financial mechanisms…[and]…to promote actions leading to the mobilization and channelling of substantial financial resources to affected developing country Parties" (Article 21).

SOIL AND WATER CONSERVATION

POSTER PRESENTATIONS

Effect of Different Tillage Systems on Soil Respiration and Production on Wheat, Maize and Soybean Crop

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Abstract
Soil tillage systems can be able to influence soil compaction, water dynamics, soil temperature and crop yield. These processes can be expressed as changes of soil microbiological activity, soil respiration and sustainability of agriculture. Objectives of this study were: 1 - to assess the effects of tillage systems (Conventional System (CS), Minimum Tillage (MT), No-Tillage (NT)) on soil compaction, soil temperature, soil moisture and soil respiration and 2- to establish the effect of the changes on the production of wheat, maize and soybean. The study was conducted on an argic-stagnic Faeoziom. The MT and NT applications reduce or completely eliminate the soil mobilization, due to this, soil is compacted in the first year of application. The degree of compaction is directly related to soil type and its state of degradation. The state of soil compaction diminished over time, tending toward a specific type of soil density. Soil moisture was higher in NT and MT at the time of sowing and in the early stages of vegetation and differences diminished over time. Moisture determinations showed statistically significant differences. The MT and NT applications reduced the thermal amplitude in the first 15 cm of soil depth and increased the soil temperature by 0.5-2.2^{0}C.Water dynamics and soil temperature showed no differences on the effect of crop yields. The determinations confirm the effect of soil tillage system on soil respiration; the daily average was lower at NT (315-1914 mmoli $m^{-2}s^{-1}$) and followed by MT (318-2395 mmoli $m^{-2}s^{-1}$) and is higher in the CS (321-2480 mmol $m^{-2}s^{-1}$). Although wheat production at MT and NT applications, had no significant differences soybean production was significantly effected from MT and NT applications. The differences in crop yields are recorded at maize and can be a direct consequence of loosening, mineralization and intensive mobilization of soil fertility.
Keywords: minimum tillage, no-tillage, soil respiration, yield.

Introduction

No-Tillage (NT) and Minimum Tillage (MT) have, in recent years, become tillage systems for soil conservation, popular in Romania. Their insertion in agricultural practice reduces soil degradation phenomena, avoids the implementation of an intensive management and reduces production costs. Implementing the NT and MT systems in Romania are perceived as having effects on soil compaction, namely a higher resistance to penetration than the conventional tillage system (CS) with effects on soil moisture and temperature. Rain water penetration in soil and the increase of the water storage on soil profile depends or is influenced by the amount and intensity of rainfall, water and soil temperature, slope and land form, by hydro-physical properties, by soil texture and compaction. All these soil qualities are closely interdependent and are influenced by the tillage system.

Soil tillage system and its intensity (CS and MT) modify by direct and indirect action soil temperature, moisture, bulk density, porosity, penetration resistance and soil structural condition. Concerning the NT system where the soil is not mobilized, the evolution of these properties is more influenced by intrinsic qualities of soil, by soil profile layering, by weather conditions and history of management. The results obtained by national and international research highly depend on soil type, climatic conditions of the area and the presence of mulch in conservative systems (CT). Many authors have determined a higher bulk density in CT in comparison with CS (Hammel, J.E., 1989; Ferreras, L.A. et al. 2000; Gus, P. et al., 2008), others have not found significant differences (Hill, R.L., Crus, R.M, 1985; Chang, C., Lindwall, C.W., 1989; Rusu, T. et al., 2009) or defined lower values of bulk density in conservative systems with mulch on the soil surface (Edwards, J.H. et al., 1992; Lal, R. et al., 1994).

Penetration resistance has been observed to be more sensitive than bulk density to detect effects of tillage management (Bauder, A., Black, A.L., 1981; Hammel, J.E., 1989). Measurements of resistance to penetration can provide a composite image of the effect of compaction and moisture status. Several authors have concluded that high penetration resistance in conservative systems

reduced root growth (Cornish, P.S., Lymbery, J.R., 1987; Kirkegaard, J.A. et al., 1994, Moraru, P.I., Rusu, T., 2010), affecting water and nutrient uptake by crops (Oussible, M. et al., 1992).
Low soil-surface temperatures due to accumulation of crop residues (Griffith, D.R. et al., 1973; Al-Darby, A.M., Lowery, B., 1987; Gupta, S.C. et al., 1988) can adversely affect emergence and seedling growth under no-tillage in mid-latitudes (Munawar, A. et al., 1990).
Soil water content is also another factor that is affected by tillage because of changes produced in infiltration, surface runoff, and evaporation (Zhai, R. et al., 1990). The increase in soil water storage under conservation tillage can be attributed to reduced evaporation, greater infiltration, and soil protection from rainfall impact (Sarauskis, E. et al., 2009a).
Soil respiration leads to CO_2 emissions from soil to the atmosphere, in significant amounts for the global carbon cycle (Moraru, P.I. et al., 2010). Soil capacity to produce CO_2 varies depending on soil, season, intensity and quality of agrotechnical tillage, soil water, cultivated plant, fertilizer etc.
The soil conservative systems in different areas have to show specific features according to ecological properties and to cultivated plants characteristics; thus, this system must be applied in different ways (Fabrizzi, K.P. et al., 2005; Riley, H.C.F. et al., 2005; Jitareanu, G. et al., 2006).
Our research follow the effects of the three tillage systems, NT, MT and CS on soil properties (bulk density, penetration resistance, temperature and moisture, soil respiration) and on the production of wheat, maize and soybean, obtained on an argic Faeoziom from the Somes Plateau.

Materials and Methods

The data presented in this paper were obtained on argic-stagnic Faeoziom (SRTS, 2003), at University of Agricultural Sciences and Veterinary Medicine in Cluj-Napoca, within the Research Center for Minimal Systems and Sustainable Agricultural Technologies. The field is a class II quality type, having 78 points for arable use. The soil profile is of type: Amp – Am – A/Btw – Btw – B/C – Cca. The clay content on 0-40 cm depth varies between 42.1 and 45.7%. On 0-20 cm depth, soil has a reaction at the limit neutral - weak acid, with a value of 6.02. The presence of carbonates in the next horizon, the 120-210 cm depth determines an increase of pH value to 7.88. The base saturation degree of 75% frames this soil type in the eumezobasic soils. As for the humus content, the soil is appreciated as good, namely 4.33% in the first 20 cm and 3.27% in the 20-40 cm depth. The field is with 8% slope, with the ground water level at 10 m depth.
These areas were was our research presents a medium multi annual temperature of 8.2^0C medium of multi annual rain drowns: 613 mm. The experimental variants chosen were: A. Conventional system (CS): V_1 – reversible plough (22-25 cm)+ rotary grape (8-10 cm); B. Minimum tillage system (MT): V_2 – paraplow (18-22 cm) + rotary grape (8-10 cm); V_3 – chisel (18-22 cm) + rotary grape (8-10 cm); V_4 – rotary grape (10-12 cm); C. No-Tillage systems (NT): V_5 – direct sowing. The experimental design was a split-plot design with three replications. In one variant the area of a plot was 300 m^2. The experimental variants were studied in the 3 years crop rotation: maize (*Zea mays* L.) - soy-bean (*Glycine hispida* L. Merr.) – autumn wheat (*Triticum aestivum* L.). The analysis and determinations were done according to acting methodology and standards (SRTS, 2003; MESP, vol. I-III, 1987, Guide to Agrotechnics and Experimental Technology).
The biological material was represented by the LG32 – hybrid maize, Felix – of soya-bean and the Ariesan – species for the wheat. Except for the soil tillage, all the other technological sequences of sowing, fertilizing, are identical in all the variants. Weed control was supplemented each year for the NT version with herbicide before seeding, using Roundup (glifosat 360 g/l), 4 l/ha.
To quantify the change in soil properties under different tillage practices, determinations were made for each crop in four vegetative stages (spring, 5-6 leaves, bean forming, harvest). Soil parameters monitored included soil water content (Aquaterr MT300 – Capacitive Sensor), temperature (Aquaterr MT300 – Silicon Junction Sensor), soil bulk density (determined by volumetric ring method using the volume of a ring 100 cm^3), penetration resistance (FieldScout SC900 – digital penetrometer) and soil respiration using ACE Automated Soil CO_2 Exchange System. The average result values, obtained in the vegetal phases were statistically processed, taking into consideration the last three cultivation years within the crop rotation. The results were statistically analysed by ANOVA test (PoliFact, 2008). A significance level of $P \leq 0.05$ was established a priori.

Results and Discussion

Minimum Tillage (MT) and No-Tillage (NT) application reduce or completely eliminate the soil mobilization, due to this, soil is compacted in the first years of application. The degree of compaction is directly related to soil type and its state of degradation. Significant differences are recorded up to 18 cm depth. Determinations made on Faeoziomul argic (table 1) shows a bulk density greater in case of the direct sowing at maize crop (1.35 g/cm^3) and soybean (1.38 g/cm^3), respectively at rotary harrow and direct sowing, in case of wheat (1.32-1.38 g/cm3). The state of soil compaction diminishes over time, tending toward a specific type of soil density.

Soil tillage system influences more significantly the penetration resistance. This is because the resistance to penetration is a more complex determination that depends on the condition of soil settlement and its humidity. The differences were mainly determined in the first 20 cm and there were no differences in the depth.

All determined values were higher in NT and MT compared with CS, the differences being significant distinct positive or significant positive at NT. Differences are also depending on the crop (table 2): wheat – CS: 1524 kPa, CT: 1621-1735 kPa; maize – CS: 1421 kPa, CT: 1523-1624 kPa; soybean: CS: 1643 kPa, CT: 1755-1799 kPa.

Table 1. Influence soil tilage systems on soil bulk density (g/cm^3), 0-50 cm depth

Variants	Wheat	Maize	Soya-bean
Plough	1.24^{ws}	1.20^{ws}	1.22^{ws}
Paraplow	1.28^{ns}	1.22^{ns}	1.26^{ns}
Chisel	1.29^{ns}	1.22^{ns}	1.25^{ns}
Rotary grape	1.32*	1.31^{ns}	1.32^{ns}
Direct sowing	1.38*	1.35*	1.38*

Note: wt – witness, ns – not significant, *positive significance, ^{0}negative significance.

Table 2. Influence soil tilage systems on soil penetration resistance (kPa), 0-45 cm depth

Variants	Wheat	Maize	Soya-bean
Plough	1524^{ws}	1421^{ws}	1643^{ws}
Paraplow	1626*	1523*	1762*
Chisel	1627*	1523*	1755*
Rotary grape	1621*	1621**	1774*
Direct sowing	1735**	1624**	1799*

Note: wt – witness, ns – not significant, *positive significance, ^{0}negative significance.

Moisture determinations (table 3) shows significant differences, statistically insured, at NT (wheat: 76%; soya-bean: 86%), although high values were recorded at MT, too. Soil moisture was higher in NT and MT at the time of sowing and in the early stages of vegetation, then the differences diminishes over time.

Soil temperature increases in all variants with MT and NT, with differences insured statistically, at wheat crop (table 4). The differences are recorded especially in the first 15cm, where the NT recorded lower thermal amplitude compared with MT and CS.

Soil respiration (table 5) varies throughout the year for all three crops of rotation, with a maximum in late spring (1383 to 2480 mmoli $m^{-2}s^{-1}$) and another in fall (2141 to 2350 mmoli $m^{-2}s^{-1}$). The determinations confirm the effect of soil tillage system on soil respiration; the daily average is lower at NT (315-1914 mmoli $m^{-2}s^{-1}$), followed by MT (318-2395 mmoli $m^{-2}s^{-1}$) and is higher in the CS (321-2480 mmol $m^{-2}s^{-1}$).

Wheat has ensured equal productions between 3745-3856 kg/ha (table 6), with no significant differences between tillage systems. Maize responded better at the soil loosening, at the mobilization of soil fertility and nutrient mineralization, providing a production of 6310 kg/ha. The production was between 5890-6145 kg/ha at MT, being significant negative at rotary harrow,

respectively 5774 kg/ha at NT, being distinct significant negative. The soybean crop productions are between 2112-2341 kg/ ha, being significant positive at MT and NT.

Table 3. Influence soil tilage systems on soil moisture (% v/v), 0-50 cm depth

Variants	Wheat	Maize	Soya-bean
Plough	61^{ws}	83^{ws}	75^{ws}
Paraplow	65^{ns}	88^{ns}	77^{ns}
Chisel	64^{ns}	85^{ns}	76^{ns}
Rotary grape	64^{ns}	86^{ns}	86^{*}
Direct sowing	76^{**}	89^{ns}	86^{*}

Note: wt – witness, ns – not significant, *positive significance, ^{0}negative significance.

Table 4. Influence soil tilage systems on soil temperature (^{0}C), 0-50 cm depth

Variants	Wheat	Maize	Soya-bean
Plough	17.3^{ws}	23.2^{ws}	22.2^{ws}
Paraplow	19.3^{*}	23.5^{ns}	22.5^{ns}
Chisel	18.9^{ns}	23.4^{ns}	22.5^{ns}
Rotary grape	19.4^{*}	23.9^{ns}	22.3^{ns}
Direct sowing	19.5^{*}	23.9^{ns}	22.6^{ns}

Note: wt – witness, ns – not significant, *positive significance, ^{0}negative significance.

Table 5. The influence of soil tillage system upon soil respiration (mmoli $m^{-2}s^{-1}$)

Culture	Soil tillage systems	Plough (witness)	Paraplow	Chisel	Rotary grape	No-Tillage
Wheat	Spring	721	714	708	641	532
	5-6 leaves	321	320	321	318	315
	Bean forming	1531	1460	1414	1408	1383
	Harvest	2114	2111	2070	1942	1914
Maize	Spring	1014	1010	1010	982	914
	5-6 leaves	1580	1523	1541	1512	1510
	Bean forming	2340	2308	2312	2252	2218
	Harvest	2250	2242	2221	2208	2141
Soy-bean	Spring	1140	1140	1129	1092	1042
	5-6 leaves	1620	1615	1612	1580	1550
	Bean forming	2480	2395	2382	2350	2320
	Harvest	2350	2314	2318	2270	2183

Table 6. Influence soil tilage systems on yield of wheat, maize and soya-bean (kg/ha)

Variants	Wheat	Maize	Soya-bean
Plough	3812^{ws}	6310^{ws}	2112
Paraplow	3856^{ns}	6120^{ns}	2251^{*}
Chisel	3795^{ns}	6145^{ns}	2198^{ns}
Rotary grape	3745^{ns}	5890^{0}	2241^{*}
Direct sowing	3786^{ns}	5774^{00}	2341^{*}

Note: wt – witness, ns – not significant, *positive significance, ^{0}negative significance.

Conclusions

The state of soil settlement is changed through the tillage, which increases bulk density and penetration resistance in MT and NT, but does not modify soil moisture and temperature.

MT and NT systems reduce the thermal amplitude in the first 15 cm of soil and increase soil temperature by 0.5-2.2 ^{0}C.
Carbon-dioxide efflux from conventional minimum tillage and no-tillage soils under wheat, maize and soubean was measured for for each crop in four vegetative stages (spring, 5-6 leaves, bean forming, harvest) using ACE Automated Soil CO_2 Exchange System. Tillage appeared to affect the timing rather than the total amount of CO_2 production: the daily average is lower at NT (315-1914 mmoli $m^{-2}s^{-1}$), followed by MT (318-2395 mmoli $m^{-2}s^{-1}$) and is higher in the CS (321-2480 mmol $m^{-2}s^{-1}$). An exceeding amount of CO_2 produced in the soil and released into the atmosphere, resulting from aerobic processes of mineralization of organic matter (excessive loosening) is considered to be not only a way of increasing the CO_2 in the atmosphere, but also a loss of long-term soil fertility.
Water dynamics and soil temperature showed no differences that could affect crop yields. Productions obtained at MT and NT don't have significant differences at wheat and are higher at soybean. The differences in crop yields are recorded at maize and can be a direct consequence of loosening, mineralization and intensive mobilization of soil fertility.
Application of MT and NT systems can lead to soil conservation in the Somes Plateau, without affecting crop yields, especially on soils with high initial fertility.

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Modeling Soil Mixture on Watershed Flood by HEC-HMS Model

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Abstract
The aim of this study is to investigate the role of soil mixture on flood regime of watersheds. In this research Hec-Hms Model is used to investigate effect of soil type mixture on peak discharge and watershed flood volume in BilleSavar located in northwestern of Iran. This model was selected because It could be considered soil type, physiographic characteristics, vegetation cover and land-use. Soil hydrological group map was evaluated and verified with rainfall-runoff data modeled by Hec-Hms. The results showed that due to heavy textured soils with low permeability, runoff potential increases. Flood discharge peak is calculated for 2,5,10,25,50,100 years return periods and it observed that with increasing return period the effect of soil mixture on flood decreased and approximately its effect tend to be constant. Other parameters have a critical role in the flood peak.
Keywords: HEC-HMS Model, Rainfall-Runoff, Soil Texture, Land Use, Vegetation Cover.

Introduction
Estimate the amount of runoff in a basin is very important. For the control and direction of surface water surplus and transferring it to the appropriate location, using different methods by researchers and research centers of the world has been studied and evaluated. The use of Runoff-Rainfall Models used extensively in this field and Rational Methods gradually replaced the models in which not only a maximum flow rate, Not only is the maximum flow rate, but the surface flow regime at each point area is calculated , were replaced (Howkis,1978). Khosrow-Shahiand Saghafi(2006) were used the HEC-HMS model to determine the sensitivity of some of the factors affecting flattering flood under watersheds using hydrograph analysis of output basins of Damavand(Iran).The results showed that the hydrological behavior of sub-basins relatived to output is non-linear. Neshat and Sedghi (2007) in a study on basin garden property in Khuzestan province, Iran, the data of rainfall - runoff model and Implementation of HEC-HMS model, were used to calculate the CN zone that results from Implementation of model indicate compatibilitycurve number method. Vieux B.E And coworkers(2002) to predict lightning floods (Flash Floods) and debris flows that could threaten basin in Taiwan that were used rainfall - runoff Vefflo model. The model used was able to predict water level at any point of the basin. Finally, after simulating the flow and compare it with Hydrograph observations ability the model to predict the flow was estimated. Due to the hydrograph peak output was three points, the model was able to simulate both the peak it well, and the third peak was not as well accuracy, that this would increase the model error. Comoronic and coworkers(2005) effects of land use change in flood basin PoRiver were investigated near the city of Bologna Da .in the conducted study was used a model of rainfall - runoff and a hydrodynamic model showed the results of user changeable effect on hydrograph simulation. Radmanesh and coworkerswere(2005) evaluated, HEC-HMS model to predict floods from rainfall in the Yellow River Basin in southwestern Iran. In this study, six storm observations with six simultaneous flooding of the basin outlet in the study area and its surrounding areas were selected .Then the model parameters in the SCS were studied. The results obtained indicate good fit of observed peak discharge Hydrograph and simulated hydrograph .Time reaching to peak in the hydrograph in all studied cases is equal to or less than one hour. The results indicate the importance of choosing the objective function optimal values of model parameters. The research study showed that HEC-HMS model and other hydrological models have been used to simulate different basins, but effect of various land uses in a Basin in different return periods that have significant effect on flood hydrographs have not been investigated. Therefore in this study HEC-HMS model is used to simulation of flood hydrographs for various periods under various land uses.

Materials and Methods

Runoff of soil conservation equation (SCS)

Until 1950, the Organization of American soil conservation was not present the equation that can be applied by using the data available for all points. Relation of rainfall - runoff obtained by Sherman and Mvkas (1949) was generalized somewhat, but did not land enough to justify .purpose of the organization (SCS) provides a method that not based on statistics measure of rainfall – runoff. And the purpose is present of method That by having basin soil characteristics and select the rainfall design , excess rainfall can be calculated .The Organization after the necessary investigations ,was introduced "Rainfall - Runoff" as follows:

If the cumulative amount of rainfall runoff against cumulative rainfall is plotted in a chart, Be noted that Primary rainfall amounts per, there will be no runoff and the time delay from onset of precipitation, runoff, come forth. Contact the relevant parameters are as follows:

$$P=S+Q \quad (1)$$

$$S=Ia+F \quad (2)$$

$$P=Ia+F+Q \quad (3)$$

In this regard:

P: rainfall altitude results in terms of inches. S: maximum cumulative influence potential in inches, Q: The amount of runoff from rainfall in inches, Ia: basic maintenance amount in inches, F: cumulative Influence amount of rainfall in inches.

The values obtained for rainfall on the watershed soil surface and the effective factors for the Ia , values range can be changed from zero to S. So if in a rainfall flooding conditions quickly be achieved ,can stated that almost all the resulting rainfall has been changed to runoff and in Mathematical language can be presented the following relations:

$$Ia=0 \quad (4)$$

$$S=0$$

$$P=Q$$

$$F=0$$

According to the relation (4) and with more precise attitude, rainfall altitude, P, can be called up runoff maximum potential. Victor and Mvkas (1949), based on the assumptions presented the following equation:

$$S/S'=Q/P \quad (5)$$

In which:

S is the maximum retention potential in situations where the initial detention is not considered.

The difference between rainfall and runoff in the lack of basic maintenance amount, is equal to amount of cumulative influence (F)

$$F=P-Q \quad (6)$$

$$Ia=0.2\ S \quad (7)$$

Equation 5 is converted to the following equation.

$$Q=\frac{(P-0.25)^2}{P+0.85} \quad (8)$$

Default accepting used in equation (7), Runoff amount can be calculated by equation (8) that the amount of runoff altitude depends on to two factors, precipitation altitude (P) and maximum influence potential (S).

Which (S) has been linked to another parameter called curve number (CN) by the following equation .

$$S=\frac{1000}{CN}-10 \quad (9)$$

Profiles of HEC-HMS model

HEC-HMS model that is a hydrological simulation model of basin, works in Windows environment and its main basis, is the HEC-1 model that has been used many years to simulate the different

basins in basins of different countries including Iran, HEC-HMS model for flood simulation has two main parts; converting rainfall to runoff model (Loss method transform) and the flood mapping process in streams (Routing method). This model uses these methods to convert rainfall to runoff ; constant value methods, SMA model (Soil Moisture Accounting), network-based SMA model, curve number method (Cure Number), network- based curve number method, the Ampt neck and Zero casualties model. For runoff into Hydrograph model uses these methods: clark hydrograph methods (Clark unit Hydrograph), wave kinematics, hydrograph Clark mode (Mode clarkUH), Snyder hydrograph, S user hydrograph, the user unit hydrograph, and SCS unit hydrograph.In this study, according to data from the region ,to calculate the losses in different Marber , curve number method and for conversion runoff into hydrographs the SCS hydrograph is used. HEC-HMS model uses standard methods such as Muskingum Konj , latency (Lag Time), Muskingum, Modified pulse, Muskingum Konj uses eight spot and kinematic wave ,for flood mapping process in the waterways. In the present study for flood mapping process in the waterways Muskingum method is used.

Case Study

Nar Gheshlagi catchment with an area of approximately 49.45 square kilometers in the Bilesavar city, is located in North West in Iran. Residential areas inside the basin are: Agha kandy, Up Goli Blaq and down Goli Blaq ,Chanaq, Sari Blaq, Khan Aflan Kandy, Fafash Abad and Yal Blaq.
The lowest altitude of the basin is 280 m and the highest altitude of basin is 1100 meters above sea level. The study Basin was divided into two parts and six sub-basins.

Determining the hydrological groups of soil and curve number (CN)

Basin vegetation has a great importance in estimating the basin's curve number with the identification of soil textures and its permeability. Thus, according to the classification in (SCS) method for hydrological group of soil that means four Group C, B, A and D; Results of this study and each sub-basin curve number CN is presented in Table 1.

Table 1. Specifications hydrological groups and sub-basins curve number CN.

	Sub1	Sub2	Sub3	Sub4	Sub5	Sub6
Area	8.09	9.03	10.80	2.83	9.34	14.74
Hydrologic group	C	C	B	B	C	B
Curve number CN	75	79	68.6	79	79	74

Results

In this study, for simulating the flood of study area, the HEC-HMS model is used, this area was divided into six sub - basin and in introducing of basin model, was introduced to the HEC-HMS modeling system, that schematic model is shown in Figure 1. In meteorology introducing, zone precipitation Hitograf , was introduced under the return periods of 2, 5, 10, 25, 50 and 100 years old, into the model. Also information about the curve number, flood waterways and other information of relevant sites were considered. Flood hydrograph of sub-basins from Sub1 to Sub6, under the different return periods of estimation and finally flood hydrograph, was plotted in the main Basin outlet. These hydrographs were obtained for various return periods that summary of results is shown in Table 2. the basin flood hydrograph with the 100-year return period is presented in Figure 2. Peak discharge of each sub watershed was evaluated after watershed simulation with different return period which its result shown in table 3. Even though subwatershed with high flood potential could be derived from table3 but the subwatersheds areas are not equal. Therefore, table 4 is calculated for flood potential in relation with area. Since S2, S4 and S6 subwatersheds are high potentially in producing flood, because of their soil permeability, shape factor and other geometry parameters. Flood potential increasing with increasing return period, but increasing percent in high return period such as 100 years (13%) is less than low return period such as 5 years (93%). High

rainfall intensity lead up to rapid saturate soil and lessen CN effect and so on all rainfall produce runoff.

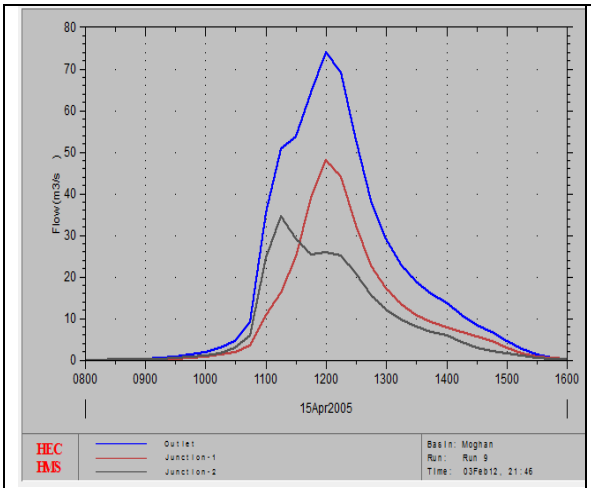


Fig.2.Basin flood hydrograph with 100 year return period, the current situation

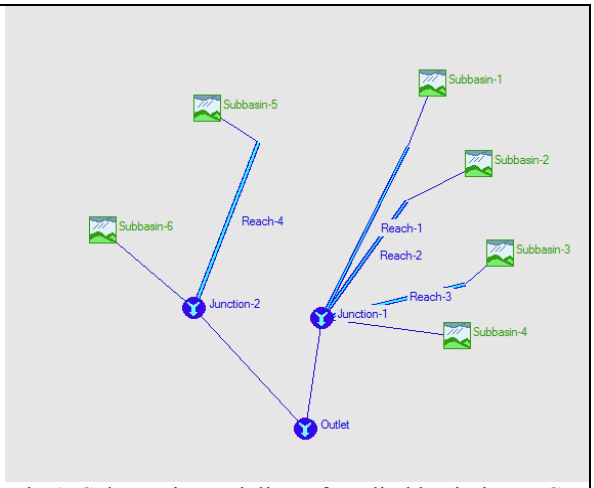


Fig.1. Schematic modeling of studied basin in HEC-HMS model

Table.2. The maximum output instantaneous flow rate under different return periods based on cubic meters per second

	T=2	T=5	T=10	T=25	T=50	T=100
Maximum output rate	14.73	27.00	42.90	52.90	65.23	73.86

Table3. Subwatersheds peak flood discharge in different return period

	T=2	T=5	T=10	T=25	T=50	T=100
Sub1	2.69	5.1	8.73	10.46	13.23	15
Sub2	4.41	8.47	13.98	17.09	21.44	24.25
Sub3	2.58	4.97	8.24	10.22	12.86	14.65
Sub4	1.48	2.94	4.67	5.50	6.77	7.64
Sub5	3.58	6.75	10.96	13.46	16.77	18.96
Sub6	5.67	11.03	18.30	22.52	28.44	32.29

Table4. Subwatersheds peak flood discharge per unit area in different return period

	T=2	T=5	T=10	T=25	T=50	T=100
Sub1	0.33	0.63	1.08	1.31	1.63	1.85
Sub2	0.49	0.94	1.55	1.89	2.37	2.68
Sub3	0.24	0.46	0.76	0.95	1.19	1.36
Sub4	0.52	1.04	1.65	1.94	2.39	2.70
Sub5	0.38	0.72	1.17	1.44	1.79	2.03
Sub6	1.05	2.04	3.39	4.17	5.27	5.98

Conclusion

1-watershed soil permeability is directly related to runoff, flood is intense in watersheds with impermeable soil.

2-watershed soil permeability has less effect on flood potential, with increasing rainfall intensity all rainfall would produce runoff.

3-watershed soil permeability is not the only parameters effect on flood potential, other parameters such as watershed shape factor, concentration time and geometry parameters should be considered.

4 - Comparison of the maximum instantaneous flow rate induced by sub-basin shows that the maximum flow rate increases with area increasing, but not necessarily the increasing area does not have a direct relationship with increasing flood flow rate and may be smaller basins provide greater flow rates.
5 - with change in curve number CN, potential severity of the basin is altered, but the same increase or decrease the CN has no effect on the basin flood Flattering, because of its is CN effect on latency.
6 - with determine effect of Sub-basins on basin flood Flattering potential we can priority corrective action to reduce flood risk, depending on the severity of the flood basins.

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A Study of the Slope and Area of the Watershed Factors in the Initiation of Gully Erosion
(Case study: Shekarkalat Gully region in Sanganeh of Razavi Khorasan in Iran)

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Abstract
Gully erosion is one of the most complex and destructive types of water erosion. This type of erosion, especially in arid and semiarid regions in the world, where exploitation of soil resources, water and vegetation is not based on the scientific principles and appropriate capacity and natural environmental conditions, causes huge destruction.Thus, understanding factors affecting on gully formation and development plays an important role in watershed management and prevention of land degradation along side with sustainable development.In this research in the cold semiarid climate and in Shekarkalat gully region in Sanganeh of Khorasan-e- Razavi it was tried to study the role of slope and area of the wateshed on gully initiation and development. Thus after selection 30 gully and field measurement of gullies' volume, drainage area above gully headcuts and their outlets and upstream slope was determined and the relationship between the volume of gully as the dependent variable and independent variables such as slope and upstream area of the gully was determined by regression method using SPSS software. The results revealed that among the independent variables, area of the outlet watershed has the most important factor on the gully development at Shekarkalat at the level of 5% and determination coefficient of 46%. It is implied that for each unit increase in this variable, 0.68 unit will be added to the gully volume.
Keywords: Shekarkalat, Sanganeh of Razavi Khorasan, Iran, slope, area of watershed, gully development.

Introduction
The factor which creates and moves water is water erosion. It is a common kind of soil erosion. It is 55.6% in the world and it is introduction as a common kind of soil destruction (Ahmadi, 1378). Each year about 26 billion tons of soil erosion in the world disappears. soil erosion rate was estimated about 2 billion tons of annual that 7/6% of the world, including soil erosion is In Iran (Soleymanpour from the Mirsanjary, 1386). Among water erosion types, gulling erosion is very important. First , it is performed few researches in this field. Second, erosion production share is 100 times more than splash and surface runoff erosion (soufi , 1382). Gully is an erosion channel whit more than 30 cm depth (soil science association in America, 1984) or Cross-sectional area more than 929 cm^2 (Poesen and et al, 2003) that not be destroyed by tillage (Bradford and Piest, 1978). Visible losses of the soil much erosion production area destruction, not balance resources of environment, dams tanks fulfilling the result of such erosions. So to become familiar whit effective factors in creating and initiation gullies play important roles in catchment lines management and prevention of area destruction.

Material and Methods
In this research was selected Shekarkalat as one of gullies erosion in the region of Razavi Khorasan Sanganeh in Iran. Sanganeh has been 120 km north east of Mashhad and the border of Iran and Turkmenistan. Area of this region is 2000 hectares. The regional climate is cold semi-arid desertification based on domarten method. The average height of above sea level is 750 meters and average annual rainfall and average rainfall of 24 hours is respectively 200 and 230 mm. The land use is pasture (Rangavar, 1386). The average gullies volume is 235/33 m3, the average area is 207/96 m2 and the gullies average length is 54/88 meters. Figure 1 shows the location of the Sanganeh gully region in Iran.

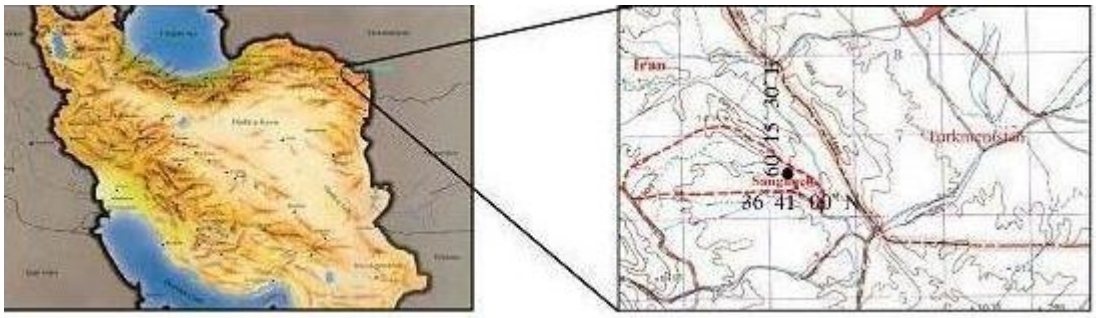


Fig1. General view and location of the Sanganeh study watershed, Iran

After determining the parts Razavi Khorasan province and Located in semi-arid climate of the region Shekarkalat. Topographic map 1:25000 in 1373 and picture through satellite (IRS) showed the catchment line and the gullied erosion line. After considering the gullies we determined 30 gullies in order to measure the gullied erosion volume. We determined 10 meters as an appropriate distance for the determination of the width computation and the measurement in gullies. Each gully dimension computation consists of the depth, width and height (Fig 2). The collection of the few volumes in gully make the gullied erosion volume. We measured some of the characters related to the catchment area (drainage area) in selected gullies like area and slope which is in gully out let and escarpment upstream in desert. We measured the vegetation cover closed grain and the barren soil percentage in catchment which is situated above the escarpment of each gully by accidental arrangement of at least 10 plots which are one square meter at the end of the transects. Finally we analyzed the relationship between the erosion volume and the slope, area initiation and development through step by step method by spss soft ware.

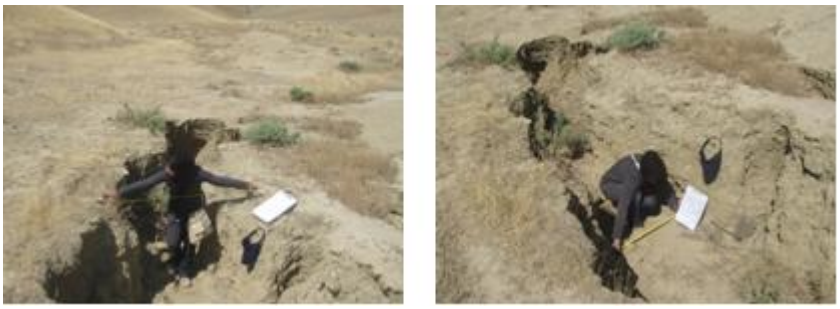


Fig 2. Measured width the top and bottom of the gully

Results and discussion

Conclusion of surveyed gullies show that each gully produced 235.33 m3erosion. Gully initiation catchment area is 386.06 to 4670.57 m^2 and gully development area is 107.87 to 1172.1 m2, The slope of the gully development is 1 to 8% and the slope of the gully initiation is 1 to 5% (Table 1).

Table 1. The results were statistically significant variables in Shekarkalat

Ave	Max	Min	Variables
235.33	1253.35	15.77	Sediment (m3)
3	8	1	Development Slope (%)
1	5	1	Initiation Slope (%)
517.44	1172.1	107.87	Development Area(m2)
1652.57	4670.57	386.06	Initiation Area(m2)

Among independent variables of slope, out let catchment area and catchment area of gullies escarpment, the variable of out let catchment area is much effective on the level less than 5% with coefficient of 46% on shekarkalat gullies development. Adding a unit to this variable increases the gully volume 0.680% unit. So the productive runoff volume plays an important role on shekarkalat gulling region initiation. Table 2 shows the final equation related to regression.

Table 2. The final equation using stepwise regression and the coefficients

Equation	Coefficient	The significant level
y = 0.13 x	46 %	5 %

It is mentioned a sample of the researches results performed about slope, area of the gully catchment area and runoff volume in order to compare the results of this research whit the other researches inside or outside the country.

In a research called "the surveying of gulling erosion mechanism in Kerman", Heidary in 1383 dealt whit the effective factors in gullies initiation by the help of volume. Modulating rainfall each year the gully top and bottom, gully bed slope and the gully drainage area, soil cover and it is EC and Ph, he concluded that the effective factors on Kerman gullies initiation is catchment area and high slope related to the gullies escarpment. It affects on the surface runoff which is produced through the area land use change. A research in 1384performed by Shahrivar et al showed that the linear regression equation between volume and area of the gully catchment area is considered as an effective factor in gulling erosion:

$Y= 62.69 + 157.4X2$ $R2= 0.35$, $F= 12.2169$, Signif. $F= 0.0001$

According to R2= 0.35, of the gulling erosion changes is by the factor. Kukals et al in 2002 studied about behavior, gulling erosion movement and it is relationship whit catchment area characters in India. Measuring parameters, they concluded that catchment area and slope factors are the most important factors in gulling erosion of such areas. Energy and runoff make the gullies. Suri and markuich in 2009 surveyed about road, riprap and topography in making temporary gullies in Israeli. The research showed that slope and catchment area above the gullies are the most important factors in making and initiation the gullies.

Conclusion

The meaningful linear and positive relationship between the gullies volume and outlet catchment area in research results, it is observed that productive runoff volume plays an important role on initiation the gullies of the gulling area in Shekarkalat we should perform actions in dividing the surface to smaller parts. Also there are important strategies in increasing vegetation cover which decrease the surface runoff.

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Evaluation of Soil and Water Conservation Measure in Dejkord basin (IRAN) Evaluation by WOCAT program

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Abstract
Lack of using a standard method for the evaluation of watershed management measures in Iran did not provide a base for comparing the results of various applied technologies at the watershed scale. This study introduces the results of applying WOCAT programme for the assessment of bio – mechanical alternatives which have been done in DEJKORD basin (northwest of Fars Province). The results of this research indicated that the creation of the Watershed union and the implementation of various technologies of soil and water conservation, such as the plantation of almond and apple trees on the contour lines instead of annual rainfed crops on hills with 8 to 30 %slope, and capacity building of the rural people in 1998, are the most dominant causes of the success of the Watershed Management project. The first successful sign of this project is the significant reduction of surface runoff and soil erosion. By employing these technologies, 15,000 hectares of rainfed drylands was changed into rainfed and irrigated Almond (10,000 hectares) and Apple (5000 hectares) gardens. The management and executing of these technologies were carried out by a Watershed Management union. The Ratio of B/C after the implementation of these technologies is 5.2 and the ratio of income from fruit trees (to the previous one) is 15 times. The second effect of this project is reversing the trend of migration process from rural to municipal areas. Many young people are now back to the region. The success of this project has caused the extension of the technologies to the neighbor region. The last success of this project is executing sustainable development for the region. The availability of detailed information provided a scientific base for application of WOCAT in DEJKORD Project.
Keywords: Watershed Management, WOCAT, Technology, DEJKORD, soil and water conservation.

Introduction
Critical and sensitive areas to erosion are emerging and spreading in spite of having good potential for food production by the areas. Increasing of population and their need caused more exploitation of natural resources by people in the past few years. Outcome of their work was destruction of land and water resources and soil loss. Soil and water are the two critical and resources for agriculture production and thus is an urgent and ongoing need for research to devise ways to manage soil and water resources in a more sustainable manner. Integrated watershed management (iwm) is a vital approaches for sustainable development as the watershed is the hydro-geological unit that harbors these natural resources. Despite of numerous efforts and successful Watershed and Soil Conservation projects and the lack of a single standard method, evaluation and information from successful projects such as DeJkord, enough information transferring was not carried out to other provinces or overseas. World needs to the above cited cases caused presenting WOCAT (World of strategies and technologies to protect soil and water) in 1992 by the World Association of Soil and Water Conservation.

WOCAT (World Overview of Conservation Approaches and Technologies) is an established global network of Soil and Water Conservation (SWC) specialists, contributing to sustainable land management (SLM). WOCAT's goal is to prevent and reduce land degradation through SLM technologies and their implementation approaches. The network provides tools that allow SLM specialists to identify fields and needs of action, share their valuable knowledge in land management, that assist them in their search for appropriate SLM technologies and approaches, and that support them in making decisions in the field and at the planning level and in up-scaling identified best practices *(www.wocat.net)*.

WOCAT's vision is that land and livelihoods are improved through sharing and enhancing knowledge aboutsustainable land management.

WOCAT's mission is to support innovation and decision-making processes in sustainable land management, particularly in connection with soil and water conservation (SWC). This is done by:

• connecting stakeholders,

• analysing and synthesising experiences and setting direction,
• enhancing capacity and knowledge,
• developing and applying standardized tools for documenting, monitoring, evaluating, sharing and using knowledge (Liniger et all., 2008a,2005a).

Materials and methods

Study area

The study was carried out in DeJkord village. Dejkord village is located in north – west of Fars Province in I.R.IRAN and west of Eghlid District. The latitude and longitude of the village is in 51º 55′ 30″ to 51º 57′ 30″ E and 30º 40′ 30″ to 30º 43′ 00″ N(figure1). The landforms of the study area generally are rolling (with slope 8-16%) and medium mountain ridges (with slope 16-30%). The site study is located between 2000 and 2700m above sea level. Climate of the site study according to Demartonne classification is temperate Mediterranean. Mean annual temperature (last 21 years, Sedeh rain station) is approximately 12.85°c. The annual rainfall varies between 500 and 750 (last 21 years, Sedeh rain station) with an average of 508.30 mm. Precipitation is seasonal with low amount during summer. The average depth of the soil in this region is 50cm. Dominant top soil textures are sandy loam, loam, and sandy clay loam and are commonly shallow with low amounts of organic matter (usually below1%). The results of soil analysis showed that silt decreases and sand and clay increase with soil depth. The range of clay, silt, and sand is 16 to 35 %, 9 t0 33 %, and 47 to 73%. EC is less than 1(dS/m). This region is composed of 12 villages with population about 8500-9000 in 1996. Gully erosion is increased with slope gradient in hills with wheat and barely rainfed farms.Top soil loss and scouring top soil in this region are main problems in land utility.



Figure 1: Location of Dejkord basin in google earth

Methodology and tools

WOCAT tools

The World Overview of Conservation Approaches and Technologies (WOCAT) program was initiated during the 1992 ISCO conference, held in Sydney, Australia. (Liniger et al., 2002a,b; Van Lynden et al,. 2002; WOCAT., 2003; WOCAT., 2004a, b). The World Overview of Conservation Approaches and Technologies (WOCAT) has developed a set of standardised tools to document, monitor and evaluate soil and water conservation (SWC) know-how world-wide, and to disseminate it around the globe in order to facilitate exchange of experience and better decision making and planning. (WOCAT)World Overview of Conservation Approaches and Technologies has the mission of providing tools that allow SWC specialists to share their valuable knowledge in soil and water management, assist them in their search for appropriate SWC technologies and approaches, and support them in making decisions in the field and at the planning level. WOCAT has developed three comprehensive questionnaires and a database system to document all relevant aspects of SWC technologies and approaches, including area coverage .The methodology for

mapping soil degradation and conservation. A set of three comprehensive questionnaires and corresponding databases has been developed to document all relevant aspects of SWC technologies and approaches, and the mapping of their area coverage . The collection of information on SWC technologies and approaches focuses on case studies that describe the technology and its human and natural environment, where it is used, and which approach was used for its implementation. The questionnaire and database on the SWC map aims at providing a spatial overview of soil degradation and conservation .It can be applied at different scales, from local to national and international level (Godert Van Lynden., 2002*).* In this project we only used the technologies Questionnaire of WOCAT. The questionnaire on SWC technologies addresses the specifications of the technology (purpose, classification, design, and costs) and the natural and human environment where it is used. It also includes an analysis of the benefits, advantages and disadvantages, economic impacts, acceptance, and adoption of the technology.

Rsults

Results of questionnaire of WOCAT indicate that land use before conservation have been annual rainfed crops such as wheat and barley and land use after conservation have been almond and apple trees on the countor lines. A Cooperative Watershed Management Society composed of 8000 members and covering 8 villages has been formed for instruments and the improvement of the rural people in 1377. The Fars province office of natural resource in order to capacity building of the watershed resident started to give lands for non –irrigated plantation which are suitable for improving the watershed. Now a days about15000 hectares of those lands covered to irrigated/non –irrigated gardens of almond and apple trees. out of 15000 ha, 10000 included productive almond gardens ,and 5000 hectares included apple garden(figure2).



Figure2. Almond and apple trees on the countor lines

This garden are located in 2000-2700 (m) altitude. The average annual rainfall (last21 years, Sedeh rain station) is 508.30 mm and the average depth of the soil in this region is 50cm.the top soil texture is sandy loam, loam and sandy clay loam. The results of soil analysis show that from top to bottom the amount of silt decrease and sand and clay is increases. The amount of clay, silt, and sand is 16 to 35 %, 9 to 33 %, and 47 to 73%. EC is less than 1(dS/m) and soil organic matter varies from 0.2 to 1%. The economic annual income of land users was about U$80 per hectare before and U$1500 per hectare after applying the watershed projects. This study indicated that The satge of intervention was rehabilitation phase due to high erosion in this region. The applied technology (tree planting) is very simple that needs to low level of technical knowledge so that it is feasible to use by members of the Dejkord Cooperatives Watershed Management Society (DCWMS). Dominant members of the DCWMS have 1 to 5 hectares gardens and some people have 5to10 hectares gardens. The Ratio of B/C after the implementation of these technologies is 5.2

and the ratio of income from the new technology (cultivation of fruit trees) to the previous one (rainfed wheat and barley) is 15 folds.
Tree planting in this area in addition to increasing economic income and capacity building of residents caused soil conservation and created hope and believe between them. This project deleted the opposite targets for land using and protecting. This project directed all activities in the direction of sustainable exploitation. It means reducing soil erosion and increasing economic income of residents. Another effect of this project is the reversal of the immigration process. Many young people are now willing to come back to the rural region.
Many local residents migrated to cities due to the lack of employment opportunity and fortunately are coming back with development since applying this project. Increased recreational opportunities due to gardens establishment, improving cultural opportunities, increasing conservation knowledge, improving situation of socially and economically disadvantaged groups, improving food security are the others benefits of this sort of technology.

Conclusions

Assessment of soil and water conservation technologies in Dejkord with WOCAT programme indicated the success of Ecological, Economical and Social aspects. The Ecological impacts of applied technologies in this project are plant diversity, reduction in surface runoff, and soil erosion. This project has been more successful in social and economic sections. One of the successful aspects in this region, is the resident acceptance of introduced projects. Public offers for excuting this sort of project is very high. People around Dejkord village are encouraged by observing demonstration fields. The office of natural resources is under pressure to prepare opportunities for performing executive projects. Poverty alleviation is second interesting result of this project. Creation of job opportunities such as providing job for employment workers (even non-resident) in the season of fruit harvesting and providing opportunity for employment of educated young people and study at universities in the field of agriculture and watershed management.Reversing the trend of migration process from rural to municipal areas is the third important outcome of this project. The fourth effect of this case study is executing sustainable development for the region.Implementing the WOCAT questionnaires in this case study was easy due to availability of required data in the fields of Ecology, Economic and Social sectors. In brief, application of these technologies help watershed residents to have more income and providing opportunities for future to have a representative area for sustainable development.

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Zoning of the Groundwater-Level and Salinity Using Geostatistics in Chaldoran Plain of Iran

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Abstract

Currently the groundwater-level of Chaldoran Plain exhibits a decreasing trend. This study was conducted to investigate spatial variation of the groundwater-level and salinity in this area. For this reason the data of the 73 piezometric wells of this region were collected. Then by kriging method, the groundwater level and salinity maps were obtained. Results showed that by applying kriging method for estimation of the changes in groundwater effective radius, nugget effect and sill of the variogram obtained 47770 meters; 0.1 and 311.1, respectively. There is a significant correlation (r=0.874) between the measured and estimated data. The amount of spherical variogram efficiency radius of the salinity is 14400 m and its correlation coefficient is 0.88. In the Cross Validation method, correlation coefficient between predicted and measured data for the groundwater level and ground water salinity are 0.77 and 0.79 respectively.

Keywords: Geostatistics, Groundwater, Nugget Effect, Salinity, Sill.

Introduction

Currently about 90% of the groundwater aquifers of West Azerbaijan province are utilized and 6 major plains of this province are encountered to deficit of 44 million cubic meters and continuous decline in groundwater levels. The recently large variations of groundwater levels over years in many parts of this province, suggest a detailed study to be undertaken to elucidate the behavior of groundwater level fluctuations in spatial scales. A very useful tool for analyzing such processes is geostatistic (Rouhani & Wackernagel, 1990). Ahmadi et al (2007) used geostatistic for spatial and temporal analysis of the monthly groundwater level fluctuations of 39 piezometric wells. Their results revealed that groundwater level drop and groundwater level fluctuations were underestimated by 3% and 6% for spatial and temporal analysis, respectively, which are very low and acceptable errors and support the unbiasedness hypothesis of kriging. They stated that kriging is a beneficial and capable tool for detecting those critical regions where need more attentions for sustainable use of groundwater.

Hu et al. (2005) investigated the north China plain groundwater variability using kriging method and prepared maps of groundwater levels and ground water salinity. They showed that shallow groundwater levels in this area tended to increase from the north to south across the county, and groundwater level decreased on average 6 m compared to the level measured in 1990, 9 years ago.

Samani et al., (2009) reported that the combination of GIS and kriging method is a powerful tool for the application, processing and analysis of spatial and temporal variations in groundwater salinity.

This study was conducted to investigate spatial variation of the groundwater-level and isalinity in Chaldoran Plain.

Material and method

Chaldoran Plain located in the north of West Azerbaijan province in Iran (39□ 05' N & 44□ 21' E) (Fig. 1). The average annual rainfall of this region is about 450 mm and includes semiarid climates.

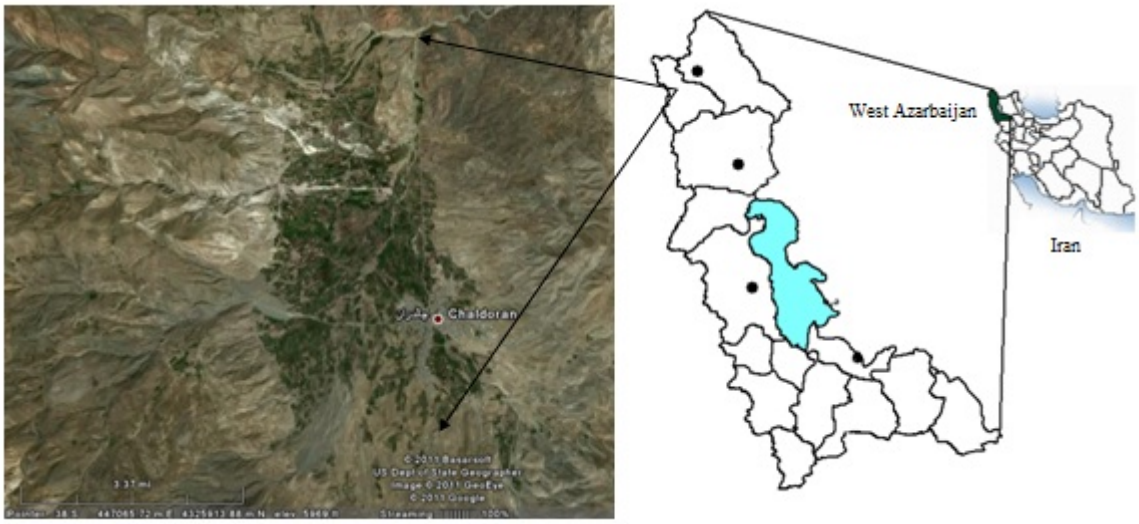


Figure 1: Study area (Chaldoran Plain - West Azarbaijan province – Iran)

For this research the salinity and groundwater-level data of the 73 piezometric wells of this region were collected. GS^+ and ARCVIEW8 softwares were used in this study. In order to check the anisotropy in the groundwater level variograms in several directions were compared. Spherical, exponential, Gaussian, and pure nugget effect models used to compute the variogram values for any possible sampling interval. Validity of the developed variogram model was tested by cross-validation technique. The most appropriate variogram was chosen based on the highest correlation coefficient by trial and error procedure. Kriging technique as an interpolation estimator used to find the best linear unbiased estimate. The most commonly used models are spherical, exponential, Gaussian, and pure nugget effect (Isaaks & Srivastava, 1989).

Result and discussion

Statistical profile of the ground-water level and salinity in Chaldoran plain are presented in Table (1). The spherical model fitted to the experimented Variogram kriging method of groundwater levels, is shown in Figure 2. Results showed that by applying kriging method for estimation of the changes in groundwater effective radius, nugget effect and sill obtained 47770 meters; 0.1 and 311.1, respectively. There is a significant correlation (r=0.874) between the measured and estimated data. The amount of spherical variogram efficiency radius of the salinity is 14400 m and its correlation coefficient is 0.88. In the Cross Validation method, between predicted and measured data for the groundwater level correlation coefficient is 0.77 and for the salinity correlation coefficient is 0.79.

Table 1: character of the ground-water level & salinity

	Ground-water level (m)	Salinity (µs/m)
Mean	9.3	183.6
Maximum	55	1270
Minimum	0	0
Skewness	2.56	2.08

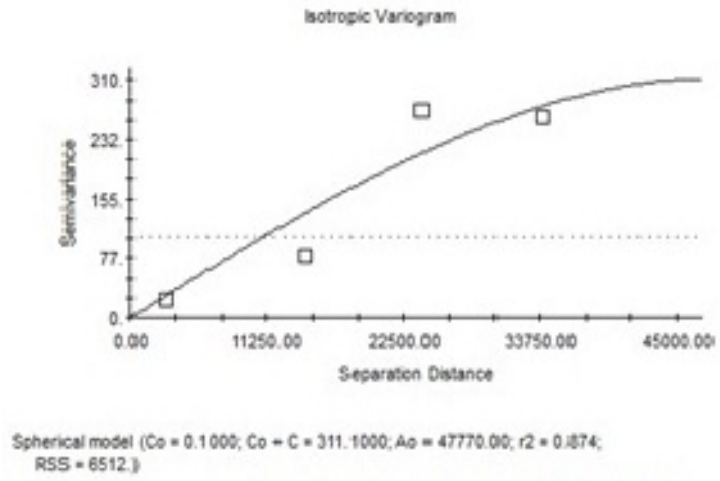


Figure 2: Variogram groundwater level

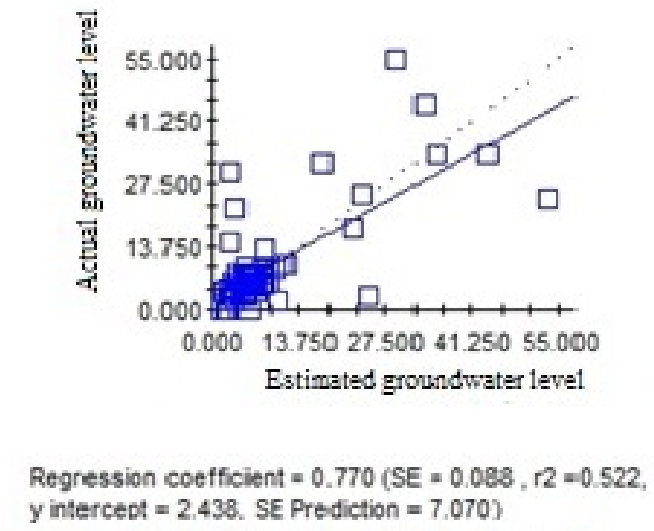


Figure 3: Cross validation of actual and estimated groundwater level

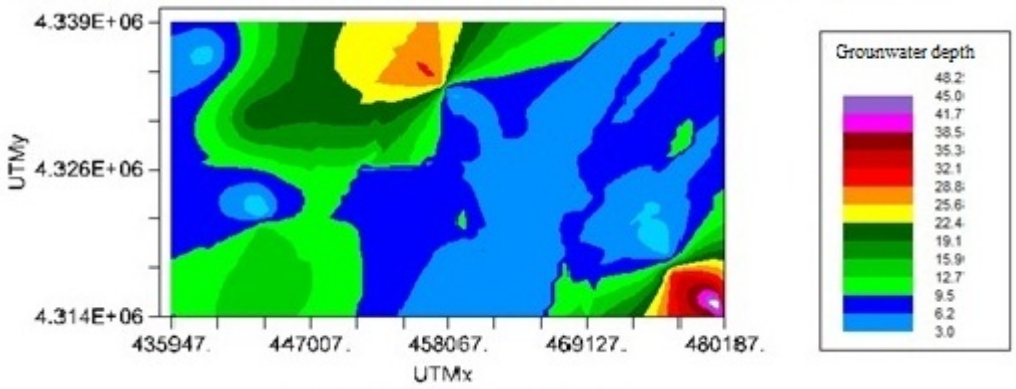


Figure 4: Spatial groundwater level map

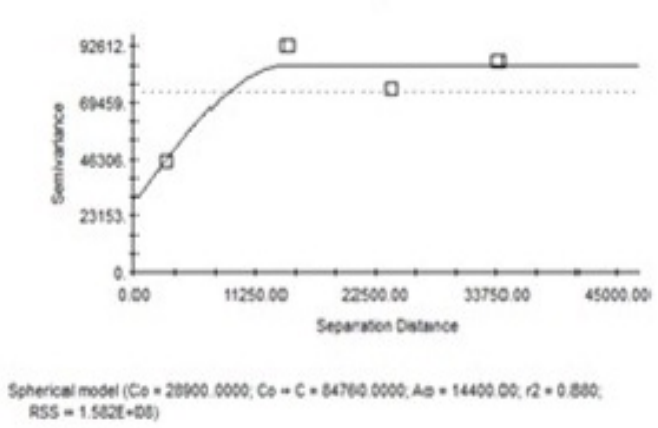


Figure 5: Salinity variogram

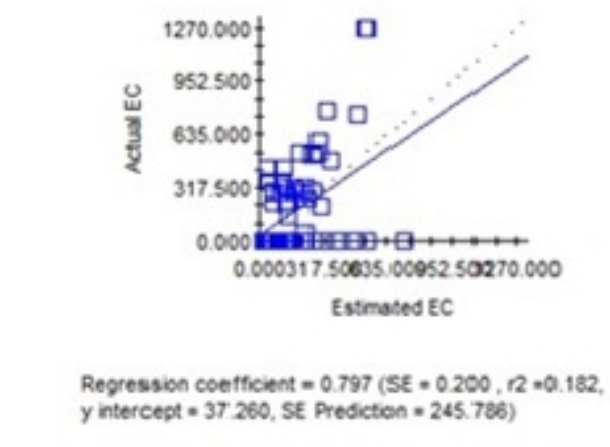


Figure 6: Cross validation of actual and estimated salinity level

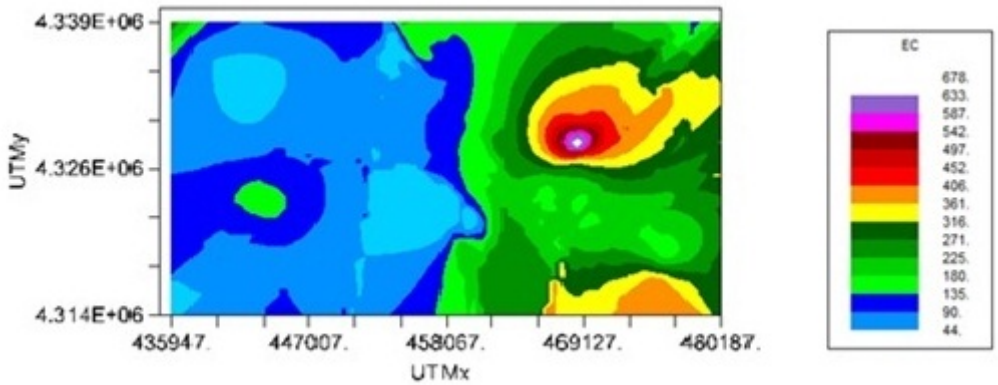


Figure 7: Salinity spatial map

According to this result, the minimum groundwater level in the western part of the eastern plains was identified. Therefore changing the pattern of cultivation and growing those crops having low irrigation water requirement in this part are highly suggested. Fortunately, the water salinity is not in a critical condition.

Acknowledgment

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Designing, Manufacturing, and Calibrating a New Portable Wind erosion Simulator

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Abstract
Dust storms are known as important problems in arid regions. Field measurements of wind erosion and its simulations in laboratory can be so useful for its control and preventions. In this research a new portable-stationary wind erosion simulator designed and manufactured in computational fluid dynamic (CFD) laboratory for dust storms simulations, wind erosion measurements, and investigating its control's methods. This simulator consisting of a diesel motor and axial suction fan as motivator section for producing wind flow through the test section. Ten cross section parts compos test section and measurement section with 8 meter in length. Measurement section consists of a hot anemometer, isokinetic optic dust measurement, sediments catchers, and saltiphone. Current simulator can be portable for use in the field and as stationary wind erosion simulator for laboratory investigations. The simulator calibrated for use and simulates dust storms everywhere. This device can simulate storms with 1-25 m s^{-1} in wind velocity and measure dust concentration between 0-2500 mg m^{-3}.
Keywords: Aeolian, arid regions, dust storms, simulator, wind erosion.

Introduction
Wind erosivity and soil erodibilty are two suitable indexes that can describe the potential of soils against wind erosion (Chepil and Woodruff, 1963). Simulate wind erosion in natural condition for each region is an acceptable method for investigate the potential and sensitivity of soils against wind erosion. In several previous years portable simulators were used for investigate the threshold friction velocity, dust emission process, impacts of surface roughness elements, and vegetation on wind erosion as related physical properties of wind erosion (Goossens, 1997; Tsang, 1997; Maurer et al. 2006; Shao, 2008; Fister and Ries ,2009). Due to that, Maurer et al. (2006) designed and used a portable simulator for wind erosion field measurements in Nijer. The test section composed of seven aluminum cross section segment and its length, broad, and height were 940, 0.6, and 0.7 meter respectively. They used this simulator for investigate the sediment flux after its calibration. Fister and Ries (2009) investigate wind erosion in Ebro Basin (Spain) as a result of land use changing and focused on the surface crust. Working section in their portable simulator had 3 m length, 0.7 m wide, and 0.7 m height.
In this research a new portable wind erosion simulator designed, manufactured, and calibrated.

Materials and methods
Portable wind erosion simulator
In this research a new portable wind erosion simulator (*PWES*) designed and manufactured in computational fluid dynamic (CFD) laboratory of Tarbiat Modares University (TMU) for dust storms simulations, wind erosion measurements, and investigating its control's methods.
Some physical parameters are necessary for designing a portable simulator. The most important factor is existing and developing a logarithmic wind velocity profile such as natural condition (Funk, 1993). The length of test section has to be large enough (more than 7 m) to developing a naturally equilibrated saltation layer (Shao and Raupach, 1992).
Due to that Raupach and Leys (1990) showed that homogeneity of air stream trough test section (working section) was better with rectangular cross-section than hemispherical shaped cross-section. Also they found out the suction air stream produce lower and smaller unwanted vortexes into test section than blower type. For that a suction system was used for manufacturing the simulator.
The simulator consisting of four cross sections parts as motivator section, test (or working) section, measurement section, and monitoring section.
Motivator section, produce suction wind flow through the test section and involves a diesel piston motor, a fan, monitoring box, covering box and chassis. Diesel motor conducted to fan directly with a plastic belt and all actions of the on/off, motor rate, rate of the fan, and wind velocity

controlled with monitoring box. All parts of motivator section located on suitable chassis and in the covering box. The dimensions of motivator section were 1.10, 1.25, and 1.50 m.
A replaceable conic entrance (fetch), honeycomb diffuser (with 4 mm diameter for each honeycomb), and ten cross section parts compos test and measurement section with 8.0 0.8, 0.8 m in length, wide, and height respectively and made of visible plexiglass with 6 mm in thickness. Measuring instruments located in the final segment (near to motivation section) and named measuring section. Measuring instrument consists of a hot anemometer, isokinetic optic dust measurement (IODM), sediments catchers (4 modified BSNE and in some tests 4 MWAC samplers), and a saltiphone. PWES can simulate storms with 1-25 m s^{-1} in wind velocity (at 40 cm above the earth surface) and measure dust concentration between 0-2500 mg m^{-3}.
All ten segments connected to each other using plexiglass belt and the measuring section connected to motivation section using a plastic connector for prevention of conducting the vibration of motivation section to plexiglass segments.
Monitoring section shows and save wind velocity, wind fellow, dust concentration, air humidity, and temperature in test section on a laptop. Furthermore dust concentration can be shown as continuous graph (dust concentration against time) trough each test in monitoring section. The general stracture of PWES showed in Fig. 1.

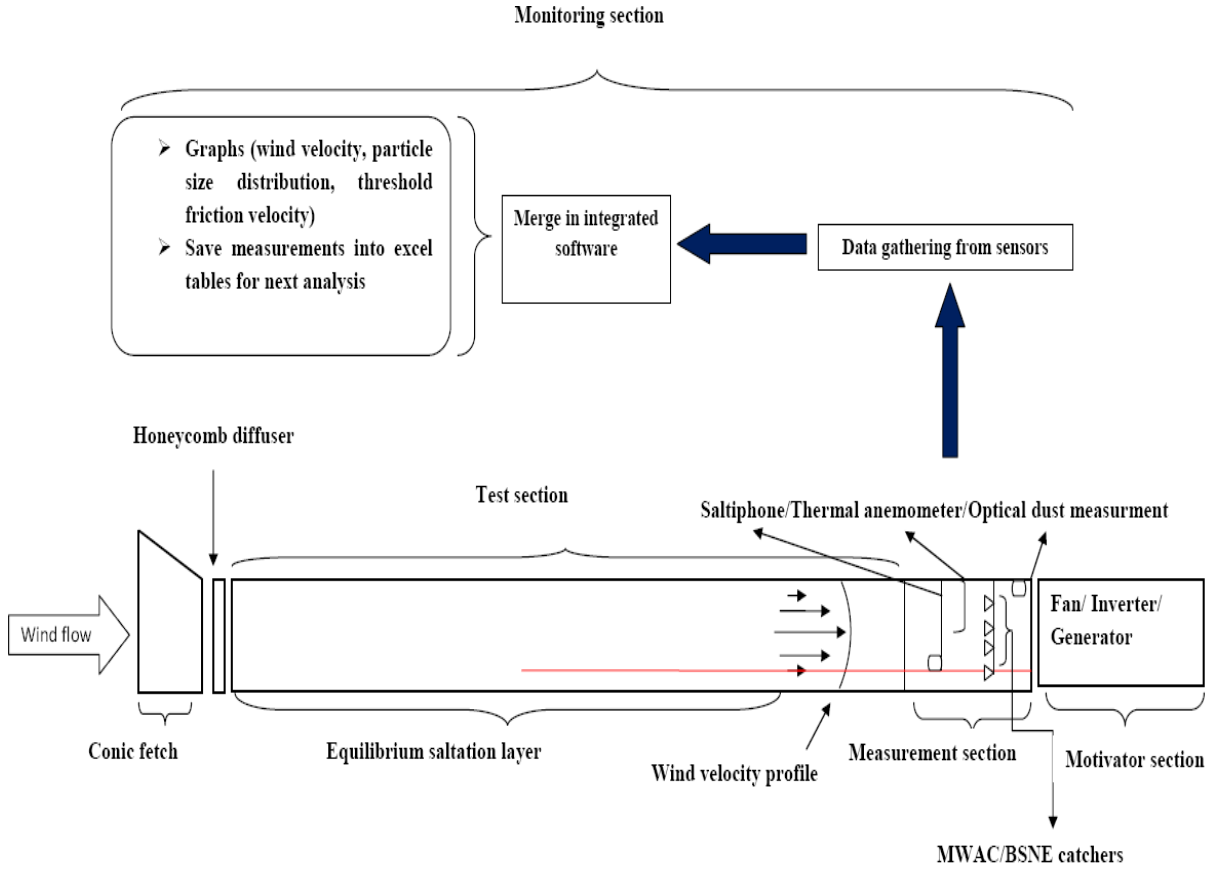


Fig. 1. General structure of portable wind erosion simulator.

Results and discussion

PWES Calibration

Calibration is a necessary step in designing a wind erosion simulator because it will be possible to investigate the aerodynamic parameters of PWES without affects of surface properties. Furthermore it's possible to comparison the results of current and other portable simulators and to proof the suitable operation of the simulator itself (Maurer et al., 2006).
In this step four smooth plexiglass sheets (similar to test and measuring section material) used for cover the earth surface and simulator system vacuumed from all sides using glue.

In four measurement points (in length) and five motor rate, wind velocity were measured in eight height (showed by y) of these point. Distance of measurement points from the motivator section were X_1=0.7, X_2=3.3, X_3=5.9, and X_4=7.7 m and Y_1=0.02, Y_2=0.04, Y_3=0.20, Y_4=0.30, Y_5=0.40, Y_6=0.50, Y_7=0.60, and Y_8=0.70 m. During the calibration tests motor was worked with 500, 1000, 1500, 2000, and 3000 rpm (rate per minute). For full calibration 160 wind velocity measured (4 x, 8 y, and 5 rpm). Fig. 2 shows the wind velocity profile due calibration tests. As it expected, wind velocity increased logarithmically. It seems wind velocity more developed in 0.7 m from downwind (near to motivator section) than other distances (3.3, 5.9, and 7.7) and developing the wind velocity profile increased with increasing the rpm of the diesel motor. Developing the wind velocity profile is necessary to have an acceptable simulation and also its measurements in wind erosion studies. Based on this, measurement section located after most developed point (0.6 m from the motivator section).

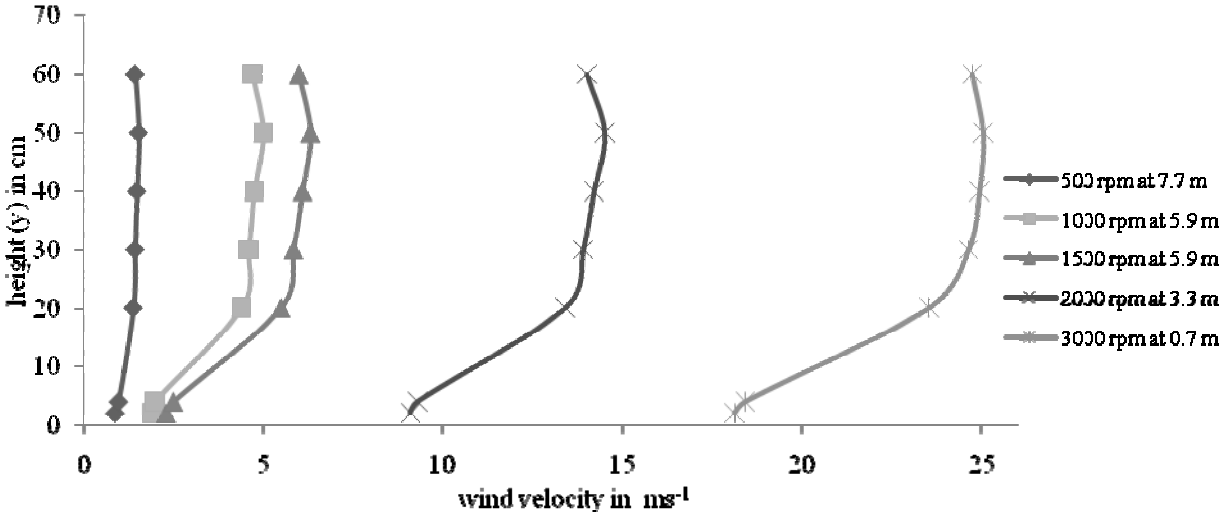


Fig. 2. Calibration results of PWES for 500 to 3000 rpm at four defined points.

Results of calibration were similar to ZALF (Funk, 1993) and CCSI (central climatology station of Iran) stationary wind tunnels and also comparable with portable simulator of Maurer et al. (2006). The general structure of current simulator is closely to portable simulator that manufactured in Hohenheim University of Germany.

PWES promotions

A big limitation in other previous portable simulators was need to generators and its portability. Because the generator was necessary to generate the energy and for big simulators (with powerful fans) a huge generators was essential and a big track was supplied for its transportations. But in our designed portable simulator the generator removed and a diesel motor conducted directly to axial fan. So the portability of our simulator is more than past simulators and all parts can transported with just a small pickup (track).

Furthermore it's possible to investigate the efficiency of passive samplers in the same condition against IODM because it's possible to used 2 type sampler in measuring section at the same time.

Visible plexiglass was a beneficial option because it's possible to see everything in the test and measuring sections while the simulator working. As an experience, in one of simulations the concentration of dust increased suddenly. After checking all sections a rat was seen in the working section that comes through the soil and dust concentration increased unexpectedly as its activities due measurement.

Acknowledgment

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Sensitivity analysis of water surface profile of the soil bed type in natural channels

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Abstract

Cross section and flow velocity in natural channels is used to derive hydraulic flow regimes, then the other flow parameters should be derived and the water surface profile could be analyzed. One of the most important effective parameters on water surface profile is cross section form and channel bed roughness. Hydraulic analysis in natural channels is more complicated and needs to be computed with models because of Disorder in cross section form and lack of uniformity bed roughness. In this research Hec-Ras Model is used to simulate water surface profile in Moghan irrigation channel located in northwestern Iran. Hec-Ras is used widely for open channel hydraulic analysis identified by US Army. Roughness coefficient of Moghan channel is estimated according to bed soil type and bed roughness. In this research roughness coefficient sensivity analysis was assumed to investigate with other parameters in nonprismatic channels. The results show that increasing the roughness coefficient lead up to increasing of water level, also sedimentation of suspended materials in the channel bed, channel capacity decreases sharply. The severe reduction in flow due to the large effect of flow depth is relative to the other hydraulic parameters.

Keywords: bed soil type, natural channel, hydraulic analysis, Hec-Ras model.

Introduction

Water is the life-giving liquid which satisfies many agricultural, industrial and drinking needs. As the reachable water resources are limited, the significance of the optimum utilization of water systems is increasing day by day. The optimum utilization is only possible through an optimum design of irrigation structure and a right management.

Water transmission channels are among the most significant parts of water supply in irrigation networks. Considering the significance of this issue, the necessity of covering big soil channel seams unavoidable. Usually, in our country, irrigation networks are at first utilized through earth and they would be modified and improved in the next years, which provides a special situation for hydraulic regime of the channel. Therefore, it seams necessary to simulate such channels. In order to apply many designs and plans due to organizing the soil channels, it is required to determine water base level and calculate its profile in these channels. A set of hydraulic and soil mechanic information are needed as a computational model and its input parameters in order to determine the profile of water level. In order to simulate the soil channels and natural rovers HEC-RAS simulating models have been applied in different researches.

Johnson et al. (1999), applied HECARS model in order to predict and determine the limits of humid lands along 10 kilometers of Greybull River in Wyoming, U.S.A. Through water deviation toward a new reservoir and determination of boundary conditions with and without deviation in similar scales, they also predicted that the whole area which undergoes flooding would increase from 167.2 to 149.2 through deviation of 28313 liters of water. These scholars believe that this is a reliable method to determine the quality of deviation effects on humid lands of river bank and it should be more evaluated in order to be used in order to specify the humid lands (touched by water) in similar projects .

The River Engendering Research Division of Soil Conservation and Watershed Management Center in Ala basin in Marvdasht, Fars and Damavand drainage basin, applied HEC-2 model to determine the maximum numbers of water base level in considered direction in two mentioned

cases in which the point numbers were manually transferred to specific profiles of the river in topographic plan and the flood affected province was stated in 5 and 25 year return periods. The profile of water level was also plotted for a 25 year return period (Abasi, 1991).
Vahabi(1997) used remote sensing methods, Geographic Information Systems, HEC-1 and Mike11 software along with the provided river profiles in Talighan drainage basin for zoning the flood risk. The banned, limited and permitted arias were specified and the conditions were mentioned in the provided zoning map .
Safari(2001) proceeded to apply the HEC-RAS model for zoning the flood risk in Neka River located in Mazandaran and concluded that this model is highly efficient to calculate the water level and flood affected provinces .
In their research, Shahrokhnia and Javan(2009) determined the sensitivity of hydraulic structures in Doroodzan irrigation network applying HEC-RAS software. In this investigation, in order to investigate the reliability, the mentioned model was at first calibrated with two sets of measured data, discharge and water level numbers. The Manning's roughness coefficient and structure discharge were used to calibrate the model. The sensitivity of structures was estimated. The discharge variation of basins derived by the changes in chokes setting was investigated as well. A new sensitivity coefficient called sensitivity due to variation of channel roughness was introduced in this research. The results also indicated that HEC-RAS model is suitable for investigation and simulation of hydraulic flows in irrigation network of Doroodzan and it can be used as a sort of accurate tool in analysis of such cases .
In this research, the HEC-RAS model was applied in order to simulate the water level profiles in the main channel of Moghan with its soil bed located in North West of Iran.

Materials and Methods

What happens in many hydraulic cases is that the design engineer has to be able to calculate the gradual variations of water depth and other flow characteristics along the channel rather accurately. The effects of basin material of a soil channel and determination of the changes in flow characteristic in upper and lower lands are among such examples.
HEC-RAS software is the advanced version of HEC-2 which has been presented by the U.S. Army Corps of Engineers as a river analysis system. HEC-RAS is a complex software system designed for mutual application in multi-purpose and multi-user networks. This system consists of a Graphical User Interface (GUI), separated hydraulic analysis components, saving capacities and data management, graphical features and reporting.
The present version of HEC-ARS supports the calculation of water level profile for steady and unsteady flows.
The simulation software has been provided in order to calculate the water level profiles in gradually variable states of flows. The system is able to consider a whole network of channels, a branch system or a single interval of the channel the component of steady flow is capable of simulating the water level profiles in sub-critical, super-critic and mixed flows. Equation (1) and Figure (1) illustrate the main computing process based on solution of one-dimensional energy equation through standard step by step method (US. Army Grops of Engineers,2001).

Equation(1): $$Y_1 + Z_1 + \alpha_1 V_1^2 / 2g = Y_2 + Z_2 + \alpha_2 V_2^2 / 2g + h_L$$

Where Y_2, Y_1 is the water level in profile, Y_2, Y_1 is the height of channel bottom from the base level, α_2, α_1 is the weighted speed coefficient, g is the gravitation acceleration and h_L is the friction loss.

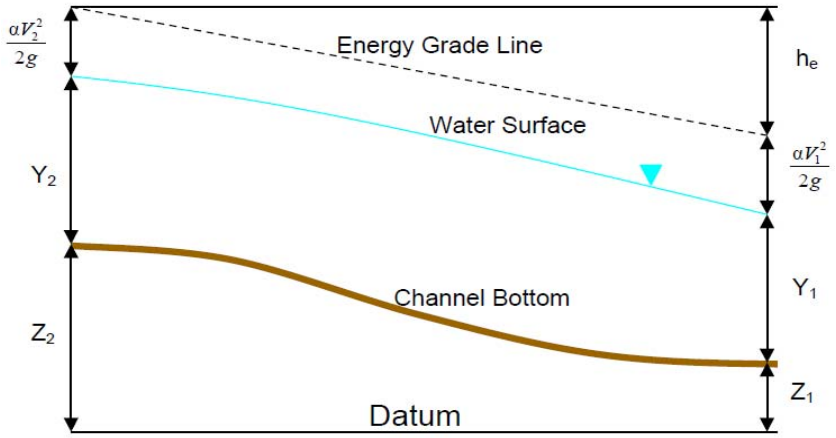


Fig.1. The energy equation between two spots

The studied zone

This research was performed in Moghan zone located in North West of Iran. The main channel of Moghan was generated in 1974 as a soil channel with 80 cubic meter capacity, But after the destruction of channel parapet and the decrease in transmission capacity and loosing the optimum profile caused some problems for this soil channel. This research investigates and analyses the effects of the variation of water level profiles caused by the change in channel basin coverage and the section along the channel and its impacts on regulatory structures (transverse regulators).

Results

In this research, at first, the longitudinal and transverse profiles are extracted by surveying camera and the channel basin material was pacified. The extracted data and the type of channel basin material were entered to the Geometrical features of HEC-RAS model. In this part, the required information such as transverse sections, interval length, Manning coefficient, etc were introduced to the model. This operation would be performed for each of the transverse sections and the longitudinal and transverse profiles would be simulated eventually. In information recording part due to flow characteristics, the information of flow in soil channel was entered and the boundary conditions and channel slope was introduced to the model considering the type of flow regime.

Although this research aims to analyze the sensitivity of water level profile unto soil channel basin material, the existence of hydraulic structures along the main channel affect the water level profile. Therefore, these hydraulic structures were simultaneously simulated as well. The model was performed and the results were concluded after the information completion.

The soil channel basin material varies in different time intervals and transverse sections. Thus, the toughness coefficient which is directly related to basin material and vegetation was entered to the HEC-RAS under different scenarios. Water level profile in soil channels with a roughness coefficient of n=0.025 is similar to figure (2).

This soil channel has been gradually utilized for many years and unprofessional performed dredging has changed it in a way that its preliminary section has been totally wasted. According to the performed investigations, the slope of channel bottom is completely amorphous and jugged which highly affect the changes in channel flow regime.

Figure (3) sows the variations of water level profile unto 0.02, 0.025, 0.03, 0.035 and 0.04 roughness coefficients. In point 1, all of the profiles are congruous because of the water level overflow derogatory structures, but as we move toward upper lands, the water level profile changes as the roughness coefficient increases, while because of a nub on channel bottom in station 14, a critical flow has been created and the sensitivity of water level numbers has reduced compared to the soil basin material, in a way that in lower roughness coefficients, the water level profiles are congruous. The maximum sensitivity is observed in the increase in roughness coefficient from 0.025 to 0.03.

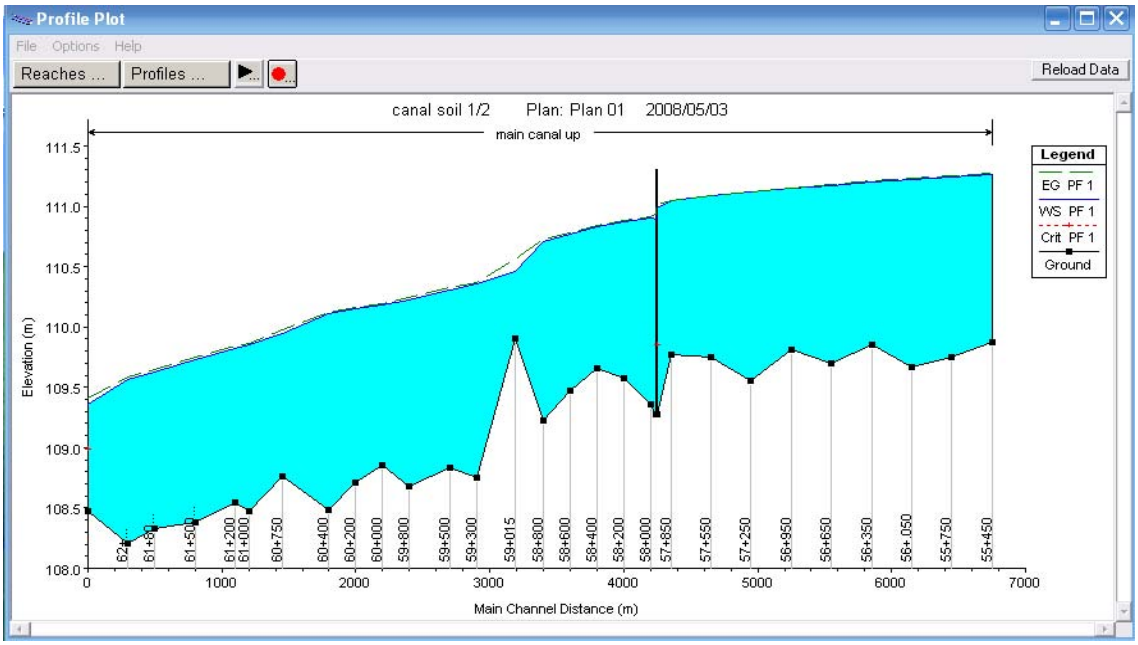


Fig.2. The longitudinal simulated model of Moghan soil channel

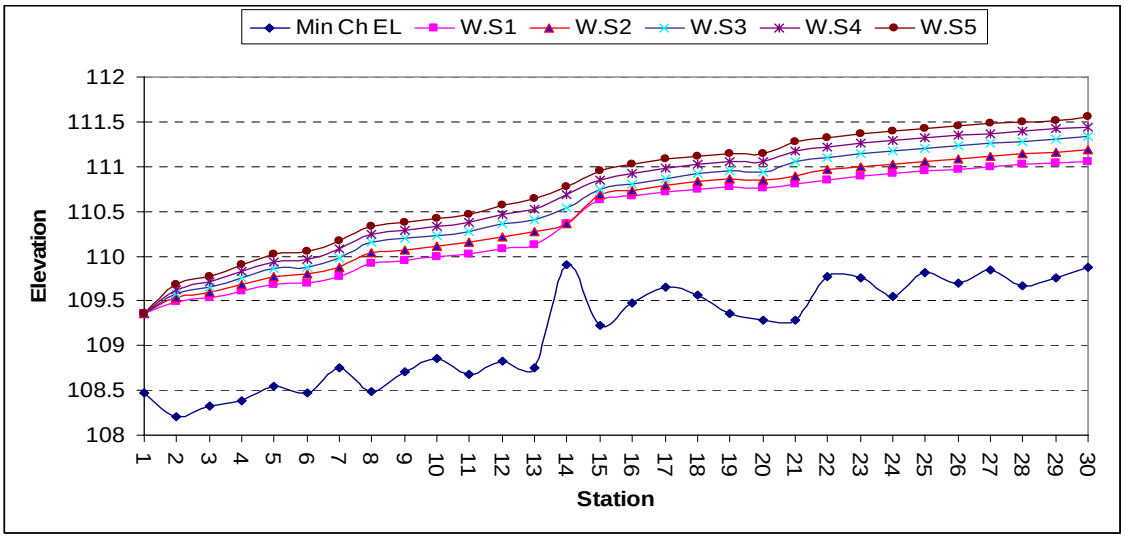


Fig.3. The variation of water base level unto soil channel basin material in different stations

Discussion

In this paper, the HEC-RAS hydraulic software has been applied in order to simulate the soil channel and extract the considered result:

1. The Moghan soil channel has lost its designed geometric section because of improper utilization during many years and it doesn't satisfy the required hydraulic conditions.
2. Considering the inappropriate dredging of this soil channel, the slope of its bottom has changed and caused critical flows were it is upraised.
3. The roughness coefficient is less sensitive to water level variations where these critical flows have been created.
4. The water base level inside the soil channel increases as the roughness coefficient goes up, but the most sensitivity is between the coefficients of 0.02 and 0.025.

5. The roughness coefficient is higher in the left and right bank parapets and this issue is more critical in maximum discharges.
6. Because of the sedimentation of the suspended materials on the soil channel bottom and inappropriate dredging the normal depth of the channel has decreased which reduces its capacity.
7. The impact of normal depth reduction is rather more tremendous on the discharge capacity of the soil channel compared to its width, the slope of sidelong parameters other geometric parameters of the channel.

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Aggregate Stability as an Indicator of Soil Crusting, Soil Erodibility and Sediment Characteristics for Inter Rill Erosion

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Abstract
Crusting and erosion of cultivated soils result from aggregate breakdown and the detachment of soil fragments by rain, and the susceptibility of soil to these processes is often inferred from measurements of aggregate stability. Here, theories of aggregate breakdown are reviewed and four main mechanisms (i.e. slaking, breakdown by differential swelling, mechanical breakdown by raindrop impact and physico–chemical dispersion) are defined. Their relative importance depends on the nature of the rain, as well as on the soil's physical and chemical properties. The relations between aggregate breakdown, crusting and water erosion are analysed, and existing methods for the assessment of aggregate stability are reviewed. A unified framework for the measurement of aggregate stability is proposed to assess a soil's susceptibility to crusting and erosion. It combines three treatments having various wetting conditions and energies (fast wetting, slow wetting, and stirring after pre-wetting) and measures the resulting fragment size distribution after each treatment. It is designed to compare different soils, or different climatic conditions for a given soil, not to compare time-dependent changes in that soil.
Key words: Aggregate stability, crusting, erosion, and methodology.

Study of erosion and sediment production using MPSIAC model in Imam Kandi watershed, Orumieh

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Abstract
Nowadays, population growth and the need for food, employment, housing and economic conditions favorable for the growing population, has increased the pressure on natural resources and the overuse of these resources. The result is nothing but the destruction of natural resources is increasing. In this study, the erosion and sediment production of Imam Kandi watershed using modified PSIAC (MPSIAC) model has been studied. Methodologically, to estimate the erosion rate, the study watershed is divided into smaller units based on geology formations, as the work unit. Then 9 MPSIAC factors were calculated for 8 units of lithology regions. After entering the information and determining the factors affecting erosion, sedimentation map of the area was calculated and classified into five hazard classes. With regard to the obtained values, maximum and minimum productions of sediment are 117.12 and 58.21 m^3 km^{-2} $year^{-1}$, respectively. Also the total amount of sediment produced in 8 units of lithology is 401.61 m^3 km^{-2} $year^{-1}$. The greatest volume of sediment production is in the unit of rock granite and the lowest is in the Quaternary lithic unit.
Keywords: soil erosion, sediment production, watershed of slow, GIS, MPSIAC

1. Introduction

Increase in the current world situation, population and the need for food, employment, housing and economic conditions favorable for the growing population pressure on natural resources the result of the increasing degradation of natural resources is not anything. Obviously, soil erosion and degradation of natural resources as one of the most significant aspects of human life, affecting the very obvious problems such as reduced fertility and agricultural lands (especially in sloping areas where plowing is done in the direction of the slope) and types of mass movements such as landslides, loss and creep that are as natural as it is in the [1].

Iran is also subject to erosion and more severe in the average erosion rate in Iran is higher than the global average erosion because of the uncontrolled exploitation of forest and pasture lands for timber harvest, livestock grazing and harvesting of various products with plant picking protective effect of pasture plants and plants exposed to soil removal and soil erosivity forces, especially wind and water has been grueling It is worth mentioning that the geological formations that Iran was more marl and gypsum are susceptible to erosion also had a significant impact on soil erosion [1; 2].

Officials and experts in order to prevent soil erosion and Loss of valuable source of numerous measures, such as grazed pastures Strengthen and improve the vegetation, rangeland and pasture improvement work and construction of various, but given the limited financial resources and necessary steps should be fruitful economic and operational performance improvement and protection of areas that consistently have the highest rates of erosion may be initiated and loss structures such as dams, water, small and medium-sized dams in the watershed are on the agenda estimating erosion rates and to achieve this important watershed and parts of a field and determines watershed management type, size and location of various measures to protect natural resources [5].

Research conducted by Onsatd [3] showed that the models are often used to achieve three objectives include plans to prevent erosion, water resources planning and design and the quality of surface waters has been finally scheduled.

Thus, studies of erosion and sedimentation in the chain of natural resources as one of the most important and successful of the idea and efficient watershed management plan is very important [4].

2. Materials and Methods

2.1. Study area

Emam Kandi basin in the range of longitude 44°59' 47" to 45° 3' 25"east and latitude 37° 40' 48" to 37° 5' 1 9" North is located. This watershed is one of the following areas for Orumieh in the area of 1420 ha and is located in the northwestern West Azarbaijan province. Minimum height of 1280 meters above sea level and its maximum altitude of 2230 m and 1755 m. The average height is the slope change from 0 to 60 percent of the land with a slope of less than a user is allocated to agriculture. Absolute temperature is at least equal to 5.04 °C and the maximum absolute temperature equal to 12.9 °C. Three villages Maku Kandi, Sultan Abad and within the study area the area is a main road and two roads along the asphalt road in the village of Sultan Abad and villages of Imam Kandi and Maku Kandi by two-way shuttle to the main road asphalt branches are connected Slow access to the basin of Orumieh asphalt road is Salmas.

2.2. Research method

Erosion and sediment yield of the Imam Kandi basin using modified PSIAC (MPSIAC) have been conducted. MPSIAC model with nine of the surface geology, soil, climate, runoff, topography, land cover, land use, land degradation and erosion of river upstream of the annual precipitation in the watershed is estimated to estimate the erosion of the watershed as the unit of work is divided into smaller units and 9 PSIAC factor model modified for each of the 8 units of stone that are intended to work as a unit is calculated, considering the importance and priority to conservation measures and corrective action units for different parts of the watershed is a watershed in the plans.

For estimation of the surface geology and soil quality models used for watershed dam in Khuzestan province were dose and climatic factors and the runoff from the IDF curves and discursive relations and Justin in the watershed was estimated the factors to estimate the topography, land cover and land use and physiographic and vegetation studies conducted in the watershed of the remaining factor of 2 is used to slow erosion and land degradation upstream river and estimated by calculating the total scores of the soil surface (SSF) method.

Bureau of Land Management (BLM) completed For every unit of rock that has been working as a unit deposition rate (R) for each rock unit MPSIAC deposition rate per unit amount of sediment produced in lithological formations determined using the formula provided by the model And in the end what has been calculated considering the SDR rate for 50 percent of all business units, the total amount of And in the end what has been calculated considering the SDR rate for 50 percent of all business units, the total amount of erosion of the rock units at each level (business unit) is calculated (Table 1).

Table 1. Model MPSIAC and ties the score of the nine factors (Johnson and Gebhardt, 1982)

Relation and necessary explanations	Factor
$y_1 = x_1$: The geological characteristics of the hardness index of erosion, weathering, fractures and geological reports obtained from the rock (e.g. rock-hard mass index, or score one and shale, silt stones, lichens, and marine grade or are 10 indicators)	Surface geology
$y_2 = 16.67 x_2$: x_2 is the Universal Soil Loss Equation Soil erodibility coefficient estimates (USLE) in the method of Wischmeier and Smith (1978) estimated	Soil
$y_3 = 0.2 x_3$: x_3 is the rainfall amounts of 6 hours with a return period of two years to weather reports obtained from mm	Climate
$y_4 = 0.2x_4$: x_4 is the height equal to the total annual runoff in mm plus the annual peak flow rate in cubic meters per second per square kilometer multiplied by 50	Runoff
$y_5 = 0.33x_5$: x_5 is the steep of slope is the percentage	Topography
$y_6 = 0.2x_6$: x_6 is the percentage of bare soil	Ground cover
$y_7 = 20 - 0.2x_7$: x_7 is the equal to the percentage of canopy	Land use
$y_8 = 0.25x_8$: x_8 Rubber with a total score of the soil surface (SSF) that the Office of Land Management, United States (BLM) obtained	Upland erosion
$y_9 = 1.67x_9$: x_9 is the managing gully erosion score of the soil surface (SSF)	Channel erosion

3. Results and discussion

The numbers in the table 2 is characterized by the highest volume of sediment in the watershed is slowly on the surface of granite petrology units of the rock formation located on the Qom (OML), Mila (εM), Zagun - Lalun (εZ-l) and Kahar (Pεk) deposition in the middle class granite and the highest production volume of sediment in this formation are rock units of Permian (Pr) and (εb) deposition in the lower classes are finally, Quaternary geology of ore deposits, with the lowest production MPSIAC model described in the very low level of watershed to slow production. The maximum and minimum values obtained sediment, respectively, 117.12, 58.21 of a total of 8 units of sedimentary petrology 401.61 cubic meters per square kilometer is the results of the estimated production rate of deposition and erosion of granite rock units exposed to erosion than other business units are located the lithology of this unit should be located in priority conservation measures and corrective actions, and because most of the visible erosion of rocks in this unit is a drainage ditch erosion of this unit have also the result should be reinforced with vegetation ranging from transplant the main stream and pile on the scope of work and also create a rigid structure of China's waterways and structures in quite a short gabion channel grade 2 and the structure stone cemented in grade 3 and with low to moderate stream erosion control the action. Petrology units located on the Qom formation (OML), Mila (εM), Zagun - Lalun (εZ-l) and bay (Pεk) located in middle-class and second deposition of protective measures are these units should work in erosion and shallow groove along a stream erosion will also occur due to the slip phenomenon in the formation of different ways such as Qom and Mila should be strengthen vegetation and grazed pasture improvement projects along with the construction of building structures considered. Rock units of Permian (Pr) and (εb) of sediment production are too low and the wear tracks and drainage problems in these two domains are stabilized and stream bed depending on the amount of water flow through the creation of vegetation and building structures be considered.

Table 2. Total sediment production and erosion

Described class	Class of sediment yield	Total erosion $_{(m3/km2)}$	Annual sediment production $_{(m3/km2)}$	Coefficient (SDR)	Degree of sediment yield (R)	petrology
Very low	1	161.502	80.751	0.5	58.21	Qtz
High	4	2521.55	1260.775	0.5	117.12	Gr
Medium	3	538.392	269.196	0.5	74.23	OM_L
Low	2	342/676	171.338	0.5	61.68	Pr
Medium	3	779.232	389.616	0.5	84.5	εM
Medium	3	811.292	405.646	0.5	85.62	$\varepsilon_{Z\text{-}l}$
Low	2	487.118	243.559	0.5	71.45	εb
Medium	3	784.034	392.017	0.5	84.67	Pεk

Quaternary deposition of lithological units in the class are very low and the unit is working to preserve and improve the current situation it will Quaternary unit also has a low level and slope of the agricultural lands in this unit is much better at promoting the cultivation and tillage methods and desirable species in the slope of the soil erosion.

Figure 1 shows the final map of sediment yield rate in Imam Kandi watershed using MPSIAC method.

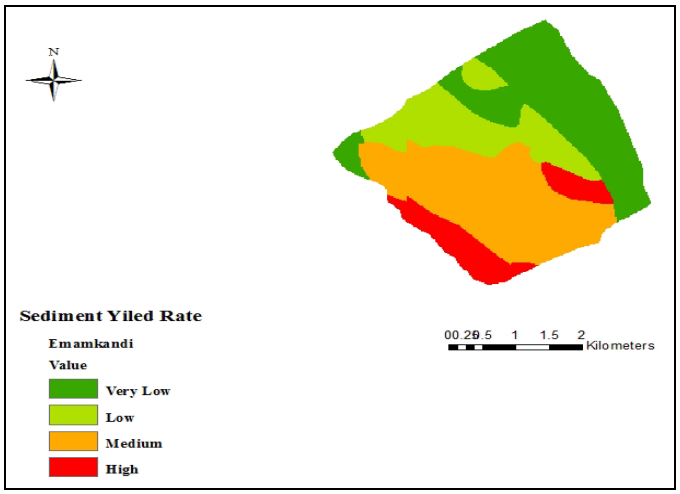


Figure 1. The map of sediment yield rate

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The Knowledge Needs for Vegetables Farmer in Dropping Irrigation Area of Middle part

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Abstract
The research is aimed to determine the level for the know lodge needs of the vegetables farmers , and precognitive the relation ship between the level knowledge needs for vegetables farmer and each of this factors , age , area land , number years of vegetables cultivated number of employing for dropping irrigation , The Attitude toward employing of the anew Agricultural technologies , the middle provinces have been chosen to conduct this research , and it was collecting ratio %50 from it , the sample was authoress from , Baghdad , Babylon , Karbala and West . Stratus congenital random sample was chosen from each province with ratio %1 from vegetables the sample was included of (61) researchers. The measurement was included of 10 items to measure med the level knowledge and laying this level from equitable level, that it was 10 degrees. There search was shown the highest degree was 8, and the less was 3 degree. The mean was 5.21 degree and the S.D was 1.14 degree, and there was relation ship between the levels of knowledge needs with each of the research variables.
Keywords: Dropping Irrigation, Extension, Technologies

Introduction
Vegetable crops occupy an important place in the field of agriculture due to increased demand as a result of the steady increase in the number of the population on the one hand and changes in consumption pattern on the other. And the advantage of vegetables nutritional value high as containing elements and vitamins foundation necessary to build the body (Sherine: 2007) is the vegetable crops of the crop, which occupies the center for the area planted in Iraq, with an estimated (380.50) hectares in 2008 compared to the rest of the crop (Fadel: 2000) The estimated production of vegetables b (4373) tons for the same year (EA: 2001) and given the importance of vegetables in their diets daily for individuals to be increasing the areas planted to increase productivity and this Ittalbi provide minded enough to irrigate these crops, as Water is one of the factors base and indexed in the cultivation crops, vegetables as well as soil and Awaaml climate and agricultural methods new (Abdel-Mahdi: 2001) Due to the scarcity of irrigation water in many areas of Iraq therefore has to be to provide sufficient water for the cultivation of vegetable crops, has become the technologies of modern irrigation one of the methods of the new agricultural reliable implant in cultivation of different crops including vegetable crops. Among these methods, new agricultural in the area of irrigation of crops Green is the style of drip irrigation (total: 2000) that the underlying motivation for the adoption of drip irrigation in many agricultural areas in Iraq is the low amount of water available and the high cost of the year on the water, allowing the drip irrigation system to access the largest amount of production of vegetables and less amount of water and this explains the spread of this method, or (style) in Almknatq dry and semi-arid (Muhammad: 2002). It is worth mentioning that drip irrigation to Ilaim all kinds of crops, it fits in the first place fruit trees kinds, it also fits crops green (Magdi: 2008) has Askhaddm drip irrigation for the first time in the races in the early seventies in the oases that were deployed in Western Sahara in the provinces of Anbar, Karbala Then, use this technique extensively in Najaf, Basra and Dhi Qar to grow green crops (Freddi: 2009). Zimtaz style drip irrigation used in the cultivation of green compared to irrigation methods other balance near the water is added and evaporation - allows to crop the green reduce runoff and deep percolation to the lower than possible, and that the fact that wetting only parts of the surface field limit the growth of weeds, which can consume a part of irrigation water (El-Swaify: 2006). There is scientific evidence that the drip irrigation systems give generally high proportion of vegetable production per unit area and production unit Cjm of water compared to systems of surface irrigation (David: 2008), and there are many reasons for this increase is apparent in the efficiency of water use: -

1 - The frequent irrigation when the root zone provides continuous high moisture content in the root zone, and thus the plants under less strain if the operation of the system in an appropriate manner during the growing season.
2 - The limited surface area of soft Alahachaic reduce the growth and competition for water and nutrients (FAO, 2007)
The Mohammed said, and others (Muhammad: 2003) in his study to a marked increase in the production of vegetable crops compared to irrigation systems other that has been found that there is a possibility for the application of the irrigation system Balatnqit in all kinds of land planted with vegetables saving over other irrigation, which can not be used in all types of land.
The use of drip irrigation system needs to be farmers at the level of knowledge of how to use this modern system for watering crops and vegetables that require workers to your extension to devote effort and Noguethm to highlight the importance of using a drip irrigation system to farmers as a modern system helps to rationalize water use in agriculture agricultural crops in general and vegetables in particular, as well as the use of farmers to this new system requires the intensification of the efforts of agricultural extension workers to explain and clarify and explain how to use this system through a focus on outreach activities and that would increase the knowledge and skills of farmers using this system and through holding seminars and meetings Guidelines and training courses which would satisfy the need for knowledge of the vegetable growers, and from that came this research indicates the following questions: -
1 – what are the needs knowledge of the vegetable growers in the area of drip irrigation
2 – what is the relation between the level of knowledge needs to vegetable growers and all of the following factors (age, area planted, and number of years of cultivation of vegetable crops, and agricultural expertise, and years of use of drip irrigation, and the trend towards the use of new agricultural technologies?)

Objectives:
The research aims to: -
1 - Determine the level of knowledge needs to vegetable growers in the area of drip irrigation.
2 - Identify the relationship between the level of knowledge needs to vegetable growers and all of the factors (age, area planted, number of years of cultivation of vegetable crops, agricultural expertise, the number of years the use of drip irrigation, and the trend towards the use of new agricultural technologies).

Methods and Materials
1 - Research Methodology
Use the style of curriculum loyal to the achievement of the objectives of the present research because it is appropriate to obtain data on the cognitive needs of the vegetable growers in the area of drip irrigation.
2 - Area of the research:
The search included the provinces of Central region of the research and of the 10 provinces have been taking a random sample of the provinces and by 50% to be the number of governorates 5 of the provinces make the current research, namely, (Baghdad, Karbala, Najaf, Babil, Wasit).
3 - Society and the research sample:
4 - Including the research community vegetable growers users drip irrigation system's (580) sowing was chosen proportional stratified random sample by 11% and the number of its members (61) farmer. As shown in the Table (1)

Table 1. Distribution of sample research

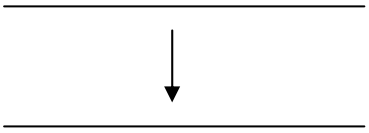
S	Governate	Total	Size of sample N
1	Baghdad	130	14
2	Babylon	108	11
3	Karbala	124	13
4	Najaf	122	13
5	Wasit	96	10
Total	580	61	

5 - Building scale needs

6 - Phase I: Preparation of the meter: Use the indirect method in measuring the cognitive demand of the growers of vegetables and is called the (benchmarking required) and includes the technique measuring the level of knowledge current growers vegetables through testing to ensure (10) paragraphs of the test was distributed to the field of drip irrigation, then be put up standard-class obtained by the subject and which represents the level in this area of the degree of the required level, which represents (10) degrees and thus the difference between the current level is required which represents the cognitive demand of the Quested the following figure illustrates :-

the The required level

Gab need



The current level

Phase II: quantization scale Set of weights (1.0) degrees and one for the correct answer and 0 for wrong answer to the paragraph. Measure the independent variables:

1 - Age: measured by the number of years.

2 - area planted vegetables measured the number of acres.

3 - Number of years practicing cultivation of summer vegetables were measured in years.

4 - Number of years the use of drip irrigation system, measured in years.

5 - the trend towards the use of new agricultural technologies, the use of Likert scale quintet, which includes five levels are (very OK, OK, I do not know, but OK, is OK too) has been given weights 1,2,3,4,5 respectively.

6 - Measurement of validity and reliability:

A - check chiming and honesty mean a measurement mode to measure, the meter has been introduced to the experts in the field of agricultural extension in order to measure the honesty and then view the virtual standard for professionals in the field of drip irrigation and to measure the content.

B - Examination of Persistence:

T - make the first test (pre-test) for this measure in January of the year 2009 on a random collection of summer vegetables, and growers who use drip irrigation system to irrigate vegetable crops, the sample included 10 respondents in order to verify the stability of the scale. As the stability refers to the degree of consensus in the outcome measurement when repeated (12) was used the way the retail mid-term to measure the stability of scale-level knowledge of the growers of vegetables and that after the dismissal of paragraphs individual and even then use the equation of Pearson to

measure the stability of the scale and then corrected using the equation Spearman - Brown has been measure the stability measure of the trend towards the use of new agricultural technologies Alvakrombach equation, because the scale used is a five-point scale (Likert).

The results were as follows: Table (2) shows the reliability coefficient and fitness

Table (2) shows the reliability coefficient and fitness

Kind of scale	Coefficient of consistency	coefficient of power
level of knowledge	0.77	0.87
the trend towards new agricultural technologies	0.83	0.91

7 - data collection Data were collected through questionnaire and personal interview as a way 02/01/2009.

8 - statistical methods: (Salah al-Din: 200 (f) of Lamia: 2008)

Used frequencies, percentages, and the average and the correlation coefficient test and simple T-test.Results and discussion: - First: - determine the level of knowledge needs to vegetable growers in the area of drip irrigation. Emerged from the results that the highest numeric value to the needs of the vegetable growers (8) grades and were less degree (3) degrees and an average account of (5.21) degrees and a standard deviation of (1.14) degrees, as shown in Table 3.

Table 3. Distribution of respondents according to the categories of cognitive emend

Categories of need	No.	%	X	SD
3-4	16	26.2	5.21	1.14
5-6	37	60.7		
7-8	8	13.1		
Total	61	100		

The table above indicates that a higher proportion of farmers were increased by 60.7% when the category (5-6) degree and the lowest proportion of farmers were increased by 13.1% when the category (7-8) the degree and this indicates that most growers Greens have a need for knowledge in the field of drip irrigation, and this refers to the weakness of their level of knowledge in that area due to the lack of implementation of activities and agricultural extension programs in the field of irrigation Balatnqit as well as non-participation of vegetable growers in the area of training courses on cultivation of vegetables through drip irrigation.

Second: Identify the relationship between the level of knowledge needs to vegetable growers in the area of drip irrigation;

1 - Age: The results of the search, the highest age of respondents was 86 years old and less age was 17 years old and Imitate of (51.13) years and drift standard rate of 16.86 years as shown in the table (4), we can deduce from the table (4) that the highest proportion of respondents at age group 41-63 years and by 42.6% The table shows that as increasing age Category less need knowledge in order to accumulate expert knowledge has in the use of technology of drip irrigation as well as the possibility of obtaining knowledge through agricultural extension activities that are exposed or from other sources of information available to him. To find out whether there was a correlation between age of respondents and their need for cognitive use the simple correlation coefficient of Pearson and it is 0.86 and this indicates the existence of a negative correlation between the two variables are significant at the level of significance 0.01

2 - area of agricultural land:
3 - The results of the search that the highest acquisition of gricultural land for vegetable growers were by 90 acres and less possession of the rate of 2 acres and an average of 14.76 acres and arithmetic standard deviation of $ 3.8 acres as shown in Table 4.
We conclude from the table above that the highest proportion of respondents in category 2-31 acres and by 88.6% and this shows that if agricultural land significantly with the Category, which pushes him to increase his knowledge in the field of drip irrigation through the extension activities of different eading to an increase in cognitive needs. To find out what if there was a correlation between agricultural land of the respondents and their need for knowledge use simple correlation coefficient of Pearson and it is 0.46 and this indicates the existence of a positive correlation between the two variables are significant at the level of significance 0.01
3 - number of years of cultivation of vegetables
The results of the search, the highest number of years of cultivation of vegetables to farmers by the respondents was 70 years, the number was less than 3 years, an average account of 24.70 and standard deviation of 406 years as shown in Table 4. We conclude from Table 4 that the highest proportion of respondents to the number of years of farming for vegetables when the category was 3-25 years old and by 60.7%. That means increasing the number of years of cultivation of vegetables leads to reduced cognitive demand of the farmers in the area of drip irrigation in order to gain farm experience and knowledge through a practiced for the cultivation of vegetables and use of this technology. To find out whether there was a correlation between the number of years of cultivation of vegetables for respondents and their need for cognitive use the simple correlation coefficient of Pearson and its value was 0.578 and this indicates the existence of a negative correlation is significant at the level of significance 0.01.
4 - Number of years the use of drip irrigation technology
The results of the search, the highest number of years the use of drip irrigation technology for the respondents was increased by 2 years and the lowest number was zero and the arithmetic average of 5.54 a year and a standard Banhrlv 1.7 years. As shown in Table 4. We can deduce from Table 4, that the highest percentage of respondents were at category 5-8 years old and by 46% This means that the more the number of years the use of respondents to the technology of drip irrigation is increasing level of knowledge of the farms and therefore less need of knowledge in this area and find out what if there was a correlation between the number of years the use of drip irrigation technology for the respondents and their need for cognitive use the simple correlation coefficient of Pearson and it is $ 0.25 which is significant at the level of 0.01.
5 - the trend towards the use of new agricultural technologies:
The results of the search, the highest value reflect the direction of the study sample was to use new agricultural technologies were increased by 38 degrees and the lowest value was increased by 21 degrees and an average account of $ 29.34 degrees and standard deviation of $ 4.25 degrees, as shown in Table 4. We can deduce from Table 4, that the highest proportion of respondents were at category 27-32 degrees and by 49.2%, this means reduced need for the knowledge the greater the tendency farms queried about the use of agricultural technologies and new may be attributed to the aspiration of farms to the new one in the cultivation of vegetables through participation in outreach activities to on the field, and field notes as well as the training courses in this regard led to an increase in knowledge of the field of drip irrigation and thus lead to lower cognitive needs in this area.
To find out whether there was a correlation between the trend towards the use of agricultural technologies and the need for cognitive use the simple correlation coefficient of Pearson and it is $ 0.24. This indicates that there is a negative correlation between the two variables are significant at the level of significance 0.01.

Table 4. The distribution of respondents according to the independent factors

independent factors	Groups	No.	%	r	level of importance	x	S.D
age	17-40 41-63 64-86	19 26 16	31.2 42.6 26.2	0.6-	**	51.13	16.86
Area of erath	2-31 32-61 62-91	54 6 1	88.6 9.8 1.6	0.46	**	14.76	3.8
number of years of cultivation of vegetables	3-25 26-48 49-71	37 17 7	60.7 27.8 11.5	0.57-	**	24.70	4.6
Number of years the use of drip irrigation	0-4 5-8 9-12	25 28 8	41 46 13	0.25-	**	5.45	1.7
the trend towards the use of new agricultural technologies	21-26 27-32 33-38	16 30 15	26.2 49.2 24.6	0.24-	**	29.34	4.25

• * = significant at 0.01 level of significance

Conclusions

Research conclude the following: -

1 - is the technology of drip irrigation of new agricultural techniques and economic use of irrigation water, but most vegetable growers are suffering from a lack of knowledge in the use of this technology and thus lead to the emergence of a need to have knowledge in the field of drip irrigation in vegetable crops.

The following independent factors (age, number of years the use of vegetable cultivation, the number of years the use of drip irrigation, cultivated land, the trend towards the use of modern agricultural technologies) is one of the important factors that help to increase the level of knowledge of the vegetable farmers in the area of drip irrigation. Is one of the factors contributing to higher Alltathir at the level of need for vegetable growers in the area of drip irrigation>

Recommendations

1 - it is necessary to increase outreach activities to farmers who use modern irrigation technologies through training courses, publications and guidance fields demonstration and outreach activities the media (radio and TV) for the purpose of increasing their knowledge of modern irrigation methods.

2 - the contribution of the Ministry of Agriculture and the agricultural extension system in the promotion of vegetable farmers use drip irrigation technologies by supporting the prices of the system.

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Soil degradation in Northern Iran affected by land use change
(A comparing study from different soil degradation indices)

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Abstract

The proper management of soil resources and long-term national and regional planning requires information about the degradation of soil resources. Conversion of native forests to pasture and cultivated area is usually accompanied by a decline in soil organic carbon and nutrients, and an increase in soil erosion. The purpose of this study was to assess the effect of land use change on soil degradation using aggregate stability index (MWD), soil erodibility index (USLE-K), splash erosion and soil organic carbon (SOC). For this reason, 120 soil samples from depth 0-10 and 10-20 cm were collected in three adjacent land uses in Kasilian Watershed in northern Iran including forest, pasture and agriculture area. Splash erosion was measured under laboratory conditions using a rainfall simulator and splash cup. The results of one-way analysis of variance (ANOVA) showed no significant difference between splash erosion at different land use in 95% level. Soil erodibility (USLE-K) and aggregate stability (MWD) indices and soil organic carbon (SOC) have significant differences in two depths between three land uses at 99 percent level. The results of Pearson correlation showed significant positive correlation between the percent of silt (r=0.69, p=0.018) and splash erosion in agricultural area. Also significant negative correlation was obtained between soil organic carbon and splash erosion in pasture (r=-0.767, p=0.001). Our findings can be useful for planners and decision makers to manage northern lands of Iran properly.

Keywords: Land use change, northern Iran, soil degradation, splash erosion rate

Introduction

Rapid Population growth in northern Iran requires additional farmlands for food production leading to clear cutting of forests and converting pastureland to the cropland. Between 1955 and 1999 in north Iran, pasture and forest area have decreased significantly, while arable crop land have increased, particularly in the highlands of the central Alborz Mountains of the southern Mazandaran province of Iran (Emadi et al., 2008). Soil erosion is one of the most serious environmental problems in the world . Soil erosion by water consists of sequential events of particles detachment, entrainment, transport, and deposition. Raindrops are erosive agents that initiate the movement of soil particles. (Qinjuan et al., 2008), in spite of the fact that the presence of organic matter can increase soil aggregate stability and strength. (Gajik et al., 2006). Aggregate stability is considered to be one of the main soil properties regulating soil erodibility . The aggregate size and stability can be an indicator of soil quality changes resulting from different management should be considered in certain circumstances. Soil erodibility (the K factor in the Universal Soil Loss Equation, USLE) is an important index to measure soil susceptibility to water erosion, and an essential parameter needed for soil erosion prediction. Soil erodibility is thought of as the ease with which soil is detached by splash during rainfall or surface flow or both. It is generally considered as an inherent soil property with a constant value for a given soil type and widely adopted as an important factor in soil erosion prediction models, such as the Universal Soil Loss Equation (USLE) (Wischmeier and Smith, 1978), and the Revised USLE (RUSLE). In recent years, many authors, such as Celik (2005), Evredilek et al. (2004), and Emadi et al. (2009) and Khormali et al. (2009) show land use change influence on soil erodibilty. Therefore K, have been used as an indicator for soil quality assessment. Land use change has a great influence on many soil quality attributes mostly through its effect on soil organic matter. Structural stability of soils is affected by land use, which in turn is positively associated with total organic C content (Bouajila and Jallali, 2010; Martinez-Mena et al., 2008; Gajik et al., 2006; Evrendilek et al., 2004). Many researchers have been done recently on the influence of land use change on soil properties and several quality indexes. (Haj Abbasi et al., 2007; Evrendilek et al., 2004; Celik, 2005; Emadi et al., 2008; Khormali et al., 2009).

The objectives of this study include:
- Quantifying the effect of land use change on soil degradation using aggregate stability index, soil erodibility index and Splash Erosion Rate
- Comparison of various indexes on different land uses

Materials and methods

The study area

Kasilian watershed is one of sub watersheds of Talar watershed. It is located in Alborz Mountain between 52 48 E to 53 26 E and 35 48 N to 36 32 N. Kelarestaghy et al (2006), showed that land use change was usually occurred because of forest lands conversion to agricultural in this region. And after several years passed, agricultural lands because of soil fertility losses and low yields were abandoned. Later the abandoned lands were used as pasture for livestock grazing. These lands were abandoned for 8, 15, 30 year periods after land use change.

Sampling and analysis of soil properties

Areas under land use changes were selected based on field practices in the part of Kasilian watershed. In selection of sampling areas, a great attention was taken to select the land uses that are similar in topography, climate, and mother material. Therefore, soil sampling was performed in 3 adjacent land uses such as forest, pasture and Agriculture. In every land use four sites (Celik, 2005) were selected and the samples were collected at 5 points (Emadi et al., 2008; Celik, 2005) and 0-10 and 10-20 cm depth. Thus, all of 120 soil samples were transferred to the laboratory at the right time to measure soil physical and chemical properties of the field in autumn. Physical properties of soil including clay, silt and sand were measured using the hydrometer method. Also organic matter of the soil was measured using Walki and Blacky method.

Aggregate stability index

Mean weight diameter (MWD) was determined using sieve method (Celik, 2005; Li and Shao, 2006; Emadi et al., 2009) and equ.1. Equ. 1

$$MWD = \sum x_i w_i$$

Where: Xi- an average diameter, Wi - the weight of each sieve by total aggregate weight (Haj Abbasi et al., 2007). To measure the apparent specific gravity (Bulk Density) a cylinder with an area of 10 cm 2 was used for collecting the samples from 0-10 and 20-10 cm depths.

Soil Erodiblity Index (k-USLE factor)

Soil erodiblity Index (K) was estimated based on Wishmaier et al. approach (equation 2). (Wawer et al., 2005).

$$k = \frac{0.00021.M^{1.14}.(12-OM)+3.25.(C_{soilstr}-2)+2.25.(C_{perm}-3)}{100} \qquad \text{Equ.2}$$

$$M = (m_{silt}+m_{vfs}).(100-m_c)$$

m_{silt}= Silt% , m_{vfs} = fine sand% , m_c= clay% , C_{perm} = soil permeability class , $C_{soilstr}$= soil structure class , OM= Organic matter%

Splash erosion Rate

To determine Splash erosion rate, Splash Cup were used(Morgan, 1981) and rainfall simulator with 30*30 cm2 (0.09 m2) area (Casermeiro et al. 2004)and 2-meter height(Sutherland and Ziegler, 1998). Splash cup was made by hand with a thin piece of iron based on Morgan (1981) standard plan. It has on outside diameter of 30cm with 10cm height, and an inside diameter of 10cm with 2.5cm height. The inter side of the splash cup has the ability to remove (10 cm in diameter, 2.5 cm in height), which contains holes in bottom to drain penetrative rainfall (Qinjuan, 2008). To prevent soil loss from the holes, the trays were covered by a piece of Watman paper (Qinjuan, 2008) (Fig.1). All soil samples were collected from the top layer (0-10cm) (Sutherland

and Ziegler, 1998) of soil in forest, pasture and agriculture. In the laboratory, soil samples were pre-sieved (2mm) (Ekwu and Maidugury, 1991) and put inside the splash cup. Each soil sample was undergone 10min rainfall periods with the intensity of 3.3 mm/min (198 mm/hr) (Clarke and Walsh, 2007) (Fig.2). At the end of each rainfall period, active soil trays were taken away from splash cup and separately dried (before and after rainfall) by oven for 24 hours at 105 degrees(Legout, et al., 2005; Sutherland and Ziegler, 1998). Later samples were weighed. Splash erosion rate (S) explain the rate of soil that eroded by splash erosion per minute. It is calculated according to the following formula (Luk and Cai, 1990):

$$S = \frac{D_{t2} - D_{t1}}{(t_2 - t_1)A} \qquad \text{Equ.3}$$

Where: S is the splash rate of a given rainfall period (g/min·m2); Dt_1, Dt_2 represent the total detachment after rainfall time of t_1, t_2, respectively (g); t_1, t_2 represent the rainfall time (min); A represents the area of splash plate (m^2).



Fig1- Splash cup and inside tray contain of soil used in laboratory

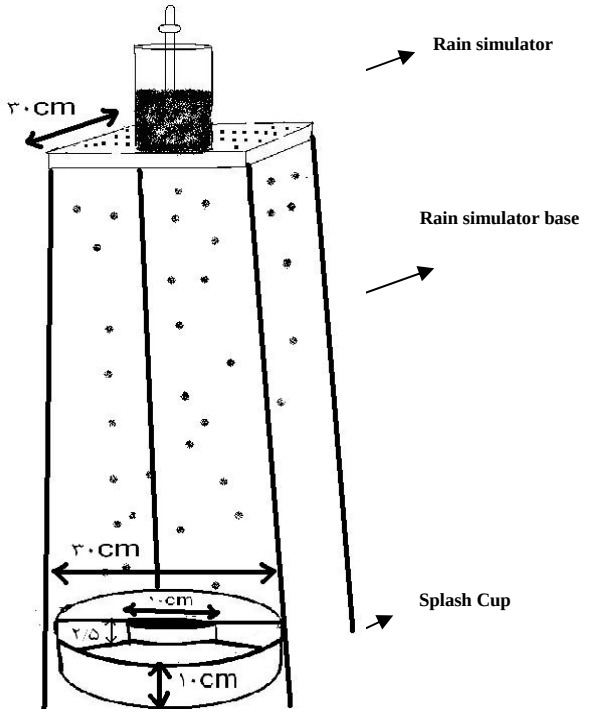


Fig2-View of Rainfall simulator,
Base rainfall simulator and Splash cup

Statistical analysis

One way variance analyze ANOVA and comparison of multiple averages were used by Duncan method at the significant level of 0.05 to compare the MWD, BD, K-USLE, OM%, particle size distribution, splash erosion rates between different land uses. Also present or absent correlation between physical and chemical soil properties with degradation Index, was investigated by Pierson correlation method and the regression relations present at significant level of 0.05. All statistical analysis was performed in SPSS.16 software.

Result & Discussion

Aggregate Stability Index

ANOVA show that MWD had significant differences in various land uses at 95% level. Duncan result showed that there were significant differences between agriculture and forest, also agriculture and pasture in both depths at 99% level (Table1). MWD is considerably larger in forest and pasture than in agricultural lands, this is consistent with Bouajila and Jallali, (2010); Khormali et al., (2009). In the process of conversion of forest and pasture to cultivated land, erodibility

increases due to removal of permanent surface, loss of SOM and stability reduction of aggregates (Celik, 2005 quoted Loach and Pukny, 1995, Miss, 1996, Boiks - Fayus et al. 2001). Khormali et al. (2009) believed that high losses of OM%, increase in silt content, decrease of microbial activity and using heavy cars are main factors for MWD decreasing, following deforestation(Fig2.A.B.).

Table1-Anova result of MWD and K-USLE in different land uses.

Soil Factor		Sample number	mean±S.D	F	P
Splash Erosion Rate	0-10	60	97.08±52.23	0.687	0.507 n.s
	10-20	-	-	-	-
MWD	0-10	60	0.501±0.257	15.815	0.000**
	10-20	60	0.532±0.254	14.836	0.000**
Soil Erodibility Index	0-10	60	0.07±0.123	9.783	0.000**
	10-20	60	0.07±0.14	7.773	0.001**

**P <0.01, *P <0.05

Studies have shown that soils with higher aggregate stability have more stability than being destroyed by soil erosion (Celik, 2005). In the present study there was also negative correlation between the MWD and K-USLE (-0.191) and is consistent with the results.

Soil Erodibility Index (K-USLE)

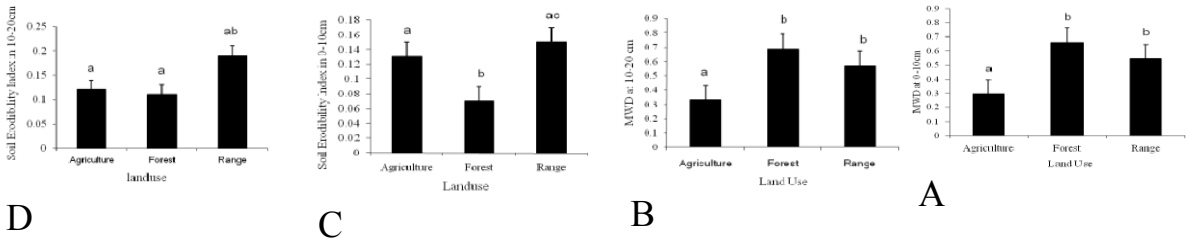


Fig 2- comparison of mean values using Duncan method at 95, 99% levels.

ANOVA analysis show that K-USLE had significant differences at both depths 0-10 and 10-20cm. Duncan result showed that there were significant differences between agriculture and forest, also forest and pasture at 99% level at 0-10cm depth(Table1). Also there were significant differences between agriculture and pasture, forest and pasture at 99% level at 10-20cm depth(Fig2.C.D.).

Celik (2005) have studied soil erodibility index in various land uses and presented that soil farming has higher susceptibility to water erosion than forest and pasture soil. Also Evrendilek et al., 2004); Emadi et al. (2008) and Khormali et al.(2009) reported similar results. However, the finding of this paper emphasized on increase of soil erodibility value due to agricultural practices effect. From this paper it was understood that K-USLE in pasture was higher than agriculture. The reason for this is that pasture is actually conversion of forest to agriculture then agriculture to pasture. In fact agricultural destructive effects and also grazing pressure have double impact on ecosystem destruction.

Splash erosion Rate

ANOVA analyses show that there were not significant differences between splash erosion rates in different land uses.

Correlation between degradation indicators and physical, chemical characteristics of soil

The correlation between Splash erosion rates and soil properties (Legout et al., 2005) was evaluated using Pearson correlation test at 0-10 cm depth. Results showed the correlation between Splash Erosion Rate and OM% in pasture (p=0.001, r=-0.767) at the 99 percent confidence level. Also significant correlation exists between Splash Erosion Rate and silt% in agriculture (p=0.018, r=0.69) at the 95 percent level of confidence(Table2). To select the best models, data were fitted in Excel with a variety of models and the best models were selected with a higher coefficient. In the correlation between splash erosion rate and OM% in the pasture land use, the best model with

explaining factor (R^2=0.63) and in correlation between the splash erosion rate and silt% in agriculture land use, the best model with explaining factor (R^2=0.55) and between Splash Erosion Rate and K-USLE in agriculture land use with an explaining coefficient were selected.

Table2 -Result of Pearson correlation between Splash Rate erosion and soil properties on top soil (0-10cm)

	Land use		Bulk density	MWD	Soil Erodibility Index	OM%	Sand%	Clay%	Silt%
Splash Erosion Rate	Agriculture	Pearson Correlation	0.25	-0.2	0.45	-0.22	-0.31	-0.037	0.69
		Sig. (2-tailed)	0.27 n.s	0.39 n.s	0.04*	0.35 n.s	0.17 n.s	0.87 n.s	0.018**
	Range	Pearson Correlation	0.00	0.00	0.03	-0.76	-0.31	0.29	0.12
		Sig. (2-tailed)	0.98 n.s	0.99 n.s	0.90 n.s	0.001**	0.18 n.s	0.21 n.s	0.61 n.s
	Forest	Pearson Correlation	0.24	-0.03	0.18	-0.17	-0.04	0.02	0.05
		Sig. (2-tailed)	0.28 n.s	0.88 n.s	0.44 n.s	n.s 0.5	0.84 n.s	0.93 n.s	0.82 n.s

**P <0.01, *P <0.05, n.s. There is no significant difference
a. Correlation test of total parameters have been performed with only 20 samples.

Correlation results show that there is significant difference between MWD and BD% (sig=0.259, r=0.046) at 95% level and between MWD and OM% (r=0.433, sig=0.001) at 99% level. Result of Splash Erosion Rate did not confirm the presence of significant difference between various land uses. While different studies emphasized that there exists a correlation between aggregate stability and OM% (Ekwue and Maidugury, 1991). Also in the present study because of existence of significant differences on top soil in various land uses, results of Splash erosion Rate was expected, while result do not show significant differences between Splash Erosion Rate on various land uses. But findings of Sutherland and Ziegler (1998) present the accuracy of laboratory conditions in this paper. Because they also used similar laboratory conditions for rainfall simulation on splash cup. Ekwue and Maidugury (1991) utilized similar aggregate size in measurement of Soil Detachment Rate on Splash Cup. Rainfall duration accuracy used of this study (10min) was consistent with Sutherland and Ziegler (1998). Existence of negative correlation coefficient in pasture land use between Splash erosion and OM% is consistent with what was found by Qinjuan et al. (2008); Gajik et al. (2006); Legout et al. (2005) and Ekew & Midugory, (1991). Also positive correlation coefficient exists between Splash erosion rate and silt% in agriculture land use that do not consistent with Bhattacharyya et al., 2010 and Legout et al., 2005 and in the other sample there was not significant correlation between particle distribution and Splash erosion Rate, but in attention to Pierson coefficient there is negative correlation between Splash erosion rate and sand % in all land uses that conflict to Legout et al. (2005) finding. It presents that sand% increasing can lead to Splash erosion decreasing that it can be due to heaviness of sand particles. Also positive correlation exists between silt and clay% with Splash erosion Rate in all land uses that it can be due to lightness of silt and clay particles and facility of their movement than sand particles. Only in one condition there exists negative Pierson coefficient between Splash erosion rate and clay % in agriculture land use (Bhattacharyya et al., 2010; Legout et al., 2005) that can be due to this problem that by rain drop pressure influence aggregates would be destructed and empty space filled with fine sediment, in result by increasing of clay% Splash erosion rate would be decreased.

Positive significant correlation exists between BD and MWD that conflict to Li and Shao 2006 finding. Positive significant correlation exists between OM% and MWD consistent with findings of Li and Shao, 2006 and Evrendilek et al., 2004. Because agricultural practices destroyed large aggregate and decreased aggregate stability value, these findings are consistent with results of Nardi et al., 1996.

Conclusion

The results of this study showed that changes in splash erosion rate and soil erodibility index trends were similar. In a way that the highest amount of both upper indexes was observed in pasture and lower amounts were in forest land use. Result of this study emphasize on this object that conversion of land use from forest to agriculture then from agriculture to pasture cause soil degradation and create worse condition for pasture while restoration of vegetation is done there. This requires more attention to the re vegetation and soil conservation of pasture and agriculture in this region. Appling special management programs are essential, for example; pasture restoration, livestock grazing programs, regulating the rate of livestock entrance, restriction programs, fertilizer and crop management. While there are no planning and management plans that perform upper factors, susceptibility of water and soil resources in downstream would be increased.

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Floodwater Spreading For Desertification Control in Semi Arid Region of Koohdasht (Southwest Of Iran)

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Abstract

In arid and semiarid regions, this phenomenon is much more fragile than areas. Reducing groundwater is a kind of drought that due to excessive extraction of underground water resources has been created. Proper use of land and water is the best way to prevent desertification. Prevent flooding in desert areas are now one of the best methods is to solve this problem. Thus, in many arid and semiarid ecosystems other Flood desertification is a major key. The most important achievements of spreading Flood are artificial recharge of aquifers, the establishment of fruit trees, trees, forage production and reducing flood risk. In the plains of Koohdasht and Romeshkan (100 km south west of Khorramabad city in Lorestan province), this plan is implemented. In order to stabilize the suspended solids and artificial recharge aquifers in alluvial fans on the edge of the Roomeshkan and Koohdasht plains about 26,000 ha land with capacity of 200 million cubic meters had been allocated (in1996).More than ten Flood Spreading Networks was chosen in Koohdasht Plain 3000 and 2000 ha for the lowland plains of the southern margin of the East and Rome. That same year, over 250,000 seedlings of annual and biennium Eucalyptus, fig, olive and acacia was planted on the Flood. All flood events during the years 1996 to2010 has reached 180. Many events have been 12 times a year. Volume of flood trapped 45 / 0 to 20 million cubic meters per year respectively. Volume during the flood trapped 15 years has amounted to 220 million cubic meters. The flood, trees and plants working, restoration and maintenance of pastures and marginal alluvial fans, plains to the lush area has become. More than 200,000 trees and 3,000 ha of pasture have been restored. The establishment of canopy trees more than 90 percent and 75/52 percent of the 5 / 82 percent is reached. Canopy from 75/52 percent to 5 / 82 percent is reached. These achievements include the licensing of wells, to reduce damages in flood plains and Romeshkan and Koohdasht, increasing agricultural output and construction of gardens and farmers' income has increased.

Keywords: Floodwater, Desertification, semi arid, Lorestan, Koohdasht.

Introduction:

Many people know flooding as a sign of God anger. Is flood a roaring and muddy, natural flow? After sediments were deposited in, the water remains is clear so it is the source of life.

Really, which reservoir is better than the course alluvial for store abundant water volumes in environment? Annual water harvesting is 13.5 million cubic meters so during the ten years of project implementation 130 million cubic meters of water have been stored. Project Site is of coarse alluvial plain of Koohdasht and its objectives are as follows:

Artificial discharging Koohdasht aquifer and increasing water table level.

Flood prevention.-

Drought Management.-

-Water supply for pastures and trees on the flood spreading field.

-Identify appropriate methods of flood spreading which are suitable to area.

In this plan for flood control and infiltration, the interval operations were performed as fallow:

1. Reduce water velocity in the upper stream by creating check dam and Gabion.

.2.Building stilling basins and desalting basins

3. Creation of channels and Blankets which was compatible with land slope.

4. Spreading floodwater by using different methods.

Materials and methods

Project Location Profile:

Koohdasht County is a part of the Karkheh basin. The county is located between 33° 24′ to 34° 38′ northern latitude and 47° 27′ to 47° 49′ eastern longitude.

Area = 456 kg m

Average height = 1030.6 m

Average annual rainfall = 420 mm

Project Site slope is between 5 to 30 percent.

Design and Construction of Floodwater spreading:
Three floodwater spreading fields are in margins of Koohdasht plain (3000 ha), a floodwater spreading field is in roomeshkan plain and another field is in the Keshmahoor plain (4700ha).
Respectively from the upstream, different operations included checkdam, Gabions, stilling basins, water diversion channels, reservoir Blankets and large plots (with a volume about 1200000 cubic meters) have provided a potential for infiltration and reservation of floodwater.
Restore rangelands and destroyed forests by planting about 200000 trees with different species such as figs, olives, hair, pistachio,pistachio,cypress,eucalyptus and acacia in the fields has been done with irrigation in the first year and one time in the second year. Between 90 to 96 percent of different species have been survival and establishment.
Rangeland rehabilitation, protection and seeding of rangelands in the degraded areas in the field were be done.

Table 1: Volume of performed operations in the field

Area name	Date	Area (ha)	The volume of stilling basins &spillways (m^3)	The volume of channels (m^3)	Number of planted trees	Restored rangelands (ha)
Koohdasht	1996-98	3000	64000	291000	92000	3000
Roomeshkan	1992-99	6000	100000	800000	75000	2000
Keshmahoor	1999	500	7000	68000	3000	1000

Results and Discussion
-Most important achievement resulting from the Project after 10 years, providing a Model for floodwater spreading operations in mountainous areas while Weakness of this method is reduce permeability of catchments and loading large volume of sediment in the field.
Water harvesting for different years (Between 6 to 13 times a year).-
-In the Koohdasht area in 10 years after execution of the project only once, the flood damage has happened while before the Project annual flood damage has been existed.
-Average annual total volume of harvested Water is 135 million cubic meters. During 10 years more than 120 million cubic meters of flood water has been infiltration.
-About 5000 hectares of low efficiency and destruction lands in the Koohdasht, Roomeshkan and Keshmahoor have been restored and protected. This trend has continued so that percentage changes in canopy cover is 82.5 percent (at significant level 0.01).
-Amount of forage production in the field is 1370 kg and in the similar lands that they are outside the field this amount is 210 kg.
- about 200,000 trees in Koohdasht, Kshmahoor and Roomeshkan areas is adapted, so that they have created two green belts in the margin of Koohdasht and Roomshkan plains. Positive changes in environment has occurred and provided habitats for birds and reptiles in region.
Soil organic matter and soil Slum were improved.
Percentage of bare soil in the field 6 percent and in the outside the field this amount is 65 percent.
Economic justification:
Since socio – economic benefits of plan still have not been precisely calculated, so with a simple analysis the plan can be justified.
Project life is 20 years, but it can be increased up to 50 years by management.
Flood damages related to before the implementation plan is the 50 percent of the total project cost.
Maintenance costs are 10 percent of the total initial cost.
Annual amount of stored water is 13 / 5 million cubic meters.
Increase in the amount forage production and gardens and Expand the area under irrigated (2500 ha).
Finally, we can conclude that only by reducing flood damage, saving water and increasing income, Benefit to cost ratio.

The effect on table level:

Despite the increase in rainfall and the decrease in exploitation, Groundwater table level shows a declining trend. But a change of direction in declining trend of table levels can be observed in 75 year that coincided with the implementation project. Despite the decrease in rainfall from year 76 onward, the trend of rising ground water level is visible, this trend continues up to 78 year.

Significant effect on vegetation:

When the project started until now, more than 250,000 different species of trees have been planted that their survival up to 90% has been reported. In addition to planting trees, the flood spreading has had a clear role in restoring vegetation (3000 ha). Comparison of dry forage production within the aquifer area (1374 kg/ ha) than outside the region (211.7 kg/ ha), a large change in forage production for farmers provided. Compare the amount of cover within the Flood spreading area (average 85%) and outside the arena (about 29%), shows the effect of flood spreading on the drought control.

Results of analysis of variance table relating to the plant canopy (Table 2) shows that the percentage cover inside and outside the aquifer area, there are significant differences in the level of 0.01.

Table 2: analysis of variance table relating to the plant canopy

Source of variation	DF	MS	F
Repeat	19	9.95	2.5
Cover	1	27878.4	727.99
Error	38.29	1 1	
Total	39		

Review the results of analysis of variance (table3) shows the total amount produced inside and outside the aquifer area and the dramatic differences are significant in the level of 0.05.

The mean test and Duncan test showed that the average production of 137.42 and 21.17 grams per square meter, respectively, for inside and outside the field in the aquifer is a significant percentage difference.

table3: analysis of variance the total amount produce

Source of variation	DF	MS	F
Repeat	4	251.15	585
Cover	1	33782. 83	78.63
Error	4	429.63	
Total	9		

Looking at the amount of litter amount focused on two areas of difference between inside and outside the arena with an average of 25.5 and 65.5, respectively, for inside and outside the aquifer does not exist. The statistical tests also confirmed with Duncan is the same that. Has increased to three times.

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Investigating spatial variations of Modified Fournier Index in Kan watershed

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Abstract

Rainfall erosivity is one of the important factors in erosivity equation. Rainfall erosivity is determined by two methods of direct measurement and using indices. Direct measurement of the power of rainfall erosivity at wide level and for all rainfalls is difficult and time-consuming task. Thus, different researchers by simultaneous measurement of soil loss and rainfall specifications and the relationship between them, achieved some indices based on rainfall specifications. In this study, to provide the map of rainfall erosivity in Kan watershed, modified Fournier index is extracted and calculated for 40 rain gauge and pluviograph stations with statistical period of 20-25. To provide the final map of rain erosivity by the use of modified Fournier index, different methods of geostatistics such as Kriging, inverse distance weighted with different powers and spline were analyzed. The results of the studies showed that ordinary Kriging method with Mean absolute error of 13.3 has the minimum error among other interpolation methods and in contrast inverse distance weighted method with power 1 with Mean absolute error of 15.8 has the highest amount of error. According to the obtained map, the minimum and maximum amount of modified Fournier index in Kan basin are about 28, 107 mm, respectively with the mean of 79 mm.

Keywords: Map, Interpolation, Kriging, Rainfall erosivity

Introduction

The concept of rainfall erosivity was presented by Wischmeier and Smith in 1958 (Wischmeier and Smith, 1978) to consider the influence of climate on raw erosion. Rainfall erosivity is determined by two methods of direct measurement and using indices. Direct measurement method is a good method to determine the power of rain erosivity that is done through the estimation of splash value. Because of the fact that direct measurement at wide level and for all rainfalls is difficult and time-consuming, various researchers (Wischmeier and Smith, 1978; Salles and Poesen, 2000) by simultaneous measurement of soil splash or soil loss and rainfall specifications and the relationship between them, achieved some indices based on rainfall specifications. Using these indices and without the need to direct measurement, rainfall erosivity power can be determined for different regions (Alipour *et al*., 20l2).

Generally, rainfall erosivity indices are divided into two groups of indices based on kinetic energy or rainfall intensity and the indices based on available statistics of rainfall. In the first group, to some extent, rainfall intensity or kinetic energy or both are used in providing erosivity index (Alipour et al., 2012). Some of the most important indices of this group are EI_{30} (Wischmeier and Smith, 1978), AI_m (Lal, 1976), KE>1. One of the problems of the indices based on kinetic energy and rainfall intensity is that they require long-term statistics (more than 20 years) of rainfall intensity (with short-term interval) of meteorology stations equipped with rain gauge. As there is no such statistics in most of the regions in the world, namely, for long-term periods, thus, researchers by available statistics of rainfall that are provided easily in rain gauge, they could present simpler indices. These indices are obtained whether via regional analysis of sediment production or via correlation and relation with EI_{30} index. One of the most famous indices of this group is modified Fournier index. This index is also named the FAO index because FAO used it to establish erosion risk in the North Africa and Mediterranean (Freimund and Renard, 1994; Ferro et al, 1991). Arnoldus (1977) besides the study in Marakesh showed that Fournier index has weak correlation (R^2-0.55) with EI_{30} values in 178 stations (164 stations in America and 14 stations in the west of Africa). Arnoldus (1977) by the same data and using modified Fournier index as independent variable and EI_{30} as dependent variable obtained a relationship with high correlation (R^2=0.83). Lal and Elliot (1994) consider this index an approximation of EI_{30} index for the regions without rainfall recording stations or with short-term statistics of the mentioned stations. In the south of Italy, Ferro et al., (1991) calculated erosivity index by the statistics of 41 rainfall recording stations, then established modified Fournier index of regression relationship between EI_{30} and

climatic parameters such as annual rainfall, height, average annual number of rainfall days, 1 hour rainfall, 6 -hour rainfall, 24- hour rainfall with return period of 2 years and considering correlation coefficient (R) and mean squared error, the best index was determined. Finally, by modified Fournier index and Wischmeier EI_{30}, rainfall erosivity map was provided.
In Malaysia, Shamshad et al., (2008) to determine the factor of rainfall erosivity of RUSEL model, three methods were used. In the first method, rainfall data (P) and rainfall period (D) were used. In the second method, monthly rainfall data is for the days with the rainfall of more than 10mm (rain10) and the number of rainfall days with more than 10mm (10 days) and in the third method, modified Fournier index was used. The results indicated that modified Fournier index with mean squared error 164 (RMSE=164.6) was introduced as the most suitable index. Wilkes and Sawada, (2005) by rainfall statistics of 453 meteorology stations estimated the factor of rain erosivity by modified Fournier index and then, by statistical interpolation methods, provided the annual and monthly erodibility. Ogedengbe et al., (2008) to provide isoerodent map of Nigeria and the determination of rainfall erosivity index of USLE and RUSLE used modified Fournier index. By using the mentioned index, the value of rain erosivity factor was at minimum 100 and maximum 1750 ($mj.mm.ha^{-1}.h^{-1}.years^{-1}$) in northern and southern parts of Nigeria. In addition, by isoerodent map of Nigeria was divided into erosion risk regions.
By selecting the best index and calculation of its values as plotted in meteorology stations, rainfall erosivity maps (Is erodent maps) can be plotted as zonal. The purpose of the study is to calculate modified Fournier index in rain gauge stations of Kan watershed. Also, the evaluation of different methods of interpolation to provide rain erosivity map in Kan watershed is the other aims of this study.

Materials and Methods

Kan watershed as one of the central sub-watersheds in Iran is located in Tehran province and is bounded by Alborz Mountain to the north, Tehran city to the south, Wide Mountains of Hesar and Kadku to the west. This basin is located within the longitude of 51º10' to51º22'E and latitude of 35º46' to35º57'N. Keshar, Sangan, Rendan and Kika are important branches of this basin. Figure (1) shows the location of Kan watershed of the selected stations.

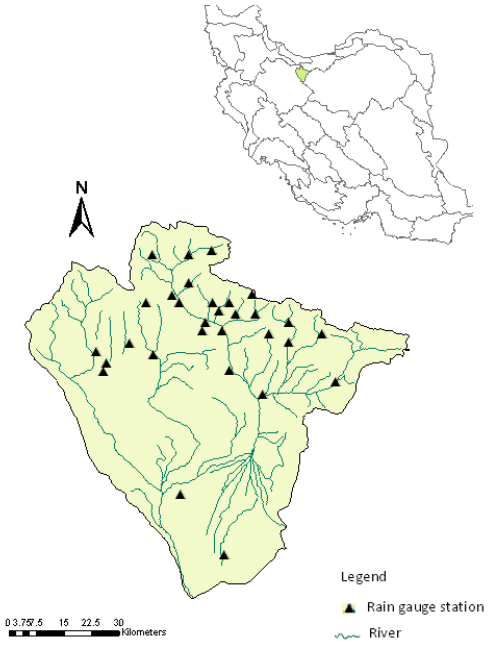


Fig. 1. The geographical location of the stations used in Kan watershed

In this study, the statistics of 40 stations were used, some of which belong to Meteorology organization and the remaining belongs to Ministry of energy. The statistical period applied for the calculation of modified Fournier index is between 20-25 years. The statistical quality of each of selected stations is done by investigation of high values and low values of daily rainfall data and their comparison with the neighboring stations. Unambiguous values are removed or reduced. The investigation of homogeneity of statistics was done by double mass method and Run test (McCuen,

1996). In the first method, by selecting a common statistical period, annual cumulative rainfall of the studied station was compared with the mean annual cumulative rainfall of some of the neighboring stations. For the investigation of homogeneity of rainfall statistics of each of the stations, the stations were used whose statistical years were equal or more than the studied station. By calculation of annual cumulative rainfall for the studied station and the mean annual cumulative rainfall of some of the neighboring stations, their distribution chart was plotted opposite to each other. In case of considerable deviation of the points of direct lone for more than 5 years, the statistics of the mentioned station was assumed as inhomogeneous and they were removed from the calculation process. For more investigation of the stations in which their statistics homogeneity was not supported by double mass method, Run test was used.

To turn point data to regional data, interpolation methods are used. The above methods are including Spline, Weighted Moving Average (WMA) with different powers and ordinary Kriging. To select the best interpolation method, cross validation technique is used. In this method in each stage, an observed point is removed and by remaining observed points, that point is estimated. This is repeated for all observed points as there will be estimations equal to the number of observed points. There are various criteria for assessment of the efficiency of interpolation methods such as Mean Bias Error (MBE), Mean absolute Error (MAE), and Root Mean Squared Error (RMSE).

Results and discussion

Table (1) shows descriptive statistics of modified Fournier index in 40 stations of Kan basin. According to this table, the minimum and maximum index is 27.03mm and 118.68 mm, respectively.

Table (1): Descriptive statistics of modified Fournier index

Statistics	Modified Fournier Index (mm)
Mean	80.60
Standard Deviation	25.38
Min	27.03
Max	118.68
Skewness	0.15
Kortosis	0.83

According to Kolomogrov test, the values of modified Fournier index in Kan basin follow normal distribution. Fig (2) shows frequency chart and Normal probability curve of modified Fournier index in Kan basin.

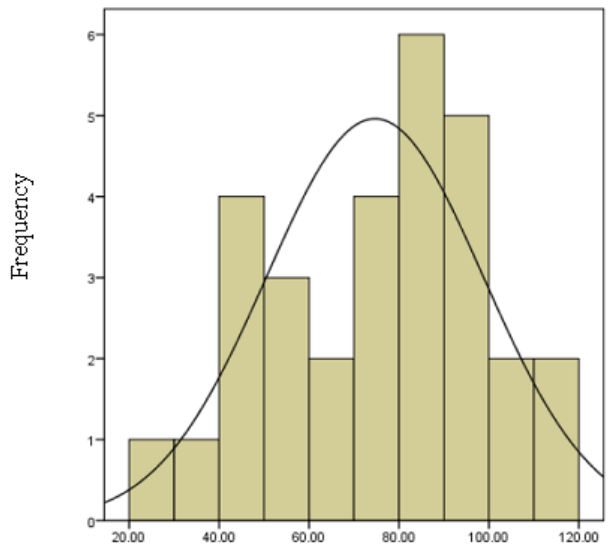


Fig. 2. Normal probability curve of modified Fournier index

To provide rainfall erosivity map, point data of 40 stations should be turned into regional data and to do this different assessment methods were assessed. In table (4) the results of assessment of different interpolation methods are shown to provide rainfall erosivity map by Modified Fournier index. Among interpolation methods, ordinary Kriging with mean absolute error of 13.3 and coefficient of determination of 0.52 has the minimum error and the maximum correlation. In contrast, inverse distance weighted with power 1 with mean absolute error of 15.8 and coefficient of determination of 0.49 has the maximum error and minimum correlation among the measured and estimated values (table 3).
As Fournier index values had normal distribution, in this study, the data without change was used in Kriging method. Fitted model on experimental semi-variograms in ordinary Krigining method is of exponential type whose range is 3.5 Km (table2).

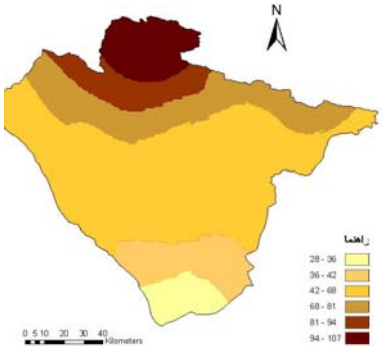
Table 2: The properties of fitted model in ordinary Kriging

Interpolation method	Model	Rang(Km)	Sill	Nugget
Ordinary Kriging	Exponential	3.5	1784	8.12

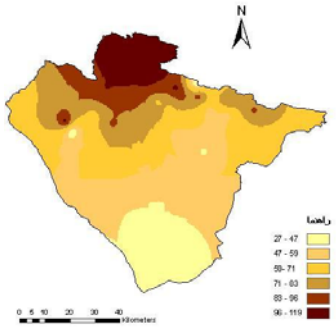
Considering the above mentioned items, ordinary Kriging is the best among other methods and it was selected as the best interpolation method to provide erosivity map of Namak lake basin. After the selection of the best interpolation method, erosivity map is provided. Figure (4) shows rain erosivity map by different interpolation methods. According to the map of ordinary Kriging method, the maximum value of modified Fournier index is 106 mm According to the maps, rain erosivity index values are the same in all the map s and modified Fournier index values are increased to northern regions of Kan basin. But the comparison of assessment criteria indicates that ordinary Kriging method is more exact in comparison with other methods and this trend is more obvious in this method.

Table 3: The evaluation results o f interpolation methods

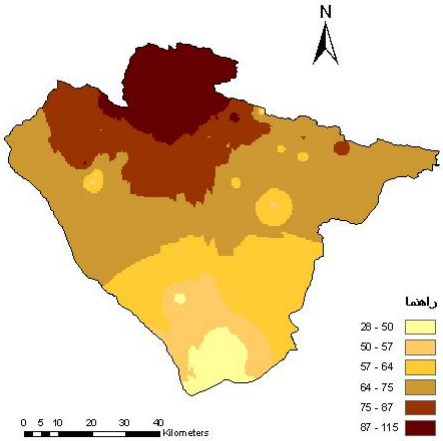
Interpolation method	MBE (mm)	MAE (mm)	RMSE	R^2
Ordinary Kriging	1.2	13.3	17.52	0.58
Inverse distance weighted(power 1)	4.3	15.8	19.51	0.49
Inverse distance weighted(power 2)	2.77	14.2	18.8	0.53
Inverse distance weighted(power 3)	2.16	13.78	18	0.50
Spline	2.3	13.9	18.8	0.49



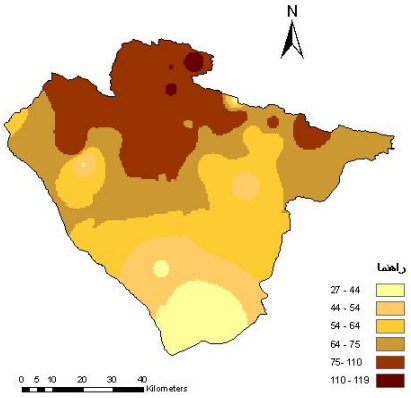
a.Ordinary Kriging



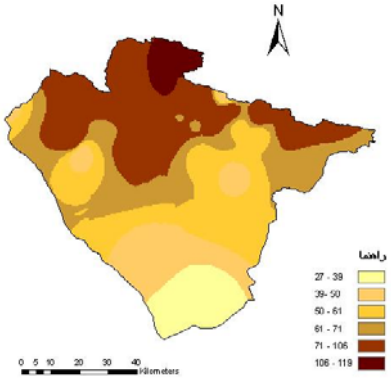
b.spline



c. Inverse distance weighted (power 1)



d. Inverse distance weighted (power 2)



e. Inverse distance weighted (power 3)

Figure. 3. map rainfall erosivity

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Plot Size Effect on Measured Runoff Volume from Bare Soil Condition under Natural Rainfall

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Abstract

Plot scale studies are widely used to determine runoff and soil erosion models basic data. In order to study the effect of plot size on runoff volume per unit area, plots with seven sizes differing in length (2, 5, 10, 15, 22.1, 25 and 30 m) and width (1, 1.2, 1.6, 1.8, 2 and 2.4 m) were constructed in Poldasht, northwestern Iran. The experiment was conducted in a completely randomized block design using four replications. Plots were established on uniform slopes of 9% with 1.4m spacing. Plots were installed on fallow and were maintained in a bare condition in the study period from September, 2010 until June, 2011. The entire runoff volume collected in tanks at the lower part of plots was measured after each event. Runoff from these plots was obtained for eleven natural storm events during the study period. Our results confirmed that the unit area runoff decreases in all events with a power function ($0.82 \leq r^2 \leq 0.95$), as plots area increases. The degree of plot scale effect on unit area runoff is considered to change with the event characteristics, being low for little runoff-producing events and high for larger runoff-producing events. Statistical analysis of unit area runoff verified that there were no significant differences among the results of 15m and longer plots but in plots with 10m or lower in length, the results were significantly different. It can be concluded that the 15m is the minimum optimal length for accurately estimating runoff in plots.

Keywords: Runoff plot, Scale, plot size, Poldasht.

Introduction

Natural experimental plots have become one of the most important methods for data gathering in surface runoff and soil erosion studies. Basic data for developing most empirical models such as USLE, MUSLE and RUSLE were originated from natural plots and calibration of these models at each region mostly is done using data obtained from these plots (Vaezi et al., 2008; Boix Fayos et al., 2006). As a result, research efforts are need to investigate factors affecting plots data quality. Spatial scale or size of plots is one of these factors which directly affect measuring surface runoff by means of field plots. The effect of plot size on measured runoff or soil loss from natural plots is known as plot scale effect (Parsons et al., 2006). A quick review of literature shows that, plots with wide range of spatial scales have been used by researchers for estimating surface runoff and in most cases there isn't any rationality for selecting each size or spatial scale of plots (Parsons et al., 2006; Boix Fayos et al., 2006; Bagarello and Ferro 2010).

Le Bissonnais et al. (1998) confirmed that the effect of scale on runoff generation is highly dependent on surface condition and spatial variability of soil properties. Joel et al. (2002) observed a decrease in the runoff coefficient with increasing plot size from 0.25 to 50 m^2, they also reported the validity of this trend even during continuous runoff. Van de Giessen et al. (2000) considered the importance of rainfall-runoff temporal dynamics on the scale effect of plots and demonstrated that the scale effect varies enormously according to the temporal pattern of runoff producing rainfall event.

Literature review shows that there is not a single scale effect for all conditions and it is reported to be site specific and to dependant on the size of the monitored plots or catchments besides there is a very limited database on natural plots data in Iran so that, the main objective of this study was to determine and quantify the scale effects of runoff plots in a range of plot sizes in general used by different researchers.

Materials and Methods

Study area

Plots used in this study were constructed at the experimental watershed in Poldasht region of west Azerbaijan province which was located in the Northwestern of Iran. The watershed encompasses an area of 300 km^2 between 39°0□N-39°15□N and 44°45□E-45°10□E. According to Domarton classification, the climate of the region is arid with the mean annual precipitation of 223 mm and mean annual temperature of 13°C. The soils have generally sandy clay loam texture and have about 0.58% and 16% organic matter and $CaCO_3$ respectively.

Plots construction

In order to determine the scale effect of plots on surface runoff seven plots, differing in width and length, were constructed in a uniform slope of 9% at three replications thus totally 21 plots were installed in a completely randomized blocks design for runoff measurements. Table 1 shows the details of plots length and width. Plots were installed on fallows and maintained in bare condition during the study period by means of herbicide treatment (Rejman et al., 1998). Plots were ploughed in slope direction in September 2010. The plots were surrounded using soil stack with a height of 30cm to direct generated surface runoff to the lower part of plots where runoff collecting systems composed of gutters, pipes and tanks were installed (Vaezi et al., 2008). Fig. 1 shows the geographical location and plan of constructed plots at the study region.

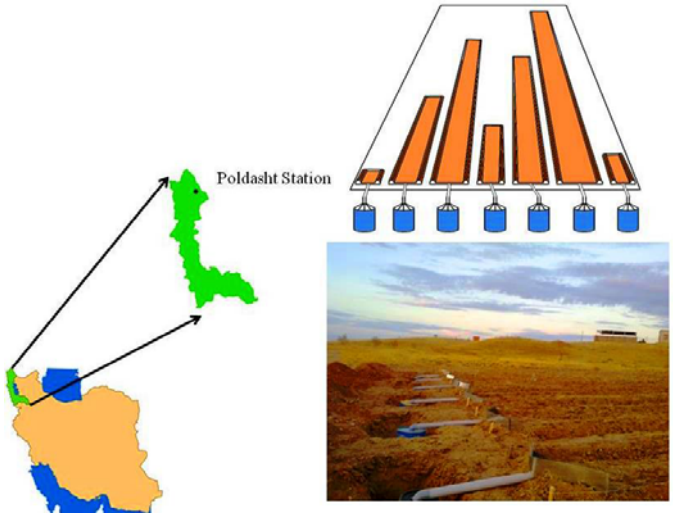


Fig. 1. Location of experimental watershed and plan of constructed plots for one of the Blocks

Table 1. Width and length of the plots

Plot Name (Treatment)	Width (m)	length (m)	Plot Area (m^2)
P1	1	2	2
P2	11.2	5	5
P3	1.6	10	12
P4	1.83	15	24
P5	2	22.1	40.44
P6	2	25	50
P7	2.4	30	74

Hydrological measurements

From September 2010 to June 2011, surface runoff was monitored on the constructed plots. Runoff collected from the plots was manually measured after each runoff producing rainfall event. Precipitation amounts and characteristics were directly measured by an automatic recording tipping-bucket rain gauge located about 200 m from the experimental plots.

Statistical analysis

This experiment was carried out with completely randomized block design with three replications for each size of plots as treatments (Table 1). To assess the scale effect of plots, total runoff volume of each plot was divided by the area of plot to obtain unit area runoff (lit/m^2 equal to mm). Unit area runoff (UAR) of all plots for each rainfall events was analyzed separately by analysis of variation using of the statistical analysis system (SAS version 9.1). Mean separation was done by Duncan range test.

Results

Rainfall events

During the study period 11 runoff producing rainfall events were occurred. Characteristics of these events are presented in table 2. Mean Intensity of runoff producing events were between 0.6 and 3.13 mmh^{-1}.

Table 2. Characteristics of runoff producing events during the study period

Event	Event date	Rainfall amount (mm)	Mean Intensity (mm h^{-1})	I_{30} (mm h^{-1})	Kinetic Energy* (MJ ha^{-1})
E1	05 April 2011	7.5	2.69	5.8	1.25
E2	23 April 2011	5.5	0.80	3.8	0.78
E3	27 April 2011	13.0	0.82	6.0	1.93
E4	01 May 2011	11.0	1.51	2.4	1.50
E5	06 May 2011	3.5	1.06	2.4	0.45
E6	08 May 2011	6.5	2.19	4.8	1.01
E7	13 May 2011	6.5	1.09	9.0	1.14
E8	20 May 2011	4.0	0.60	1.6	0.47
E9	30 May 2011	6.0	0.62	3.6	0.83
E10	04 June 2011	9.0	3.13	15.9	1.91
E11	09 June 2011	11.0	1.90	5.0	1.80

* Kinetic energy was calculated using: E= 210.3 + 87log(I) (Wischmeier and Smith 1987)

Plot size effect

Regression analysis of plot size effect against UAR showed that the following power relationship significantly describes variations of UAR against plot size at each single event.

$$UAR_{e_i} = a_{e_i} A^{b_{e_i}}$$

Where *UAR* represents the mean unit area runoff (lit/m^2, equal to mm) for e_i event; *A* is the plot size (m^2); a_{ei} and b_{ei} are empirical coefficients which are particular for each event (e_i).

Results of UAR and plot size relationship for each event are presented in table 3 and this relation for event E1 can be seen in fig. 2 as a general pattern for all events. Results showed that the mean UAR for P1 plot as smallest plot was between 0.28mm and 6.66mm for E5 and E10 events respectively. These amounts for P7 as largest plot were 0.14mm and 1.89mm for above mentioned events.

In support of the achieved general trend that confirms the decreasing of UAR with increasing plot size, in the next step mean UAR of each plot size was statistically analyzed using completely randomized block design and UAR mean separation was done by means of Duncan test.

Table 3. results of regression analysis of UAR (mm) against plot area (m^2) for each event

Event	$UAR_{e_i} = a_{e_i} A^{b_{e_i}}$		Coefficient of determination (r^2)*
	a_{e_i}	b_{e_i}	
E1	5.77	-0.373	0.83
E2	0.92	-0.275	0.90
E3	6.48	-0.411	0.89
E4	1.65	-0.276	0.91
E5	0.35	-0.193	0.94
E6	1.33	-0.301	0.87
E7	6.08	-0.429	0.93
E8	0.32	-0.165	0.95
E9	0.84	-0.244	0.91
E10	9.83	-0.401	0.95
E11	6.60	-0.397	0.89

*P value for all relations <0.01

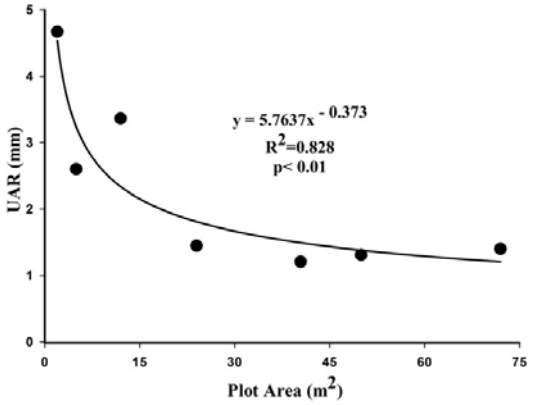


Fig. 2. Relationship between UAR and plot size for the E1 event

Results of variance analysis (Table 4) for each event confirm that the runoff generation behavior of plots differing in size is significantly different for all events except E8, which have the lowest kinetic energy and I_{30} among all events. Comparison of mean UAR of plots verified that there were no significant differences among the results of 15m and longer plots but in plots with 10m or lower in length, the results were significantly different.

Table 4. Comparison of plot size effect on UAR (mm) for each rainfall event

Plot Size	Mean UAR (mm) for each event										
(Treatment)	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11
P1	4.66^{a}	0.78^{a}	4.07^{a}	1.36^{a}	0.28^{a}	1.03^{a}	4.50^{a}	0.28^{a}	0.70^{a}	6.66^{a}	4.33^{a}
P2	2.60^{ab}	0.66^{a}	4.06^{a}	1.23^{a}	0.26^{ab}	0.74^{ab}	2.80^{b}	0.26^{a}	0.64^{ab}	5.66^{b}	4.00^{a}
P3	3.36^{bc}	0.38^{b}	2.88^{b}	0.68^{b}	0.23^{abc}	0.86^{ab}	2.61^{bc}	0.20^{a}	0.40^{bc}	4.38^{c}	3.19^{a}
P4	1.44^{c}	0.34^{b}	1.56^{c}	0.67^{b}	0.20^{bc}	0.48^{b}	1.47^{bc}	0.19^{a}	0.37^{c}	2.45^{d}	1.54^{b}
P5	1.20^{c}	0.33^{b}	1.17^{c}	0.56^{b}	0.15^{c}	0.40^{b}	1.21^{bc}	0.16^{a}	0.31^{c}	1.97^{d}	1.38^{b}
P6	1.30^{c}	0.32^{b}	1.16^{c}	0.58^{b}	0.16^{c}	0.36^{b}	0.92^{c}	0.18^{a}	0.34^{c}	2.03^{d}	1.22^{b}
P7	1.39^{c}	0.31^{b}	1.32^{c}	0.55^{b}	0.14^{c}	0.38^{b}	1.13^{bc}	0.16^{a}	0.32^{c}	1.89^{d}	1.43^{b}

Mean separation by Duncan range test (P=0.05)

Discussion

Mean UAR of plots differing in size (length and width) were investigated and results verified the decreasing of UAR with plot size increasing as a general trend which is in according with the achievements of Van de Giessen et al. (2000) and Joel et al (2002). A power relationship used to describe the variations of UAR against the plot size at the event temporal scale. Validity of power relationship between UAR and plot length was demonstrated of Bagarello and Ferro (2010). Mean separation indicated that there was a significant difference in UAR of plots. It seems that the degree of scale effect on UAR decreases with increasing rainfall kinetic energy or I_{30} which can be seen in the results of E8 at plots differing in size. According to the statistical analysis it can be concluded that the differences of UAR in plots larger than 24m^2 (longer than 15) is always insignificant which can be used as a key approach to introduce 15 as an optimal length for runoff measuring in field plots. This conclusion has conformity with the results of sadeghi et al. (2011) who suggested a length between 10 and 15 m for optimal evaluating of runoff by means of field plots.

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Wind erosion and its effects on bed and environment

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Abstract: Wind erosion as the main cause of soil erosion in arid and desert area with transfer of microscopic grains into the atmosphere will cause air and environmental pollution. In addition,will destroy Context of agricultural production namely fertile soil from the surface and also damage to Resources and infrastructure and other economic sectors. Storms in cases where wind blows with speed over than erosion threshold will detached the soil particles with different sizes from their context and move in a leap, creep, or the suspension and will transport to distant places. This phenomenon in harvest region, creating soil erosion and in other areas, proportional with wind power and speed caused the accumulation or sequestration particles. Mainly should meet its payment in first steps or when wind erosion started, because over time the severity and extent of erosion increased and control and containment of the problem will get hard.

IN this study has tried to evaluate Wind erosion process in the factors which are affecting on the quality and intensity of erosion in the central desert region of Iran (Yazd – Bahadoran) .To assess the intensity of wind erosion Irifer model is used. Understanding the dynamics and sand movement to predict the process of now, past and future and also proper and appropriate planning for erosion control has special importance. In this article Review and analysis of the wind, finding harvesting areas, assess of the various faces in harvested areas, transport and deposit, determined the critical centers of the wind erosion, estimation wind erosion threshold velocity in different faces is addressed. Important factors in wind erosion can be recent droughts and low ground water table.

Keywords: Wind erosion, Irifer model, Yazd

Introduction

In the erosion, under environmental factors such as water, wind, gravitation and etc… soil moves, and after being carried to another region, settle there. In the dry, semi dry and desert areas the main factor of soil erosion is wind. In such areas water erosion exists in high lands and aquatic sediments are moved down to low lands by water flow, when these particles are sediment, wind erosion in the plain areas shall be predisposed. In wind erosion over time, while the erosion intensity is increased, the scope and the extent of the area also increases and controlling it will be far more difficult and more complex, therefore, in the early stages we shall basically combat with wind erosion.

In this article we have tried to study and evaluate wind erosion from the aspect of the existing factors affecting the quality and speed of that. The purpose of it is identifying and separating harvest regions, transporting and sediment of wind erosion process in the study, and determining the intensity of wind erosion processes in Different faces of Geomorphology.

Materials and Methods

Arid and very arid regions of Iran, which are located in the central and southern Iran, form the main or critical centers of wind erosion in the country. In these lands due to environmental conditions such as lack of downfall, Water deficit, poor soil, salinity and alkalinity and finally Active erosive winds, conditions for the occurrence of wind erosion is very favorable.

10 606 hectares within the study area, is geographically located between the latitudes of 31°13'12" to 31°22'57" north, and lengths 54°54'6" to 54°3'48" East. The elevation change goes from southwest to north east, and these changes are performed with low to moderate amplitude almost uniformly (elevation change of 93 meters over more than 5 km). Geologically the main area of the plot area is related to the fourth period (Quaternary), which has formed alluvial zones, and In terms of geomorphology is among the Plains (83.73% plain types of srapandazh and covered) and Playa (two faces of clay - salt plain and Nebca and Rebdu sand forms of 16.27 %) units. In the present research we have used land set Satellite images ETM+ (2002) and Google earth Satellite images.

Geomorphology aspects of the area are as follows. 1- Desert pavement - Medium-grained alluvial geomorphology: this pavement works as a Shielding for the underlying soil, and the existence of verniy of the desert (darkening of pebbles) that results from intense solar radiation and the presence of iron and manganese oxides on its surface, indicates that these pebbles have been in a stabilized and fixed conditions for relatively a long time. 2-Desert pavement-small-grained alluvial geomorphology. 3- Geomorphology of the parabola shaped surfaces along with Nika (or Nebka) due to the lack of desert pavement wind erosion has happened on its surface and it can be considered as areas of harvesting and transport young Nebkas and sand arrows generally indicate the deposition direction from southwest to northeast. Rebdos creation (Domed Dunes) also indicates the effect of mutual (cross) winds (northern) and conversion of Rebdus to Nebkas. 4- Nebca and Rebdo geomorphology: erosion forms of Wavy sand zones till non wavy sand zones which are also called Ripple mark or Zibar, actually indicate the transport or transit area in the wind erosion, Ripple marks generally are drawn along the South- north, and their hillside tends towards the west with a gentle slope, and Western to southwestern winds can be considered more effective in their formation. Because of the relatively fine soil on the surface of this face, low density of pavement and little vegetation cover of wind erosion and finally plenty of Nebka and Rebdu formation can be seen. The main elements forming Nebka and Rebdo include Sand, sludge, clay and silt, and they generally spread on a smooth surface on which the amount of sand is middle, underground water level is high and adequate moisture for plant growth is available. In fact their growth (development) results from potential loss of wilderness areas, Influenced by weather conditions, the amount of erosion materials, the type and the intensity of vegetation cover, Transmission capacity of wind and Source of sediment supply. 5-Rigid river: Due to the high percentage of pebbles in the upstream parts of this face, and Due to the presence of a resistant layer resulting from sludge and clay and relatively good vegetation cover deposits in Avyds, in areas adjacent to agricultural lands, the mentioned face has been considered as a relatively resistant Region against erosion.

6-Agricultural lands with shallow erosion: the initial substrata of agricultural lands in the study area of clay-salt plains and have a heavy texture, so that residents in the surrounding area have Attempted soil amendment and increasing its cultivation by adding the sand around. The comparison of satellite images in the two periods of 1971 to 2003 AD indicates this increased level of cultivation. Because of morphological conditions, Soil Science characteristics and the existence of pistachio orchards, wind erosion is very restricted (limited) in agricultural lands. Considering the drought and fall of underground water levels in the territory, Long-term release of soil and also Increase of the amount of minerals, especially sodium minerals, there is the possibility of wind erosion in these lands so that in the classification of erosive faces, it can be considered as a region of harvesting but with the partial harvest. 7- The face of harvest area (Salt marsh Or clay - Salt plain): which has a Perfectly flat and smooth surface, without pebbles and covered with wind sediments (deposits) in the central part of the clay Plain type and Salt marsh (clay - Salt plain), and it has been considered as a harvest area. In terms of vegetation it's very poor and limited to salty species such as Zibar . In face level the effects of wind erosion can be seen clearly. Comparison of satellite images in the interval of 32 years (1971-2003) indicates its level increase and Intensity of Activity.

- Introducing the experimental model used (IRIFR.EA) and evaluating the severity and the extent of wind erosion with models: From the main equations and methods presented in wind erosion, we can mention to wind erosion equation (WEQ), Wind Erosion Prediction System (WEPS) and the reviewed wind erosion equation (RWEQ). Special (1994) believes that the desert models are laboratorial, the most accurate and yet the fastest Method for measuring wind erosion. In the method or model (IRIFR.EA), presented and designed by the researchers of our country (Ekhtesasi - Ahmadi) in 1996, the role and the influence of nine important factors affecting wind erosion and deposition rates resulting from it has been evaluated and scored, and Depending on the severity and weaknesses of each factor and its effect on sedimentation, a score is attributed to that. Total numbers indicate the intensity (severity) of wind erosion, and from it the deposition amount of each geo-morphology face and the total study area is estimated. The intensity of soil erosion and deposition rates that result from nine factor scores affecting wind erosion has been classified into five classes.

Results

In order to use these the mentioned method by adapting basic maps such as Geological formations, Vegetation cover, land use, Land forms and topography, Geology (soil science) and land capability and the other available information including moisture, wind, Surface erosion condition with Geomorphologic map in each geomorphology face, nine effective factors has been evaluated and scored.

1) Petrology: It was equal to 6.7 which was a high number and indicative of the important role of geological structures of the area in wind-led erosion.

2) The shape of lands and the ups and downs: more than 85 percent of the area under study was comprised of lands with a slope of less than 2 percent. In terms of altitude variability, the maximum ups and downs were less than 10 meters. The score assigned to the area was 8.1 out of 10 which is indicative of the flatness of area and its important role in the intensity of wind-led erosion.

3) The speed and position of wind (probability of storm): the most important cause of wind-led erosion is the speed of wind and its periodical distribution. The nearest climatological station to the area under study is Bahadoran station, but due to the insufficiency of the statistics and absence of some of the wind parameters in that station, the statistics of the Anar synoptic station were utilized. The strongest wind had a speed of about 20 meter/second which happened three times in the southeast direction (220 degree) in February, 2004 and March, 2005 and 2006. With respect to the indices assigned to speed and position factor in IRIFR model, this parameter has gained score 16.

4) Soil cohesion and its vegetation: soil cohesion and particularly its vegetation is one of the factors which play an effective role in wind erosion and sedimentation potential. By investigating samples of soil and observation of the areas based on the table presented by the model, the score assigned to this factor in the area under study is estimated to be 5.2.

5) The plenitude of vegetation: vegetation prevents the particles from moving through different ways. In addition to improving the soil structure, it will increase organic matters and decrease the speed of wind. The vegetation of the area is as follows: %56.73 of the area is covered with Artemisia, Seidlitzia and Ephedra with poor and very poor conditions. %21.29 of the area has no vegetation and %21.98 is allocated to agricultural uses. The score is calculated to be 11 which is indicative of the critical condition of the area in terms of vegetation.

6) The signs of the erosion of the soil surface: the presence of the signs of the wind activities is indicative of the erosion and the inappropriate condition of the soil in terms of erosion. The weight average of the score assigned to this factor is 8.

7) Soil humidity: if the soil is humid, though other factors are conducive to wind erosion, particles cannot move easily. Based on observations, the weight average of this factor was calculated to be 7.6.

8) Type and distribution of wind deposits: the distance and distribution of wind deposits in each area can be partly indicative of the intensity of the erosion caused by wind and the movement of the sand particles by wind. The average score assigned to this factor is 6.1 which is indicative of the existence of wind deposits including active and semi-active Nebka , Rebdo and Ripple mark in the area under study.

9) Management and the use of land: in IRIFR method, great heed is paid to the use of pasturelands, forests and agricultural areas. In order to calculate the score land observations, the application map of lands and other existing data were utilized and the average total score was estimated to be 10 which is indicative of the high effectiveness of this factor in erosion of the area under study (Table 1).

- Estimating the intensity of the wind-led erosion and sedimentation by using IRIFR model: By using the relationship between the degree of sedimentation and the rate of sediment production, the sedimentation potential can be calculated more precisely (Table 2).

$$Q_s = 41e^{(.05*R)}$$

Qs = the rate of annual sedimentation (ton/ km^2 annually)

R= the degree of sedimentation (the total scores of the nine effective factors in soil erosion by IRIFR method)

Table (1) the total scores of the nine effective factors in soil erosion in each profile, along with the intensity of erosion and sedimentation potential

facies	Area (ha) (%)	Position	petrology	Land forms and topography	Wind speed and status	soil surface and its non-living cover	Abundance of vegetation	Effects of soil erosion	Soil moisture	Type and distribution of wind deposits	Management and land use	Total Score	Slope %	Description
Medium-grained alluvium	946 8.92%	South and Southeast	6	6	16	3	13	7	8	6	10	75	3-5	Medium-grained alluvium
Medium-grained alluvium	2120 19.19%		5	8	16	3	13	6	8	5	10	74	1-3	
Fine grained alluvium	2172 20.48%	North till Central	6	8	16	3	13	6	8	5	10	75		Fine grained alluvium
Oed	542 5.11%		7	8	16	3	8	6	4	5	9	66		Fine grained alluvium
Parabola-shaped surfaces and Nebka	770 7.26%		8	9	16	8	12	12	7	8	13	93	0.1-1	Fine sediments clay plain
Agricultural and residential lands	2330 21.97%		7	8	16	4	5	5	8	5	7	65	1-3	Fine grained alluvium
Sand forms Nebka and Rebdo	1254 11.82%	South Central Division	9	9	16	12	14	16	7	10	13	106	0.1-1	Fine sediments clay plain
clay - Salt Plain	472 4.45%		10	9	16	14	15	18	9	10	15	116		
Weighted Average			6.7	8.1	16	5.2	11	8	7.6	6.1	10			

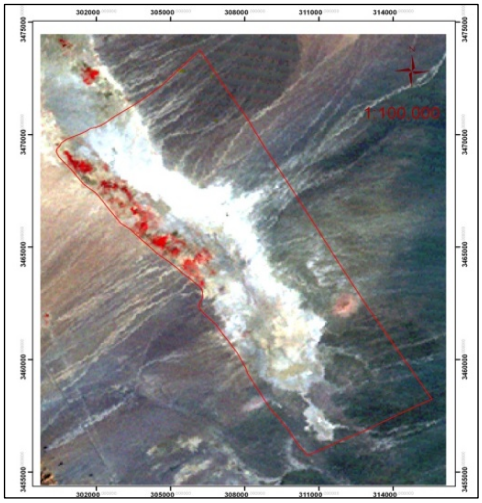
Table (2) the rate of nine factors in per facies, with the potential for erosion and deposition

facies	Medium-grained alluvium	Medium-grained alluvium	Fine grained alluvium	Oed	Parabola-shaped surfaces and Nebka	Agricultural and residential lands	Sand forms Nebka and Rebdo	clay – Salt Plain
R	75	74	75	66	93	65	106	116
Erosion class	III	III	III	III	IV	III	V	V
Erosion Intensity	Average	Average	Average	Average	High	Average	A lot	A lot
Qs (ton/km^2.year)	1147.5	1622.2	1747.5	1113.9	4300.6	1059.6	8241.4	13592

- Finding the root of the wind sediments of the area under study

The knowledge of the dynamics and the way the fluent sand move is of paramount importance to forecast present, past and the future processes and also the appropriate planning of controlling erosion. Specifying the direction and size of the areas to be harvested, specifying the route and the multitude of the passing sand in different areas can be of great help in planning and controlling the erosion caused by wind. Hence by using the step to step method of finding the root of sand hills (Ekhtesasi, Ahmadi) the areas were specified and divided and the sediments were carried (in 2 steps) and the direction and place of the areas to be harvested were determined. In the locating step the following parameters were investigated. Based on the local data of the southwest wind from the begging of February to the beginning of May, the above-mentioned wind will blow as the erosive wind which leads to the occurrence of yellow- colored storms with average intensity from the beginning of July the mild north wind blows in the area which is utilized for harvest . Due to drought and decrease of underground bodies of water, the lands are very poor in terms of vegetation and storms inflict most damages on agricultural lands located at the bottom of the area.

The studies carried out on Landsat satellite pictures in two points in time, i.e., 1970 and 2002 , -related to MSS and ETM2 respectively, indicate the increase in the level of sediments in the profile of the salt-clay plain and their expansion towards the north and east. Moreover, during this time period there is an increase of agricultural lands on clay lands. The inhabitants of the area have taken sand from the low profile of the salty- clay plain and attached theses lands to their agricultural lands. Morphological studies of the sand areas was not carried out, for there was no sand hill (sand deposits with large and measurable sizes). Thus the direction of the ripple marks and Nebkas was investigated through desert samples and ground control. Since the direction of Ripple marks was mostly from north to south or vice versa and the range is towards the west with a mild slope, the west winds are more effective in forming them than southwest winds. The development of the Nebkas behind the sand hills along the southeast direction further reinforces this conclusion.



Red tones: agricultural landWhite Tone: clay - salt deposits

Green ton: agricultural land Blue and cream tones: clay – salt deposits

Figure 1:Landsat MSS image of studies area (1970)

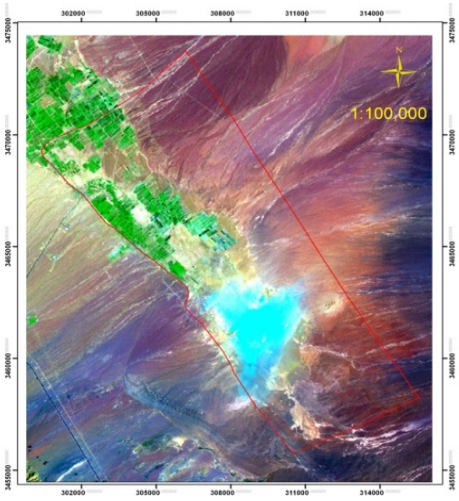


Figure 2: Landsat ETM image (2002)

Wind is one of the most important factors which pave the way by erosion caused by wind. If all other factors of erosion are present, but the factor responsible for the movement of particles (wind) is not, wind-led erosion wind doesn't naturally occur. Analysis of wind and previous studies and are used to analyze the situation and the wind condition of different areas also indices like the multiplication product of average speed with wind frequency are utilized to identify strong winds. According to the data of the table, southwest and north winds are more frequent and have higher speed and intensity. If vulnerable lands be exposed to such winds, the winds will be erosive. In the locating step, it can be stated that in accordance with the direction of the dominant winds of the area and also considering the morphology of the existing sand deposits which are in the form of sand arrows and particularly the direction of their expansion and the dominant wind, the area under study is capable of being used and the process of wind-led erosion occurs in it and lacks sedimented areas.

Table (3) The winds index of Anar synoptic station in statistical period (1986-2005)

Calm	N	NE	E	SE	S	SW	W	NW	Wind direction
-	4.07	4.4	0	0	6.28	5.7	4.7	4.6	The average wind speed
76.42	4.49	2.08	0	0	0.55	6.26	1.38	0.67	Win Frequency
-	18.27	9.15	0.00	0.00	3.45	35.68	6.49	3.08	Wind Index

In order to measure the threshold speed of soil erosion caused by wind in the present study (based on the minimum speed of wind in a definite altitude) the surface soil aggregation method and the relationship between the diameter of the particles of surface soil with the threshold speed of soil erosion were utilized.

Table (4) Estimate the threshold velocity of wind erosion in geomorphological facies

facies	Medium-grained alluvium	Medium-grained alluvium	Fine grained alluvium	Oed	Parabola-shaped surfaces and Nebka	Agricultural and residential lands	Sand forms Nebka and Rebdo	clay - Salt Plain
Threshold velocity	More than 10	More than 10	7-10	7-10	5.5-7	More than 10	4-4.5	5.5-7
Erodible	very little	very little	little	little	Average	very little	High	Average

In general, the profiles of the carriage and harvest areas in the regions under study can be classified as follows: considering the density of the pebbles and the sensitivity of the soil ,the desert paving stone profiles will be classified as harvest areas of the low rate and hardly active (o3). Considering the high percentage of pebbles and in the neighboring agricultural lands due to a strong layer of sediments, dried rivers in high altitude can be classified as of low rate and hardly active (o3). The agricultural lands with superficial erosion are among the of the low rate and hardly active (o3). Profiles of Nebka, Rebdo and parabolas shaped surfaces with fairly soft soil and no pebble is indicative of the carriage and harvest areas. The profile of salty-clay plain covered with erosive sediments can be classified as active harvest region.

Table (5) The score of effective factors in severity of erosion in harvesting areas

Geomorphological facies in harvest area	Area (ha)	Type of Land	The effects of surface erosion	Vegetation density	Density of pebbles	Soil Texture	Soil resistance	Soil salt	sand dunes Distance	Total score	Harvest intensity	Mark on the map
Parabola-shaped surfaces	770	12	12	10	16	7	7	7	7	78	Active	O1
Salt-clay facies	472	12	12	10	16	7	10	9	3	79	Active	O1

Table (6)The score of effective factors in severity of erosion in transported areas

Geomorphological facies - (Regional (Transportation	Area (ha)	Mark on the map	Transport intensity	Total Score	Reduce visibility and cause damage	Existence natural wind channels	Wind deposits at the foot of the rocks	Width the transit areas	The harvest areas distance
Sand forms Nebka and Rebdo	1254	T_2	Semi-active	46	8	10	10	10	8

Table (7) Indicators identify and prioritize critical centers of wind erosion control and the results of the rating (C)

Priority Index and scores range	Priority1 15-20	Priority2 5-15	Priority3 0-5
1-The type of wind erosion	Harvest areas	Sediment areas	Transport areas
2-Activity in each stage of wind erosion	Sensitivity class (I)	Sensitivity class (II)	Sensitivity class(III)
3-Damage to biological and economic resources at the crisis center or in the path of that on the people questionnaire	Damage to the city, village or facilities, and agricultural and major roads	Damage to agricultural land and minor roads and facilities, grade 2	Damage to pastures, pristine and uncoated lands
4-The amount of the people or executive agencies request through the see of sand office or people questionnaire	Strongly requested by the people and Governmental	Application is limited and only has been asked in a .questionnaire	has not been Requested
5-Far or near erosion facies to the resources under damage and its direction towards the affected source	<5Km	5-10Km	>10Km
Total scores	75-100	25-75	0-25

Table (8) prioritization of crisis centers of wind erosion control in the study area

Geomorphologic facies (harvest and transport areas)	The type of erosion	Activity	Areas of damage	The requested amount	Facies away or close to the sources of damage	Total score	Priority
Parabola-shaped surfaces	18	15	8	6	8	55	C_2
Salt-clay facies	18	15	2	1	1	37	C_2
Sand forms Nebka and Rebdo	3	12	5	4	10	44	C_2

In order to determine the priorities of the necessity of operational procedures the underlying table of the identification of critical centers of erosion caused by wind was utilized. The results of scoring of the related parameters in critical centers are shown in table 9.

Table (9) results of the scoring project priority parameters within the studies area

Critical center of wind erosion	Population	Agricultural lands	Lines, roads	Economic facilities	Specific materials	Destruction of vegetation	Damage estimates	Total score	Priority
Parabola-shaped surfaces	7	6	7	-	-	3	7	30	III
Salt-clay facies	2	1	1	-	-	1	1	6	III
Sand forms Nebka and Rebdo	4	3	3	-	-	1	3	14	III

Discussion

As it is shown in the table of prioritizing the critical centers, the carriage and harvest areas with average intensity, in the area under study are considered as second priority in terms of critical centers of erosion caused by wind and the third priority in terms of the necessity of the operational procedures. The main effective critical center in areas under study ate the parabolas –shaped surfaces. According to the socio-economic studies the most damage to these areas are done to the top agricultural lands of this center such as Asgar Abad and Mahmud Abad. In Asgar Abad about 2 hectares of the lands have been dried completely and in Mahmud Abad due to the salty condition dominant on agricultural lands, the rate of harvest has decreased to one third of the normal rate. It should be born in mind that among the main reasons of crisis is the removing the sand from the profile by the inhabitants of the area during the past many years which was done to lighten the heavy soil for agricultural purposes and expansion of the agricultural lands in the area under study.

Based on the study the condition of erosion caused by wind can be analyzed as follows:
In the desert paving stone lands and agricultural lands which are located in the northern half of the area under study, the lands are in a normal condition in terms of wind-led erosion and the highest rate of erosion is seen in the central half to the north and includes carriage and harvest profiles.
Accumulation of the sediments near the plants, the sides facing the wind, the existing bodies of waters in the foot of yellow hill, existence of Nebkas and Rebdos which have resumed their activity are indicative of the fact that the area is active in terms of wind-led erosion.
The existence of plant dune denotes the beginning of the wind-led erosion in the area from the past. Nowadays, the aggravation of the drought, decrease in underground bodies of water due to the digging of subterranean and using their water, decrease of the water provision by rivers and surface flows have intensified wind-led erosion.
The existence of the wind-led erosion profiles such as parabolas- - shaped works, active Nebkas, the accumulation of sediments in water passages, the high length of the average diameter of particles and high frequency of quartz show that the wind-led sediments are near the area.
Considering the changes in the life of people and increase in the planting of pistachio in the area under study, the inhabitants have remove the sand from the central parts of the area under study (near parabolas surfaces and salty-clay plain) in order to make the agricultural soil lighter and this area has led to the increase of erosion .
With respect to processing of the satellite images in two different points of time, an increase in the wind-led sediments and salty minerals was observed in the parabolas- shaped profiles in the direction of the dominant winds towards the agricultural land. On the other hand, the profile of salty-clay plains, due to the frequency of the salts which distribute the particles such as plaster and sodium can be considered as harvest areas in the region area under study. The expansion of the sediments is mostly towards the northeast of the area under study.

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Persian Gulf Mangrove Ecosystem: Opportunities and Threats

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Abstract

In the aftermath of the 2004 tsunami, compelling evidence has emerged from field studies in several affected countries, indicating that mangrove forests played a crucial role in saving human lives and property. Mangroves prevent coastal erosion, and act as a barrier against typhoons, cyclones, hurricanes, and tsunamis, helping to minimize damage done to property and life. Iranian Mangrove Forests occur between the northern orbits 25˚, 11 to 27˚, 52. These forests exist in the north part of the Persian Gulf and Oman Sea, along three coastal Provinces in the south of Iran. Those provinces from southwest to southeast are Bushehr, Hormozgan and Sistan and Balouchestan, respectively. Areas of Iranian mangrove forests are 10700 ha. Maximum area (9206 ha) are between Khamir estuaries and Qeshm Island and minimum area (1 ha) is in Bardestan. Two species of mangrove are found within Iranian mangrove forests, Avicennia marina and Rhizophora macrunata. Avicennia marina endures severe temperature and salinity changes of Persian Gulf so considered as dominant specie in this region. Iranian mangrove forests is one the richest biodiversity and important ecosystems in northern part of Persian Gulf. However, factors such as overexploitation of mangrove leaves and branches by rural, sever waves and tidal extreme action in some regions, The alternation of river and delta direction to sea, the continuous changes of climatic condition as well as road construction within the forests, nonexistence of forest conservation programs, urban and industrial wastewater and finally pollution and contamination especially oil pollution are threatening mangrove forests. Therefore, considering degradation and destruction of mangroves, there is an urgent need to conserve and restore the mangroves as defense against tidal waves.

Keywords: Iranian mangrove, Persian Gulf, ecosystem

Evaluation of the Purification Capacity of Some Main Iranian Rivers Based on BOD: A Brief Review

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Abstract
Chemical approaches, measuring the contents of chemical variables such as BOD, COD, nitrogen, or phosphorus, were frequently used as a popular tool to evaluate the degree of water pollution. The highest and the lowest purification capacity of "Karkheh" river (31° 40' 57 N, 47° 48' 24 E) was determined between March and October, suggesting that pollution decreased moving toward down river. Contrary to this, evaluating water quality, using BOD, of "Karoon" river (31°19' N, 48°40' E) showed that pollution is much more in down river than up river maybe due to wastes accumulation. Moreover, BOD in some stations of "Gorgan Rood" (48° 34'N, 124° 25' E) was studied indicating that annual BOD average for the river is 1.7 to 2.48 mg\lit. The highest value recorded, however, was 9.7 mg\lit. In another study, water pollution of "Kor" river (29° 33' 7 N, 53° 26' E) was investigated indicating that pollution levels has continuously grew, however, having controlled industrial wastes it drastically diminished. As for "Anzali wetland"(37°25'N 049°28'E) 15 station including "vorudi,khorujı,dakhele talab" were studied. Results showed that the further the mouth of the river, the lower the pollution was recorded. It is possibly due to lower amount of polluter and the role of wetland purification potential. It could be inferred that aquatic ecosystem including rivers are potentially and naturally able to minimize the pollution, concluded that the wastes of urban and industrial wastes have not being exhausted to these valuable ecosystems.
Keywords: Purification capacity, BOD, pollution, industrial wastes

Relations between Some Structural Stability Indexes and Physicochemical Soil Properties of Bafra Plain

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Abstract
This study was conducted to determine relations among structural stability indexes (aggregate stability, AS and structure stability index, SSI) and some physicochemical properties of Bafra Plain surface soils. For this purpose, 30 surface soil samples (0-20 cm) were taken from arable lands of Bafra Plain. Particle size distribution, field capacity and permanent wilting point, Atterberg limits, particle density, pH, electrical conductivity, organic matter and $CaCO_3$ content, available Ca, Mg, Na, K contents and cation exchange capacity were determined in the study soils. Significant correlations were found between soil physicochemical properties and each stability indexes. According to results, used structural stability indexes differed in the study area.
Keywords: aggregate stability, structure stability index, physicochemical soil properties, Bafra Plain

Introduction

Soil is a natural resource that must be sustainably managed for the future of humankind (Amézketa, 1999). Today, well-qualified agricultural land used for needs posed by rapid population growth and industrial developments. Decline in well-qualified land, increasing food demands, land use for purposes other and inaccurate applications accelerated soil erosion and cause soil losses. Soil erosion is one of the most important environmental problems in the world causing great losses every year as well as affecting sustainable economic development (Jianping, 1999). In many cases, erosion causes an almost irreversible decline in soil productivity and other soil functions (Biot and Lu, 1995; Bruce et al., 1995), and leads to environmental damage. For this reason, preventing of soil erosion is of paramount importance in management and conservation of natural resources (Hudson, 1995; Morgan, 1995; Agassi, 1996; Tejada and Gonzales, 2006). Soil erodibility is the inherent susceptibility of soil particles or aggregates to become detached or transported by erosive agents such as rainfall, runoff, wind and etc. (Toy et al., 2002; Morgan, 2005).
Various tests and techniques have been developed in order to assess structural stability and erodibilty of soils. Some criteria were obtained by using these tests and techniques applicable at both laboratory and field conditions and erosive nature of soils and losses started with detachment were tried to estimate (Sönmez and Özdemir, 1988). However, it was determined that none of these criteria had applicability and reliability qualities applied alone and for all soils. Leo (1963), affirmed that structure stability index could be a good criteria to exhibit structural stability of soils. Aggregate stability has been shown to be a good indicator for erodibility (Chan and Mead, 1988; Coote et al., 1988). Maintaining high soil aggregate stability is essential for preserving soil productivity, minimizing soil erosion and degradation and minimizing environmental pollution derived from soil degradation as well (Amézketa, 1999).
The objective of this study was to determine relations between some structural stability indexes and physicochemical properties of surface soils in Bafra Plain.

Materials and Methods

Research area is located in the Black Sea Region. Temperate climate features are dominant in this plain. Mean annual precipitation is about 796.5 mm and mean proportional moisture is over 70 %. Disturbed soil samples were taken from surface (0-20 cm depth) of 30 different arable lands in the plain. Locations of soil samples taken were shown in Figure 1.

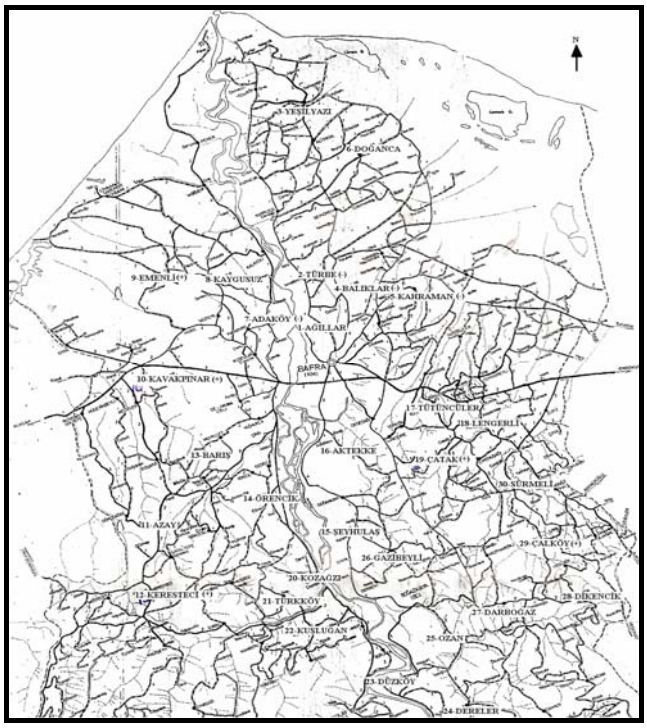


Figure 1. Places of soil samples used in the study

Some physical, chemical and mechanical analyses were conducted on air-dried samples stored at room temperature and from which crop residues, root fragments and rock larger than 2 mm in diameter had been removed.

Selected properties of soils were determined by following methods: soil reaction (pH) and electrical conductivity (EC) in 1:1 soil: water suspension (w/v) by using pH-meter and EC-meter (Bayraklı, 1987); soil texture by hydrometer method (Gee and Bauder, 1986); cation exchange capacity (CEC) by Bower method (Rowell, 1996); $CaCO_3$ content by Scheibler calcimeter method (Kacar, 1994); soil organic matter (OM) by modified Walkley-Black method (Kacar, 1994); field capacity (FC), permanent wilting point (PWP) and moisture content at pF 2 values by using pressure apparatus (Black, 1965); particle density by pycnometer method (Demiralay, 1993); available cations (Ca, Mg, Na and K) by ammonia acetate extraction method (Richards, 1954); Atterberg limits were determined according to Demiralay (1993).

Aggregate stability values of soils were determined by using Wet-sieving method (Demiralay, 1993) and structure stability index of soils was determined by using equations given Leo (1963). Statistical assessment was done using TARIST (1994) computer package program.

Result and Discussion

Soil Physicochemical Properties

Some physical and chemical properties of surface soil samples taken from the plain were given in Table 1. As shown in these tables; clay, silt and sand contents of soils vary between 20.57–57.99 %, 21.43–43.45 % and 16.35–55.39 %, respectively. Soils have generally fine texture. pH values of soils change between 7.10-8.15 and they have generally slight alkaline reaction. Organic matter contents of soils are between 0.92-3.25 % and they have generally moderate and slight organic matter content. Soils show differences in terms of $CaCO_3$ content. Electrical conductivity values of soils are under the threshold levels (2.0 dS m^{-1}) for salty soils and they haven't salinity problems (Soil Survey Staff, 1993). Available Ca, Mg, Na and K contents of study soils vary between 11.17–51.83, 2.83–9.83, 0.56–2.37, 0.18–1.76 me $100g^{-1}$, respectively. Cation exchange capacity of soils change between, 17.50–57.82 me $100g^{-1}$, moisture content at pF 2, field capacity and permanent wilting points values for soils are between 26.16–49.53 %, 19.00–42.20 %, 9.16–29.58 %, respectively. Atterberg limits vary between 28.60–70.80 % for liquid limit, 19.94–39.53 % for plastic limit. Particle density values of soils are between 2.01–2.46 g cm^{-3} values.

Table 1. Descriptive statistics of the soil physical and chemical properties

Properties	Minimum	Maximum	Mean	Std. Deviation
Sand, %	16.35	55.39	30.38	10.74
Silt, %	21.43	43.45	30.03	5.67
Clay, %	20.57	57.99	39.59	10.98
pF 2, %	26.16	49.53	37.63	5.45
LL, %	28.60	70.80	45.68	11.34
PL, %	19.94	39.53	26.90	4.59
PWP, %	9.16	29.58	18.05	5.44
FC, %	19.00	42.20	30.40	5.38
PD, g cm^{-3}	2.01	2.46	2.29	0.12
$CaCO_3$, %	0.31	44.87	9.30	9.68
Ca, me $100g^{-1}$	11.17	51.83	28.23	9.12
Mg, me $100g^{-1}$	2.83	9.83	5.63	1.97
Na, me $100g^{-1}$	0.56	2.37	0.85	0.40
K, me $100g^{-1}$	0.18	1.76	0.60	0.36
CEC, me $100g^{-1}$	17.50	57.82	35.32	8.86
OM, %	0.92	3.25	2.17	0.61
pH	7.10	8.15	7.55	0.24
EC, dS m^{-1}	0.17	0.80	0.33	0.16
AS, %	6.98	76.90	44.79	24.01
SSI, %	26.82	72.96	50.51	13.73

LL: Liquid limit, PL: Plastic limit, PWP: Permanent wilting point, FC: Field capacity, PD: Particle density, CEC: Cation exchange capacity, OM: Organic matter, EC: Electrical conductivity

Structural Stability Indexes

In this study, we examined structural stability of soils by using two indexes named aggregate stability (AS) and structure stability index (SSI). AS and SSI values of the plain soils varied between 6.98 and 76.90%, and 26.82 and 72.96 %, respectively (Table 1).

Determination of aggregate stability of soils is very important and useful in terms of resistance against to erosion. Aggregate stability is considered to be one of the main soil properties regulating soil erodibility (De Ploey and Poesen, 1985; Cerdá, 1998) in semiarid environments (Dunne et al., 1991). Generally, the soils including higher aggregate stability or aggregation are more resistance to erosion. Also, less runoff and soil losses occur in these kinds of soils due to higher infiltration ratio. But a limit value based on aggregate stability or structure stability index of soils to determine their susceptibility to erosion hasn't been developed yet (Özdemir, 2002). When aggregate stability values increase, soils are considered as to be resistant to erosion. The structure stability index values of soils were calculated by using the percentages of silt and clay contents obtained from mechanical analyze and measured in suspension. If structure stability index increases, susceptibility of soils to the erosion reduces. According to these information, 9, 10, 12, 19 and 29 numbered areas in Figure 1 can be identified as more resistant to erodibility with their higher index values, and 2, 4, 5 and 7 numbered areas were described as more susceptible to erosion with their lower index values.

Soil samples having higher stability indexes had also high cation exchange capacity, organic matter and clay contents. Similarly, soil samples having lower AS and SSI values had lower cation exchange capacity, organic matter and clay contents. Organic matter encourages plant growth by increasing water holding capacity and aggregation in soils and indirectly increases the resistance of soil against to erosion. Several authors have shown importance of soil organic matter content on soil susceptibility to erosion (Barthes et al., 1999; Auerswald et al., 2003; Tejade and Gonzales, 2007) and reported that an increase in soil organic matter content entails a decrease in soil loss. Clay content is effective in the formation of stable aggregates in soils. Sönmez (1980) established

that when cation exchange capacity increased, aggregate stability and erosion resistance increased in soils and there was a significant positive correlation between these two properties. He indicated that soils having higher cation exchange capacity have also higher aggregate stability values depending on the type and amount of clay and organic matter content. Sönmez (1994) and Aksoy (1968) stated that clay, organic matter, calcium and magnesium contents in soils reduced soil susceptibility to erosion by increasing structural stability.
Significant positive or negative correlations were determined between physicochemical soil properties and structural stability indexes at different levels (Table 2).

Table 2. Correlation coefficients belong to relations between soil properties and selected parameters

Soil properties	AS, %	SSI, %
Sand, %	-0.52**	-0.91**
Silt%	-0.45*	ns
Clay, %	0.74**	0.93**
Silt+Clay, %	0.52**	0.91**
pH	ns	ns
EC, dS m^{-1}	0.39*	0.38*
OM, %	0.41*	0.42*
$CaCO_3$, %	ns	ns
FC,%	0.64**	0.70**
PWP,%	0.79**	0.79**
pF 2, %	0.65**	0.70**
LL, %	0.85**	0.80**
PL,%	0.75**	0.59**
PD, g cm^{-3}	-0.89**	-0.71**
Ca+Mg, me $100g^{-1}$	0.74**	0.63**
Mg, me $100g^{-1}$	ns	ns
Ca, me $100g^{-1}$	0.73**	0.60**
Na, me $100g^{-1}$	ns	ns
K, me $100g^{-1}$	ns	ns
CEC, me $100g^{-1}$	0.73**	0.63**
AS,%	1.000	0.79**
SSI, %	0.79**	1.000

EC: Electrical conductivity, OM: Organic matter, FC: Field capacity, PWP: Permanent wilting point , LL: Liquid limit, PL: Plastic limit, PD: Particle density, CEC: Cation exchange capacity, ns: not significant, *: $P< 0.05$, **: $P<0.01$

As had significant positive correlations with clay content, field capacity, calcium content, cation exchange capacity, permanent wilting point at 1% level. Structure stability index gave significant negative correlations with sand content and particle density at 1% level. Also, significant positive correlations were determined among used stability indexes and organic matter content at 5% level. Soil organic matter content has a direct relationship with soil erodibility (Emadodin et al, 2009). The aggregate stability of soil increased, when organic material was combined with clay particles and it contributed to chemical bonding (Morgan, 1986). There was not a relationship among stability indexes and soil properties such as pH, silt content, available Na, K and Mg, $CaCO_3$ contents. Candemir (1998) found that the basic soil properties such as; clay content, cation exchange capacity, organic matter gave significant relationships with structure stability index, clay ratio and soil erodibility factor in her study conducted in order to determine susceptibility of soils to erosion in Çarşamba Plain.
The structural stability index values were also predicted using the equations. These equations were derived according to the relationships among the soil properties and structural stability indexes. The correlations between estimated and measured index values are given in Figure 2 and 3.

$$AS = 392.628 + \left[(clay\ content x 0.61) - (PDx158.52) - (Ca + Mgx0.27)\right] \quad \text{Eq.1}$$

$$SSI = 40.059 - \left[(sand\ content x 0.571) - (PWPx0.426) - (clay\ content x 0.508)\right] \quad \text{Eq.2}$$

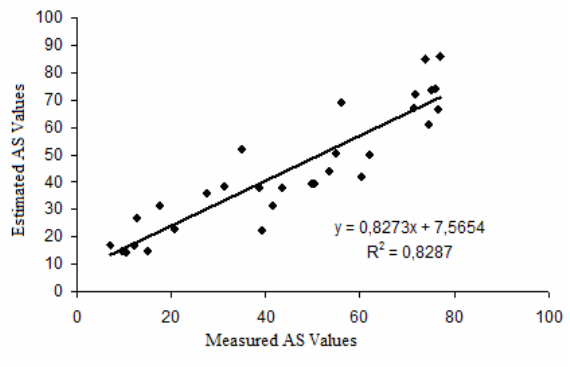


Figure 2. Relations of measured and estimated AS values

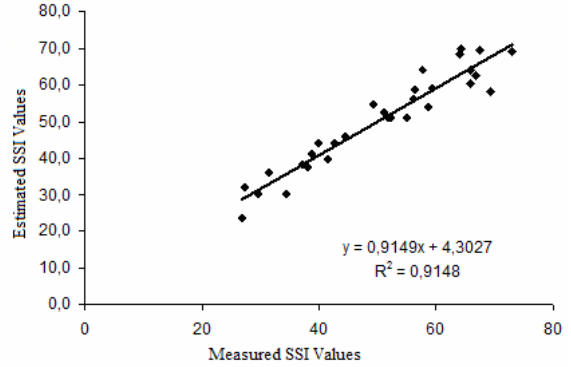


Figure 3. Relations of measured and estimated SSI values

Conclusion

As a result, the structural stability indexes of the soils in Bafra Plain in Samsun had significant positive correlations with clay, silt+clay, EC, organic matter, field capacity, permanent wilting point, pF 2, liquid limit, plastic limit, Ca+Mg, Ca and cation exchange capacity and significant negative correlations with sand content, particle density. It was found that when some areas in the plain are more resistant to soil erodibility, some areas are less resistant. Also, these indices were estimated by using multiple correlations between several soil properties. It is concluded that the soils of plain showed differences in terms of erodibility according to their AS and SSI values.

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Effects of Organic and Inorganic Amendments on Erosion Ratio of Acidic Soil

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Abstract
The objective of the present investigation was to find out the effect of incorporating of various organic and inorganic matter sources such as lime (L), zeolit (Z), polyacrylamide (PAM) and biosolid (BS) on the erosion ratio (ER). A bulk surface (0–20 cm depth) soil sample was taken from Samsun, in northern part of Turkey. Some soil properties were determined as follows; fine in texture, modarete in organic matter content, low in pH and free of alkaline problem. The soil samples were treated with the inorganic and organic materials at four different levels including the control treatments in a randomized factorial block design. The soil samples were incubated for ten weeks. After the incubation period, corn was grown in all pots. The results can be summarized as organic and inorganic matter treatment decreased the erosion ratio. Effectiveness of the treatments varied depending on the types and levels of organic and inorganic materials.
Keywords: erosion ratio, polyacrylamide, zeolit, biosolid, lime.

Introduction

Soil physical properties are important for favorable conditions for crop growth and maintaining soil quality. Many practices are known to influence soil physical properties. These include crop type (Alberts and Wendt, 1985), cultivation (Gantzer and Blake, 1978) and application of organic residues (Anderson et al., 1990; Gantzer et al., 1987; Ekwue, 1990; Gajic et al., 2006). Soil degradation involves destruction of soil structure due to loss organic matter by intensive agriculture practices (Gülser and Candemir, 2006). Most studies showed that the amelioration of soil physical properties largley based on inreases of organic carbon in the soils with using organic wastes. Effects of application of organic residues on soil physical properties are often related to increases in soil organic matter (Özdemir, 1993; Haynes, 2000). Soil organic matter is an essential but transient component of the soil that controls many physical, chemical and biological properties of the soil (Carter, 1996). The stability of soil aggregates often decreases for soil under annual crops, such as wheat or corn (Angers et al., 1999). Gantzer et al. (1987), reported that residue quantity had a larger effect on splash detachment, shear strength and aggregate stability than residue type. MacRay and Mehuys (1985) concluded that long-term pastures were ideal for improving soil aggregation.

Many studies have showed a clear relationship between total soil C and soil aggregation, bulk density, water retention and hydraulic conductivity (Khaleel et al., 1981). Benbi et al. (1998), demonstrated that amending coarse-textured soils with manure increased organic carbon content and improved saturated hydraulic conductivity, water stable aggregation and water retention.

Use of soil amendments to increase agreggate stability from soils susceptible to erosion have been examined in the recent studies (Agassi and Ben-Hur, 1992; Flanagan et al., 1997; Shainberg et al., 1990; Shainberg and Levy, 1994). One such practice is the incorporation of lime ($CaCO_3$) into the acid soil. Lime application improves soil structure in heavy-textured soil, so that water infiltration and the ability of roots to penetrate the soil are enhanced. Sugarcane germination can also be promoted by increasing soil calcium (Sürücü, 1995).

Polyacrylamide (PAM) dissolved in irrigation water (10 mg kg^{-1}) has been extensively used to prevent erosion and increase infiltration in furrow irrigation (Lentz et al., 1992; Lentz and Sojka, 2000). Polyacrylamide with high molecular weight and moderate anionic charge density (18-20% hydrolysis) was found to be most effective in preventing runoff and increasing aggregate stability (Lentz et al., 1992; Green et al., 2000). Similarly, PAM in concentrations of 5, 10, and 20 mg L^{-1} was found to be effective in controlling runoff and erosion from loamy loess and a grumusol during sprinkler irrigation (Levy et al., 1992; Flanagan et al., 1997). Soil losses in all the PAM treatments were significantly lower than those in the control treatment (Levy et al., 1992).

Soil tructure influence some soil erodibility indices such as, erosion ratio, dispersion ratio, erodibility factor and aggregate stability. This indices have been developed to determine soil

erosion susceptibility and used to ases sustainable soil use and management (Bryan, 1968; Özdemir, 1993).
The objective of this investigation was to determine the effects of incorporating various organic and inorganic amendments such as lime (L), zeolit (Z), polyacrylamide (PAM), and biosolid (BS) into acidic soil on the erosion ratio.

Materials and Methods
The soil samples (0–20 cm depth) used in the experiment was taken from Samsun, northern part of Turkey. The lime (L), biosolid (BS), polyacrylamid (PAM) and zeolit (Z) were obtained from different institutions.
The soil samples, after the lime requirements done in 0, 50 and 100% levels, were treated with the inorganic and organic residues at four different levels (BS 0.0, 2.0, 4.0 and 8.0 %; Zeolit 0.0, 0.5, 1.0 and 2.0 %; PAM; 0.0, 15, 30, 60 ppm) including the control treatments, and each treatment was replicated two times in a randomized factorial block design [(3x3x4)x2]. All pots were incubated for ten weeks. After incubation period, corn was grown in all pots. After reaping of the corn, treated soil samples have been rubbed by hand and sieved from 2 mm openings sieve. Some physical and chemical properties of soils were determined as fallows; soil organic matter content by a modified Walkley-Black method (Nelson and Sommers, 1982); soil texture by hydrometer methods (Demiralay, 1993) lime requirement by SMP method (Kacar, 1995); pH in 1:2.5 (V:W) soil:water suspension by pH meter (Black, 1965); exchangeable Na by ammonia acetate extraction and cation exchange capacity according to Bower method (U.S. Salinity Laboratory Staff, 1954). Erosion ratio was determined according to Bryan method (Lal, 1988). Statically analyses of results were done by SPSS computer program.

Results and Discussion
Soil Properties
Some physical and chemical soil properties are given in Table 1. Soil properties can be summarized as; fine in texture, moderate in organic matter content, low in lime content, low in pH and free of alkaline problem (ESP<15 %), 21,2 meq $100g^{-1}$ of CEC (Soil Survey Staff, 1993).

Table 1. Some physical and chemical properties of the soil

Sand (S), g g^{-1}	0,233
Silt (Si), g g^{-1}	0,365
Clay (C) , g g^{-1}	0,402
Textural class	Clay
pH, 1:2,5	5,4
Organic matter content (OM), %	2,93
Cation exchange capacity (CEC), meq $100g^{-1}$ oven-dried soil	21,2
Exchangeable sodium percentage (ESP), %	6,40

Erosion Ratio
After harvesting of the corn, erosion ratio values of soil samples were determined according to Bryan method. The effects of amendments on the erosion ratio values depend on the type and level of amendment materials. These situations were given in Figure 1. It was observed that the erosion ratio values of all soils decreased significantly depending on lime and amendment materials. It was suggested that the increaseing dose application of amendment materials into acidic soil decreaased erodibility**.** It was found that without lime application had the lowest effect on the erosion ratio when compared with the other applications (Fig. 1).

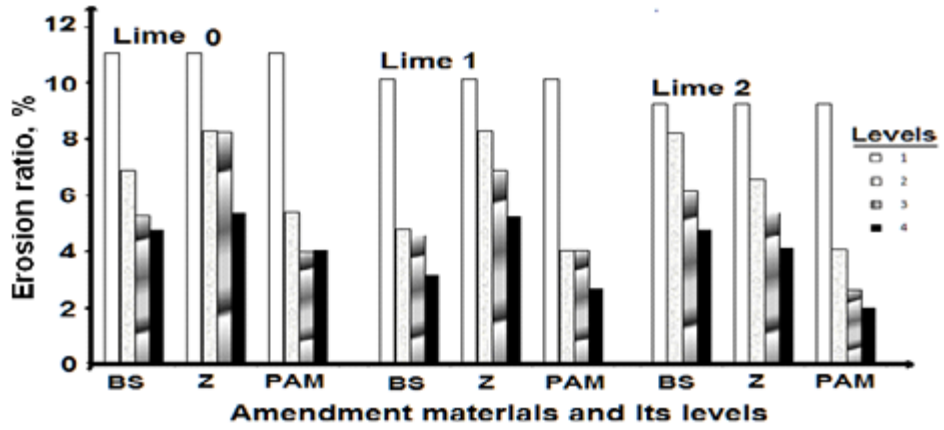


Figure 1. The comparison of erosion ratio values as a function of lime addings

Also, decreases in the erosion ratio (as a mean value) according to the lime addition levels were presented in Figure 2. The erosion ratio values were different in each treatment. It is clearly seen that zeolit application decreased the erosion ratio lower than the other amendments.

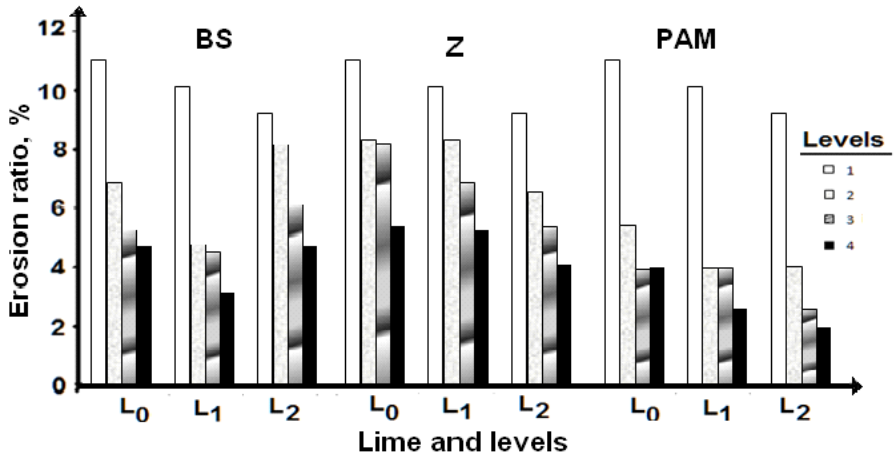


Figure 2. Decreasing of erosion ratio as a function liming

Variance analysis results on the erosion ratio values were given in Table 2. As shown in this table; erosion ratio values depending on the lime levels were significantly different at p<0.01.

Table 2. Variance analysis of the erosion ratio data

Sources	DF	SS	SM	SM
Lime (A)	2	7.138	3.569	71.756***
Amendments (B)	2	24.508	12.254	246.370***
A*B	4	7.949	1.987	39.956***
Amend. Levels (C)	3	183.946	61.315	1232.758***
A*C	6	3.772	0.629	12.640***
B*C	6	9.642	1.607	32.308***
A*B*C	12	4.736	0.395	7.935***
Error	35	1.741	0.050	
General	71	243.502	3.430	

*, p < 0.05; ** : p < 0.01; ***, p < 0.001

The effect of amendment materials (BS, Z and PAM) on the erosion ratio and their levels were statistically significant. On the other hand, erosion ratio values according to soils were different at the end of the corn grown period. Mean of square values of the amendment materials (p<0.01) and their levels (p<0.01) were statistically significant. As shown in Table 2; also interactions between lime-amendment, lime-level, amendments-level, and lime-amendment-level were significant

($p<0.01$). The compared means statistically are given in Table 3. The differences among the erosion ratio values were significant at $p<0.01$

Table 3. Mean values of Lime, Ammendments, and Ammendments Levels for the erosion ratio

Applications	0	1	2	3
Lime Levels	4.752a	4.268b	3.390c	
Amendments		4.44b (BS)	4.99a (Z)	3.57c (PAM)
Amend. Levels	6.944a	4.208b	3.507c	2.688d

As shown in Table 3; the effects of amendment materials and amendment levels on erosion ratio were different statistically. The results can be summarized as; amendment material treatments decreased the erosion ratio values of acidic soil. Effectiveness of the amendment materials varied depending on the type of the amendment material and the soil reaction. In conclusion, the effectiveness of the zeolit had considerably lower than the other amendment materials. The highest effect on the erosion ratio was obtained with the highest dose of PAM application in lime requirements done in 100% level.

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Slope-Direction & Altitude Interactions on Snow Depth and Density Distribution within the Erzurum-Ilica Sinirbasi Creek Watershed

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Abstract

Snow accumulation within a watershed is important for agricultural production especially in where a significant amount of total rain falls as snow during winter season. Snow depth and density vary depending on watershed characteristics. The objectives of this study were to determine snow depth and density distribution patterns within the Erzurum-Ilıca-Sinirbasi Creek watershed and to evaluate snow depth and density variability with slope aspects and altitude. The study site with an area of 1.465 km^2 was gridded by 50x50 m intervals in the E-W and N-S directions, and snow depth at each intersection and snow density at every other intersection of the grid system were recorded during the years between 1998 and 2008. Semivariogram analysis was performed for determining spatial variability in measured properties and block kriging analysis for estimating snow depth and density at unsampled areas within the watershed. Differences in the distribution patterns of snow depth and density were evaluated for among different altitude groups (1820-1900 m, 1901-2000 m and 2001-2125 m), main directions (E, W, N and S) and slope gradient groups (0-15%, 15-26% and > 26%). The experimental semivariograms indicated strong anisotropy with the highest variability in the mean slope direction, from east to west. The results indicated that snow depth was well-correlated with the micro topography and wind direction, and snow density was strongly dependent on altitude. Snow depth increased with increasing altitude and it was the highest at the peak point of the watershed. Most of the snow accumulated in concave-shaped topographical surfaces and in areas closed to wind. Snow density was higher in areas where wind blowing was effective. The highest snow density measurements were obtained in the south aspects of the northwest part of the watershed, because of compaction effect of wind and temperature changes during the day.

Keywords: snow depth distribution, spatial variability, Sinirbasi Creek Watershed

Estimation of water retention and availability in soils of southern Brazil using pedotransfer functions

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Summary

Pedotransfer functions to estimate the retention and availability of water in soils of subtropical regions are scarce. Thus, the objective was to generate pedotransfer functions to estimate the retention and availability of water in soils of subtropical climate of the southern Brazil. It was measured the water content at field capacity (tension of 0.01 MPa) and permanent wilting point (tension of 1.5 MPa), and calculated the available water in forty-four soils (ninety surface horizons). It was used path analysis to assess the direct effects, and multiple linear regression analysis to generate the pedotransfer functions from attributes: clay, silt, sand (five classes according to United States Department of Agriculture), particle density and total organic carbon content. Water retention is more related to the content of fine sand, very coarse sand (negative) and organic carbon (positive). The inclusion of the five classes of sand in the estimation of water retention slightly increases the determination coefficient of pedotransfer functions. The available water is more related to the content of very fine sand and organic carbon (positive), and its estimative improves when the sand fraction is divided into five classes. The pedotransfer functions to estimate water retention have better predictive ability than those generated for the prediction of available water. Thus, to estimate water availability, the sand fraction must be divided into five classes established by the United States Department of Agriculture.

Keywords: Field capacity, permanent wilting point, available water, multiple linear regression, path analysis.

Introduction

The available water influence plant growth and depends on the texture, clay mineralogy, organic carbon content and soil structure. Studies on the availability of water are scarce in soils from tropical and subtropical climate, because the methods are expensive and time-consuming. As the soil hydraulic properties vary in the space (Nielsen et al, 1973; Moraes and Libardi, 1993; Souza et al., 2004) the direct determination requires a large number of samples. The time and cost of obtaining the hydraulic properties can be reduced through pedofunctions (Bouma, 1989) which use soil properties easily measurable to estimate soil properties difficult to obtain (Meng, Taylor and Fryrear, 1987; Arruda et al., 1987; McBratney et al., 2002).

In developing countries, especially those from tropical climates, the development of pedofunctions was hampered by the lack of databases, and then is difficult to generate and validate new pedofunctions. The generation of some pedofunctions was due to the grouping of information from various studies carried out in certain places / States (Oliveira et al, 2002; Tomassela and Hodnett, 1998; Reichert et al, 2009).

Our objectives were to measure the water retention and availability in the most important soils of the southern of Brazil, and generate and validate pedofunctions to estimate water retention and availability, based on soil properties easy to obtain.

Material and Methods

Were sampled 90 surface horizons of 44 soil profiles with different physical, chemical and mineralogical properties, in areas under different vegetation cover, in 34 counties of Santa Catarina State, southern Brazil.

The soil water retention was determined in quadruplicate, using rings with 6.0 cm in diameter and 2.5 cm high, with a volume of 70.7 cm^3. Were applied tensions of 1, 6 and 10 kPa in the sand table, and tensions of 33, 100, 300, 500 and 1500 kPa, with chambers of Richards (Richards, 1949). The field capacity (FC) was considered as the moisture in the tension of 10 kPa; the permanent wilting

point (PWP) was considered as the moisture in the tension of 1,500 kPa; and the available water (AW) was calculated as the difference between FC and PWP.
The contents of total clay (0-2 μm), silt (2-53 μm), very fine sand (53-106 μm), fine sand (106-250 μm), medium sand (250-500 μm), coarse sand (500-1000 μm) and very coarse sand (1,000-2,000 μm) were determined according to Day (1965), and the content of organic carbon (TOC) was determined by the method of Walkley and Black modified by Tedesco et al. (1995).
After that, path analysis was performed to calculate the correlation coefficient (r), and separate the direct (R) and indirect effects (r_i). The FC, PWP and AW were used as predicted variables (individually) and the following physical attributes as predictor variables: (1) content of clay, silt, organic carbon and particle density; (2) content of sand, silt and organic carbon, and particle density; (3) content of sand divided into two classes, fine sand (53-250 μm) and coarse sand (250-2,000 μm); content of silt and organic carbon; and particle density; (4) content of sand divided into five classes (Day, 1965); content of silt and organic carbon; and particle density.
The independent variables were analyzed to meet the condition of collinearity weak, and when two variables were multicollinearity larger, one of the variables was removed from the model. Path analysis was performed using the GENES program (Cruz, 2011), and the results were interpreted according to Cruz (2006).
After that, the FC, PWP and AW were estimated using two sets of predictors: (Model A) content of clay (a), silt (b), sand (c), organic matter (d), and their interactions; (Model B) content of clay (a), silt (b) sand (c), organic matter (d), bulk density (e), particle density (f), total porosity (g), and sand content divided into five classes: very coarse sand (h), coarse (i), medium (j), fine (k), very fine (l), and their interactions. The interactions to generate the pedofunctions to estimate retention and availability of water were performed with 75% of the total horizons analyzed in path analysis. The validation of the pedofunctions was performed by comparing the values measured in laboratory with the estimated by models, by using 25% of the total of horizons analyzed in path analysis.

Results and Discussion

The soil had texture and organic carbon content very different. The clay content ranged from 15 to 789 g kg^{-1}, silt from 12 to 581 g kg^{-1}, sand from 17 to 973 g kg^{-1}, and TOC from 4 to 141 g kg^{-1} (Table 1). These variations affected soil water retention: the FC values ranged from 0.14 to 0.77 m^3 m^{-3}; the PWP from 0.05 to 0.56 m^3 m^{-3}; and the AW from 0.06 to 0.25 m^3 m^{-3}. These differences occur because of the wide variation in source material and in the intensity of action of the soil formation factors. The topography in the state of Santa Catarina is varied, but dominated areas with medium to high slope, a characteristic significant in soil formation.
Path analysis
The estimation of water retention in the FC and PWP was similar when was estimated with the first model, containing the clay content, or with the second model, which includes the total sand content. This occurred because the variables clay and sand had a high correlation coefficient. Moreover, the correlation coefficient of the sand and “clay plus silt” with the FC and the PWP was similar. Both models had good predictive ability; it explained 74% of the total variation that exists in the FC and PWP.
The division of the sand in fine sand and coarse sand did not improve the estimation of the model, and the division of the sand fraction in five classes, little has improved the estimation of water retention in the FC and the PWP, however improved the estimation of the available water (data not shown). In the model that uses five classes of sand, the highest correlation coefficients between the soil physical properties with the FC, were obtained with very coarse sand (r =-0.41), fine sand (r=-0 , 52), and the organic carbon content (r=0.51) (Table 2). For PWP higher coefficients were obtained with very coarse sand (r=-0.39), fine sand (r=-0.63), and the organic carbon content (r=0.32) (Table 2).

Table 1. Descriptive statistics of soil properties correlated with field capacity (FC), permanent wilting point (PWP) and available water (AW) in surface horizons of soils of the Santa Catarina State, southern of Brazil, 2011.

Properties	**Unit**	**N**	**Average**	**Standard deviation**	**Minimum**	**Maximum**
FC	$cm^3\ cm^{-3}$	90	0.43	0.12	0.14	0.77
PWP	$cm^3\ cm^{-3}$	90	0.30	0.11	0.05	0.56
AW	$cm^3\ cm^{-3}$	90	0.13	0.03	0.06	0.25
Organic carbon	$g\ kg^{-1}$	90	27	21	4	141
Sand	$g\ kg^{-1}$	90	281	272	17	973
Silt	$g\ kg^{-1}$	90	289	136	12	581
Clay	$g\ kg^{-1}$	90	430	226	15	789
∑ Clay + Silt	$g\ kg^{-1}$	90	719	272	27	983
∑ Very fine sand + Fine sand	$g\ kg^{-1}$	90	167	218	6	828
∑ medium sand + coarse sand + very coarse sand	$g\ kg^{-1}$	90	114	132	10	653
Very coarse sand	$g\ kg^{-1}$	90	27	67	0	377
Coarse sand	$g\ kg^{-1}$	90	34	48	3	224
Medium sand	$g\ kg^{-1}$	90	53	56	3	303
Fine sand	$g\ kg^{-1}$	90	125	200	3	818
Very fine sand	$g\ kg^{-1}$	90	42	48	2	208
Particle density	$g\ cm^{-3}$	90	2.42	0.16	1.85	2.75
Bulk density	$g\ cm^{-3}$	90	1.12	0.23	0.52	1.74
Total porosity	$cm^3\ cm^{-3}$	90	0.66	0.08	0.44	0.93
Saturated hydraulic conductivity	$mm\ h^{-1}$	89	206	139	3	577
Aggregate stability	mm	90	4.4	1.5	0.3	6.0

The independents variables such medium sand, silt and particle density, had a full effect higher than the direct effect for FC and PWP. For example, the full effect of silt content at field capacity (r=0.53) was higher than the direct effect (R=-0.12). This is because there are indirect effects of fine sand (r_i=0.31) and organic carbon (r_i=0.22) in water retention of silty soils (Table 2). Soils with greater silt content had higher organic carbon content (r=0.43), and carbon is the constituent which has a direct effect on water retention (R=0.51). Therefore, to know which is the attribute that determines the water retention, it is necessary to calculate the direct effects of each soil attribute through path analysis, and not only to evaluate the correlation coefficient.

By analyzing the four models, we observe through the determination coefficient, that the estimation of the available water was better when the sand fraction was divided into five classes of sand (R^2=0.63), compared to the models with two classes of sand (R^2=0.53), or with total sand content (R^2=0.48), or with clay content (R^2=0.48).

In the model 2 with use total sand, the direct effects were more related to silt content (R=0.33) and total organic carbon (R=0.50). With the separation into two classes of sand, the direct effects were higher with “very fine sand plus fine sand” (R=0.35), silt content (R=0.34) and total organic carbon (R=0.50) (data not shown). With the division into five classes of sand, the direct effects were higher at the very coarse sand (R=-0.21), very fine sand (R=0.45) and total organic carbon (R=0.74) (Table 2).

Table 2. Correlation coefficients considering the direct (R) and indirect effects (r_i) obtained through path analysis, among the sand content (5 fractions), silt, particle density (Pd), and total organic carbon (TOC), with field capacity (10 kPa), permanent wilting point (1500 kPa) and available water in soils of the Santa Catarina State, southern Brazil, 2011.

Variable	Correl. coef.	Direct effect	Indirect effect (r_i) trough:							
	r	R	VCS	CS	MS	FS	VFS	Silt	Pd	TOC
					Field capacity					
VCS[1]	-0.17	-0.41	-	0.12	-0.01	0.08	-0.01	0.01	0.00	0.06
CS	-0.11	0.14	-0.35	-	-0.04	0.08	0.00	0.01	0.00	0.07
MS	-0.61	-0.16	-0.04	0.03	-	-0.36	0.01	0.06	0.00	-0.15
FS	-0.70	-0.52	0.06	-0.02	-0.11	-	0.01	0.07	0.00	-0.19
VFS	-0.24	0.05	0.05	-0.01	-0.04	-0.14	-	-0.01	0.00	-0.14
Silt	0.53	-0.12	0.04	-0.01	0.08	0.31	0.00	-	0.00	0.22
Pd	-0.37	-0.01	0.07	-0.04	0.00	-0.10	0.00	0.02	-	-0.31
TOC	0.67	0.51	-0.05	0.02	0.05	0.20	-0.01	-0.05	0.01	-
					Permanent wilting point					
VCS	-0.16	-0.39	-	0.07	-0.01	0.09	0.01	0.02	0.01	0.04
CS	-0.12	0.09	-0.34	-	-0.03	0.09	0.01	0.01	0.01	0.04
MS	-0.63	-0.14	-0.03	0.02	-	-0.44	-0.03	0.07	0.00	-0.09
FS	-0.74	-0.63	0.06	-0.01	-0.09	-	-0.03	0.09	-0.01	-0.12
VFS	-0.36	-0.10	0.05	-0.01	-0.03	-0.17	-	-0.01	0.00	-0.09
Silt	0.46	-0.16	0.04	0.00	0.06	0.38	-0.01	-	0.01	0.14
Pd	-0.27	-0.03	0.07	-0.03	0.00	-0.12	0.01	0.03	-	-0.20
TOC	0.55	0.32	-0.04	0.01	0.04	0.24	0.03	-0.07	0.02	-
					Available water					
VCS	-0.07	-0.21	-	0.16	-0.01	-0.02	-0.06	-0.01	-0.01	0.08
CS	0.00	0.19	-0.18	-	-0.03	-0.02	-0.04	-0.01	-0.01	0.10
MS	-0.15	-0.13	-0.02	0.05	-	0.10	0.12	-0.05	0.00	-0.22
FS	-0.16	0.15	0.03	-0.03	-0.09	-	0.12	-0.07	0.01	-0.28
VFS	0.28	0.45	0.03	-0.02	-0.03	0.04	-	0.01	0.00	-0.20
Silt	0.44	0.11	0.02	-0.01	0.06	-0.09	0.03	-	-0.01	0.32
Pd	-0.47	0.03	0.04	-0.06	0.00	0.03	-0.03	-0.02	-	-0.46
TOC	0.63	0.74	-0.02	0.03	0.04	-0.06	-0.12	0.05	-0.02	-

[1] VCS = very coarse Sand (1.000-2.000 μm); CS = coarse sand (500-1.000 μm); MS = medium sand (250-500 μm); FS= fine sand (106-250 μm); VFS = very fine sand (53-106 μm); silt (2-53 μm); Pd = particle density; and TOC = total organic carbon.

Pedotransfer function

The estimation of the field capacity and permanent wilting point by pedofunctions, can be carried out with good predictive ability with data of texture, organic matter and their interactions (Model A), whereas to the estimation of the available water it is necessary the use of more complex pedofunctions, with the inclusion of five classes of sand as some of the predictor variables (model B) (Table 3).

The pedofunctions adjusted with textural attributes to estimate field capacity and permanent wilting point, had a mean predictive ability, however, pedofunctions to estimate available water had low determination coefficients (Table 3 and 4). For soils of the southern of Brazil, the increase of clay content did not increase the available water, however the soils with low sand content and high silt content, and especially total organic carbon, have higher available water.

Table 3 Pedotransfer functions to estimation of the field capacity (FC), permanent wilting point (PWP) using the soil physical attributes selected in the Model A: Soil texture and organic matter and their interactions, and to the available water (AW) using the soil physical attributes selected in the Model B: five classes of sand, silt, clay, organic matter, soil density, particle density, total porosity and their interactions, for the soils of Santa Catarina State, southern of Brazil, 2011.

Attribute	Model	Intercept	Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5
FC	A	0.41	0.0046*a*d	2.76*b^2*c^2	2.54*a^2*b^2	0.334*a^2	0.0013*1/a
PWP	A	0.36	0.0032*a*d	4.40*a^2*b^2	0.37*a^2	-	-
AW	B	0.06	0.013*d*f	0.038*1/e	0.00074*b*d	-	-

(1) *a*: sand content (kg kg^{-1}); *b*: silt content (kg kg^{-1}); *c*: clay content (kg kg^{-1}); *d*: organic matter content (g kg^{-1}); *e*: bulk density (g cm^{-3}); *f*: particle density (g cm^{-3}); *g:* total porosity (cm^3 cm^{-3}) calculate by equation: $g = 1-(e/2{,}65)$; *h*: very coarse sand (kg kg^{-1}); *i*: coarse sand (kg kg^{-1}); *j*: medium sand (kg kg^{-1}); *k*: fine sand (kg kg^{-1}); *l*: very fine sand (kg kg^{-1}). (2) R^2: determination coefficient; (3) R^2 adjust.: adjusted determination coefficient; RMSE: Root mean square error; CV: variation coefficient.

Table 4. Root mean squared error (RMSE), root mean squared relative error (RMSRE), mean error (ME), efficiency index (EF), index of agreement (d), correlation coefficient (r), index trust (c), performance, intercept (a), slope (b) and determination coefficient (R^2) for the equations adjusted between the moisture measured and estimated by different pedotransfer functions obtained in Models A and B, using different data banks of validation for soils of the Santa Catarina State,2011

Attribute	Model	N	RMSE	RMSRE	ME	Pbias	EF	d	r	c	Performance	a(1)	b(2)	R^2
			cm^3 cm^{-3}	%	cm^3 cm^{-3}	%	-	-	-	-	-	cm^3 cm^{-3}	-	-
Generation data														
FC	A	57	0.05	12	0.00	0	0.80	0.94	0.89	0.84	Very good	0.09**	0.8**	0.80
PWP	A	57	0.05	16	0.00	0	0.79	0.94	0.89	0.84	Very good	0.06**	0.79**	0.79
AW	B	57	0.02	15	0.00	0	0.73	0.92	0.85	0.78	Very good	0.03**	0.73**	0.73
Validation data														
FC	A	92	0.07	14	0.02	6	0.10	0.71	0.57	0.41	Poor	0.21**	0.5**	0.33
PWP	A	83	0.07	20	0.01	3	0.28	0.72	0.57	0.41	Bad	0.19**	0.41**	0.33
AW	B	37	0.05	35	-0.02	-18	-1.67	0.49	0.23	0.11	Poor	0.11**	0.31**	0.05

(1) Level of significance of the F test (* and ** significant at 5% and 1%, respectively) for the intercept; a level> 0.05 indicates that the parameter "a" of the equation of a line does not differ from zero.

(2) Level of significance of the F test (* and ** significant at 5% and 1%, respectively) for the slope; a level> 0.05 indicates that the parameter "b" of the equation of a line does not differs of 1.

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Estimating and Comparing the Amount of Water Erosion Using Process Based WEPP Model and Experimental Model of EPM in the Atashgah Watershed, Ardabil

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Abstract: Water erosion is one of the most important environmental problems in different parts of the world. Accurate estimation of water erosion, soil loss and deposition of sediments is very important to assess the potential storage capacity of dams. In this study, the process based WEPP model and experimental EPM model were used to estimate the amount of erosion and sedimentation. WEPP's most notable advantages include its capabilities for estimating spatial and temporal distributions of soil detachment and deposition on an event or continuous basis. In the WEPP model, with combining of sediment producers hillslopes from the Atashgah, were done the trending of runoff and sedimentation and erosion rates were simulated. The EPM method consists of four properties include erosion intensity, coefficient of land use, sensitivity coefficient of rock and soil to erosion and average slope of watershed that were created as the maps and were examined. Also, In the EPM model using the software ArcGIS, Atashgah watershed sedimentation rate was estimated. The results compared depicted that the application of WEPP model in estimating the erosion rates is closer to the reality.
Keywords: ArcGIS, Atashgah, Erosion, EPM, WEPP.

Introduction

Soil erosion, refers to the process during which soil particles are separated from their original context and cause a factor to be carried to another place (Esmali & Abdollahi, 2010).

Iran is a country located in southwest Asia. It has the total area of 1648000 square kilometers with 11% of the area under agriculture, permanent pastures 50%, forests, grove 9% and In the is taken other land 30%. The average rainfall in Iran is 240 mm which is less than one-third of the average rainfall of the world. Currently nearly 125 of 165 million hectares of land country are subject to erosion (rafahi, 1997).

Seven main types of erosion and deposition are as follows: (1)- Empirical (2)- Mathematical (3)- Conceptual (4)- Statistical (5)- Iconic (6)- Analog (7)- Physical

The WEPP model of the physical models and EPM model is of the empirical models.

The Water Erosion Prediction Project (WEPP) model was developed from 1985 to 1995, by the United States Departments of Agriculture and Interior, and was publicly released in 1995 for application on cropland, rangeland, forestland, and other managed lands (Flanagan and Nearing 1995). WEPP simulates the important physical processes that result in soil erosion by water. The model contains a climate generator, simulates surface and subsurface hydrology, irrigation, plant growth, residue decomposition, effects of tillage, soil detachment by raindrop impact and flowing water, sediment transport and deposition. At the time of its initial release, basic DOS interface programs were provided to assist users in creating input files, managing groups of simulation runs, and generating and viewing output. Since about 1997, next generation windows TM compatible interfaces for WEPP have been under development and work is near completion on a graphical watershed interface.

The EPM model was originally developed for Yugoslavia by Gavrilovic (1988). The method has been tested in some catchment areas in Iran, and it is found that results are compatible with field observation (Sadeghi, 1993; Rafahi and Nematti, 1995). Both the EPM and the PSIAC models are factor-based, which means that a series of factors, each quantifying one or more processes and their interactions, are combined to yield an overall estimation of soil loss.

Applications of Geographic Information Systems (GIS) and remote sensing techniques in erosion and sediment yield assessment have been developed recently (Hill, 1993; Bissonnais et al, 2002; Yuliang and Yun, 2002; Martinez-Casasnovas, 2003). Remote sensing techniques assist the evaluation of erosion processes and the generation of land use maps, while the integration of such

data layers with the generation of erosion-severity and sediment-yield maps can readily be performed by the use of the analytical tools of a GIS.
Since these two models are frequently used in Iran to compare the results of these two models.

Materials and Methods

Study area

The Atashgah Watershed is located on Noran Chay river, a branch of the Qara Su river in the southwestern city of Ardabil with longitude 48° 03 and latitude 38° 13 , With an average elevation 2417 meters of above sea level. Table (1) and figure (1) show some information about the Atashgah Watershed.

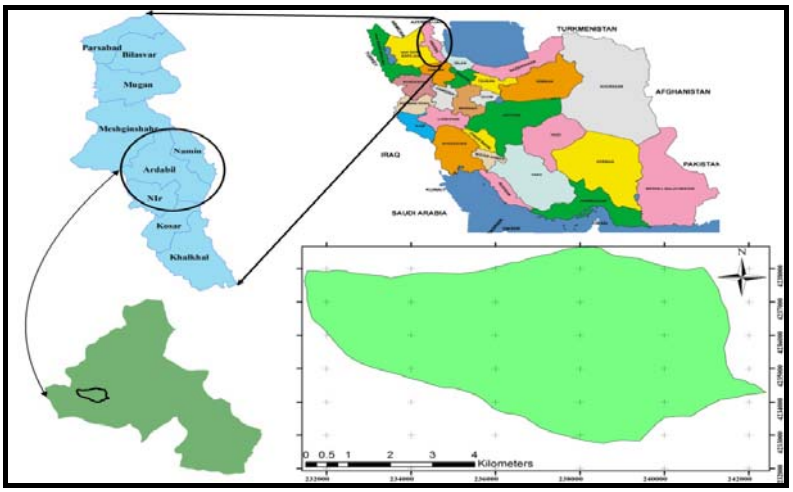


Figure 1. Position Atashgah Watershed, Iran

Table 1. Specification of Atashgah Watershed

Perimeter (k)	Average Precipitation (mm)	Average Temperature (°C)	Average Slope (%)	Average Elevation (m)	Max Elevation (m)	Min Elevation (m)	Area (km^2)
28.12	424.59	8.03	30.08	2417	3684	1774	40.56

The WEPP model

The USDA Water Erosion Prediction Project erosion model represents a new generation technology for estimating soil erosion on and sediment delivery from hillslope profiles and small watersheds. The erosion processes of detachment and transport by raindrop impact on interrill areas, detachment, transport, and deposition by overland flow in rill channels, detachment, transport, and deposition by concentrated flow in channels, and deposition in impoundments are simulated by the WEPP erosion model.
WEPP Erosion Model allows simulation of both hillslopes and small watersheds consisting of several hillslopes, a channel network, and impoundments. Thus the appropriate scale of application is on the order of tens of meters (for hillslopes) to hundreds of meters (small watersheds). This model may be used for agriculture, forests and roads. Because studied watershed was mountainous In this study, was used of hillslopes methods for estimating erosion, sedimentation and runoff model.
Inputs to the model were given through 4 files (Hillslopes method): (1) climate, (2) slope, (3) soil, (4) management.
Input data section climate: Average monthly rainfall, standard deviation of monthly rainfall, monthly skewness coefficient, The probability of a wet day after a wet day, the probability of a wet day after dry day, average minimum daily temperature, standard deviation daily minimum temperature, Average daily maximum temperature and standard deviation daily maximum temperature calculated are values for the station Atashgah (Table 2).

Table 2. Factors calculated for the Precipitation & Temperature of the study area

P & T	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Av. P (in)	1.06	1.03	1.12	2.28	2.71	1.19	0.61	0.62	1.33	1.37	2	1.33
Sk. C. P	0.1	0.09	0.09	0.18	0.17	0.09	0.06	0.07	0.1	0.13	0.15	0.11
St. D. P	0.038	0.041	0.04	0.082	0.044	0.051	0.026	0.017	0.017	0.099	0.046	0.034
[P(W/W)]	0.34	0.34	0.31	0.52	0.56	0.41	0.24	0.34	0.46	0.33	0.47	0.38
[P(W/D)]	0.13	0.15	0.16	0.18	0.27	0.16	0.12	0.09	0.16	0.14	0.19	0.15
T_{min} (°F)	18.15	18.77	25.29	32.57	39.26	45.51	50.63	53.06	49.16	42.96	33.3	23.58
St. D. T_{min}	6.73	4.59	3.61	3.21	2.82	2.27	1.46	1.99	1.33	1.78	2.47	5.04
T_{max} (◦F)	37.58	39.44	46.04	53.15	60.04	68.72	71.68	75.77	71.70	64.44	52.29	42.96
St. D. T_{max}	5.21	4.26	4.7	5.48	3.58	2.14	2.23	2.51	2.51	3.54	4.71	4.98

Input data section slope: Slope must be entered in two files, the first case slope of that range should be entered in the slope and second file on that channel slope must be entered in the file stream. Used software GIS for this work.

Input data section soil: After the land units, given the limited sampling the soil profiles were taken at whole position 6 of the watershed. Properties calculated for each one of the samples (Table 3).

Table 3. Soil properties used for simulations in soil profil Alocheyeh Savalan

Soil properties	Soil depth (cm)		
	0-20	20-45	45-150
Sand (%)	20	27	27.5
Clay (%)	33	41	41
Rock fragments (%)	10	10	10
CEC (meq/100 g)	21	22.92	21.67
Organic matter (%)	1.8	0.97	0.47
Albedo	0.11	-	-
Effective hydraulic conductivity (mm h^{-1})	1.787	-	-
Interrill erodibility (10^6 kg s m^{-4})	4.597	-	-
Rill erodibility (s m^{-1})	0.0069	-	-
Critical shear stress (N m^{-2})	3.5	-	-
Initial saturation level (%)	75	-	-

Input data section management: Build file management information should be completed this window. Also compound land utilization map was prepared and used in GIS. The model's parameters were calculated the four files up simulated to 10 years.

The EPM model

This method considers six factors that depend on surface geology and soils, topographic features, climatic factors (including mean annual rainfall, and mean annual temperature), and land use. Three naturally occurring factors control erosion development (exposed rock and soil, topography, and climate), while land use is entirely man-dependent.

The Erosion Potential Method calculates the coefficient of erosion and sediment yield (Z) of a sub-catchment area by the following equation:

$$Z = Y X_a (\Psi + I^{0.5}) \quad (1)$$

Where, Y is the coefficient of rock and soil resistance to erosion, ranging from 2 to 0.25, Xa is a land use coefficient, ranging from 1.0 to 0.05, Ψ is the coefficient value for the observed erosion processes, ranges from 1.0 to 0.1, based on the severity of erosion. The factor I is the average land slope in % (Esmali & Abdollahi, 2010).

Erosion severity is classified according to values of Z. Areas with Z > 1.0 have "severe erosion" and those with Z < 0.19 have a "very slight" erosion.

Sediment production is estimated as:

$$W_{sp} = T \cdot H \cdot \pi \cdot Z^{1/5} \quad (2)$$

Where, W_{sp} is the average annual specific production of sediments per km^2 in m^3/year, T is a temperature coefficient, calculated as:

$$T = (t/10 + 0.1)^{0.5} \quad (3)$$

With T the mean annual temperature in degrees Celsius (C), H the mean annual amount of precipitation in mm/year, and Z the coefficient of erosion calculated (Eq 1).
The model parameters were calculated by GIS.

Table 4. Percentage cover, the area, the range of annual sediment yield, and mean sediment yield of each erosion potential category, resulted from EPM model

Erosion class	Annual soil loss (kg/ha)	Mean sediment yield	Area (ha)	Percentage of area
Severe	0.200-0.077	0.1385	67	1.65
Heavy	0.077-0.051	0.064	369	9.11
Moderate	0.051-0.036	0.0435	1114	27.46
Slight	0.036-0.023	0.029	1562	38.51
Very slight	0.023-0.001	0.012	942	23.24

Results

In general, the WEPP model simulated less annual surface runoff than measured for all management systems and sites. That data were given available for 10 years, the simulations were performed, respectively, for ten years in the WEPP model.
The quantitative output of erosion severity (parameter Z) in the EPM model was evaluated mathematically by solving Eq (1) for values of factor classes, and was then collapsed into five ordinal classes.
Areas with Z > 1.0 are those with the potential for severe erosion, while areas with Z < 0.19 correspond to a slight erosion potential. The average annual specific production of sediments per km^2 in m^3/year (Wsp), was predicted using Eq (2) and (3) (Table 4) (fig 2).

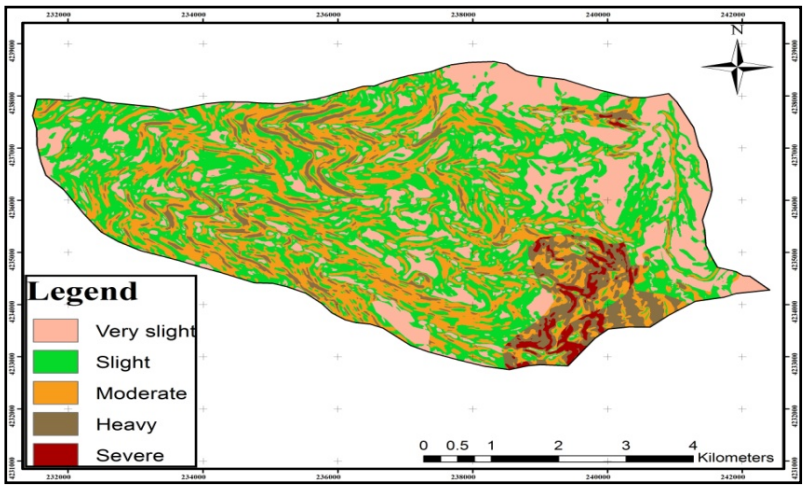


Figure 2. W_{sp} Map for Atashgah Watershed

The results compared depicted that the application of WEPP model in estimating the erosion rates is closer to the reality. This is also confirmed in the Figure 3 below.

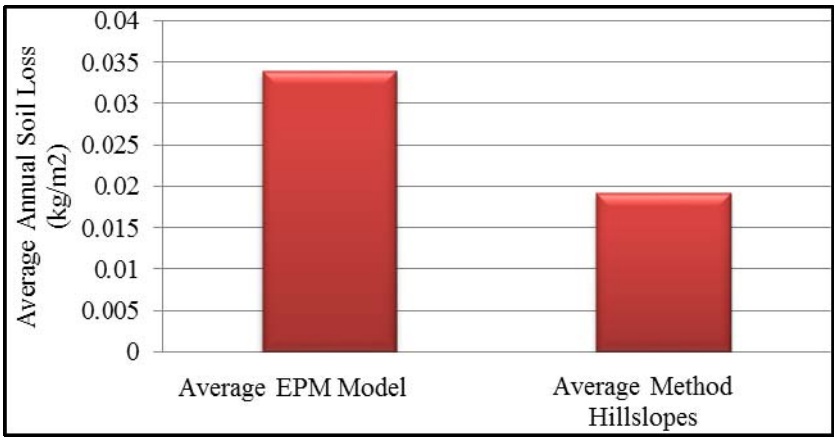


Figure 3. Comparison between two models in terms of specific soil loss

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Mathematical Evaluation of Soil Stress in Erosion Process

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Abstract: Evaluation of soil stress is important to soil management and related cultural processes to be done in appropriate time, and also important to soil fertility and conservation. In this study, stress and deformation in solid media, two and three dimensional stress, formation of deformation and linear elasticity were investigated theoretically. To evaluate the soil stress after soil erosion, an analytical expression was obtained using time independent equations between stress and deformation. Soil stress values for different soil depths after erosion were calculated using soil particle density values in this expression. The vertical surface stress after erosion was found to be directly proportional with particle density and soil depth. Increment in soil depth is more effective on soil stress than increment in particle density. When particle density ranged from 2.50 to 2.80 kg/m^3, soil stress varied between 0.0327 and 0.0366 kPa in 0.20 cm soil depth, and between 0.8175 and 0.9156 kPa in 0.50 cm soil depth.

Keywords: soil, rheology, stress-deformation equations, erosion.

Introduction

Rheology is a specific discipline which examines the attitudes of objects such as; stress, deformation, elasticity, general flow under load, formation, and time factors. Therefore, some disciplines like hydrodynamic, hydraulic, elasticity, the theory of plasticity and uninterrupted environmental mechanic also depends on the theory of rheology (Burov and Cloetingh, 1997; Qi and Hou, 2006; Burov, 2011; Hart et.al., 2011). The all massive rock shaped crystalline objects in nature transform to soil as a result of external forces. Thus, basic rheology laws can be applied to soil (Vyalov, 1986; Or and Ghezehei, 2002; Markgraf et. al., 2006). In soil rheology, some processes such as; shear, compaction, and deformation are related with irreversible deformation and develop by time.

As a result of external loads on a partially saturated soil component, the liquid between two soil particles relocates, and the contact surface area between the soil particles increases. Increasing contact surface area depends on the deformation of soil components. The determined stress-strain relationship for metal materials cannot define the deformation of the soil components. Stress-strain relationships which are improved for other materials, except metals, can be applied to soil (Prevost and Höeg, 1975; Terzaghi et al., 1996, Richards, 2000). Changes in rheological properties influence on soil physical properties which have a significant importance on soil tillage and development of plant-root system. Optimum soil tillage can be maintained when the less deformation occurred by stress.

While soil depth decreases, rheological properties such as; stress and deformation are changed by the erosion processes. Stress occurred as a result of erosion has a negative effects on optimum level of soil physical properties. Stress formation in soils varies due to potential energies of factors influencing erosion. Soil stress has a great impact on transportation of nutrients, chemicals, water and salts in soils.

In ground mechanic, there are two kinds of equations defining rheological properties especially in soil. While one of these equations expressing stress and deformation is time dependent, the other one is time-independent. Therefore, force variation, which affects on surface of media and depending on time, is not used in the first kind of equation (Koltunov et. al., 1983). The objective of this study is to examine the time independent stress-deformation equation, and to assess the soil stress after erosion theoretically.

Material and Methods

Quantitative assessment of soil stress process is related with time-independent stress-deformation equation. In this equation, isotropic stress condition and three basic stresses ($\sigma_1, \sigma_2, \sigma_3$) are

considered**.** To express of soil stress after erosion, stress-deformation equations and soil data, used in evaluation (depth, specific gravity), are the materials of derived analytical expression in this study. Mathematical approximation method is used to derive this expression.

Results and Discussion

Stress and Deformation in Solid Media

Deformation and stress condition of media (soil) are the factors affecting erosion process significantly. The force acting on unit area and spreading as a result of mutual impact among particles (atoms) express the stress of media. While the perpendicular stress acting on media surface is defined as normal stress, the parallel stress spreading on media surface is defined as shear stress. Mean of normal stress values acting on layers indicates the pressure. Stress occurring in elastic solid media causes deformation. The ratio of change of the initial length of solid media to the initial length defines the normal deformation. Internal friction angle is the measure of the shear strength of soils due to friction. A half of the decrement in the right angle due to deformation defines the shear stress.

Multiplying gravity force in unit volume (ρg) by cross sectional area (δA) and length (y) of media is equal to the total gravity force ($\rho g y \delta A$). The force balancing the total gravity force in opposite direction is $\sigma_{yy}\delta A$.

In this case, it is assumed that there are not perpendicular forces from horizontal sides, and ρ is a constant. Therefore, $\sigma_{yy} = \rho g y$ which is perpendicular force acting on unit area, expresses normal stress or pressure. This force increases through the depth linearly.

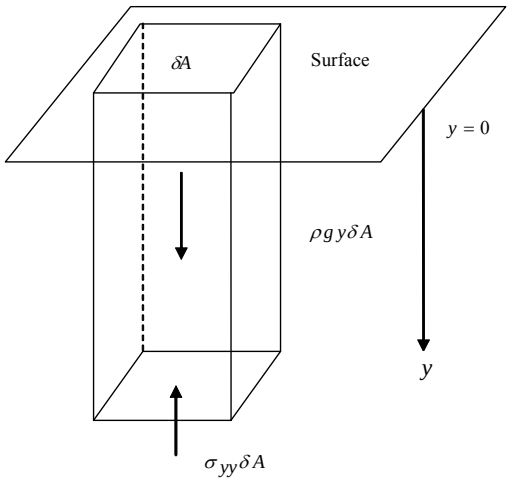


Figure 1. Surface forces and weight influencing vertical column shaped media.

Two and Three Dimensional Stress

To define a stress on any given point in media (external or internal), an infinitely small element including δx, δy and δz sides is considered in a cartesian coordinate system (Figure 2). In two dimensional cases, there is not force acting on plane in z direction, stresses in x and y directions are independent from z. σ_{xx} and σ_{yy} are normal stresses, σ_{xy} and σ_{yx} are shear stresses. Where, the first indices of σ indicates the normal line perpendicular to the plane, and the second indices indicates the direction of force. σ_{xy} and σ_{yx} shear stresses depending on surface forces affect a small part of media to rotate around z axis. In this case, momentum force of $\sigma_{xy}\delta y \delta z$ on δx is $\sigma_{xy}\delta x \delta y \delta z$ which has an opposite direction effect on momentum force, $\sigma_{yx}\delta x \delta y \delta z$, of $\sigma_{yx}\delta x \delta z$ on δy. Thus $\sigma_{xy} = \sigma_{yx}$, and rotation of the small element does not occur in the equilibrium condition. It means that shear stresses are symmetrical even if indices are replaced each other. Therefore, knowing the independent σ_{xx}, σ_{yy} and σ_{xy} stress elements is enough to explain the two dimensional stress exactly.

In three dimensional cases, additional stress elements should be added to determine surface forces acting on per unit area of randomly selected planes. In a rectangle shaped small parallel face, surface forces acting on unit area of each plane is shown in Figure 3.

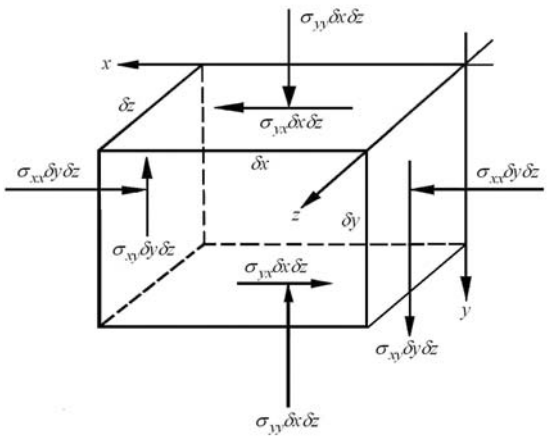


Figure 2. Surface forces acting on infinitely small parts of planes in two dimensional stress cases.

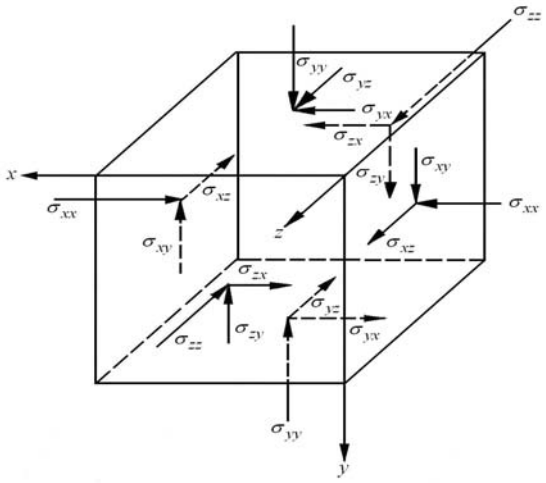


Figure 3. Stress elements acting on planes in three dimensional cartesian coordinate system

There should be three normal (σ_{xx} , σ_{yy} and σ_{zz}) and six shear stress (σ_{xy} , σ_{yx} , σ_{xz} , σ_{zx} , σ_{yz} and σ_{zy}) to determine surface forces acting on unit areas of planes. There are six independent elements of stress according to equilibrium condition of media such as; $\sigma_{xy} = \sigma_{yx}$; $\sigma_{xz} = \sigma_{zx}$ and $\sigma_{yz} = \sigma_{zy}$.

If the stress occurs in three orthogonal directions, sum of the forces acting on the stress will be zero due to usual definition of orthogonality by requiring that the inner product of two vector is zero (Verruijt, 2011). Normal stress acting on planes are perpendicular to these axes, and $\sigma_1, \sigma_2, \sigma_3$ define basic stresses. Generally, it is assumed that $\sigma_1 \geq \sigma_2 \geq \sigma_3$ and σ_1 - maximal, σ_2 - interval, σ_3 - minimal basic stress. Stress condition of solid media is determined with basic stress values, $\sigma_{xy}, \sigma_{yx}, \sigma_{xz}, \sigma_{zx}, \sigma_{yz}, \sigma_{zy}$. It is possible that two or three basic stress can be equal. If three basic stresses are equal, stress condition is isotropic and equals to pressure ($p = \sigma_1 = \sigma_2 = \sigma_3$). In this case, normal stress equals to pressure of basic or converted coordinate system, and there are not shear stresses. If the basic stresses are not equal, pressure of media is determined as $p = (\sigma_1 + \sigma_2 + \sigma_3)/3$ or $p = (\sigma_{xx} + \sigma_{yy} + \sigma_{zz})/3$. In three dimensional cases, the possible biggest shear stress is $(\sigma_1 - \sigma_3)/2$.

Deformation in Solid Media

Deformation in solid media is related with effective stresses which are a measure for the contact forces transmitted between the particles (Verruijt, 2011). As a result of stress in solid media, deformation occurs due to changing the length between contacted particles. It is possible that the length of $\delta x, \delta y$ and δz sides of a small element of rectangular prism shaped media can be changed due to deformation, but the shape of rectangular prism remains the same (Figure 4). After deformation, the sides become $\delta x - \varepsilon_{xx}\delta x$, $\delta y - \varepsilon_{yy}\delta y$ and $\delta z - \varepsilon_{zz}\delta z$. The values of $\varepsilon_{xx}, \varepsilon_{yy}$ and ε_{zz} are normal deformation. ε_{xx} shows the change of side length in parallel direction to x axis and defines the ratio of change of length to the original length before deformation $\left(\frac{\delta x - (\delta x - \varepsilon_{xx}\delta x)}{\delta x} = \varepsilon_{xx}\right)$. The values of ε_{yy} and ε_{zz} are the relative changes of the other sides' lengths in parallel direction to y and z axes. If the side lengths of media are shortened, the normal

elements of deformation, $\varepsilon_{xx}, \varepsilon_{yy}$ and ε_{zz}, are assumed to be positive. This is harmonic with being positive of stress in media. A relative change in volume of the small element of media is $\varepsilon_{xx} + \varepsilon_{yy} + \varepsilon_{zz}$.

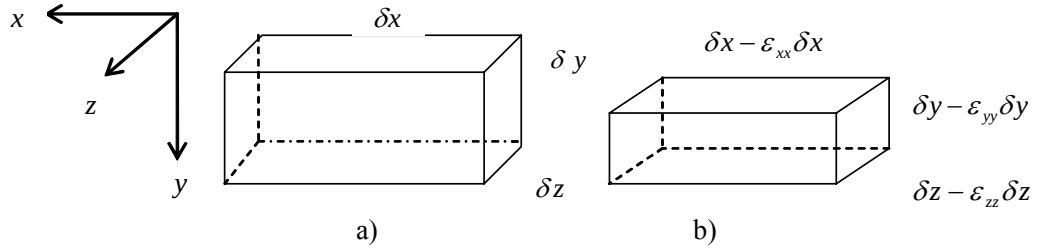


Figure 4. Deformation acting on volumetric change without changing the shape of a rectangular media. a) Before deformation b) After deformation.

Linear Elasticity of Solid Media

If stress and deformation of solid media are linearly depended and mechanical properties are independent from direction, it becomes an elastic solid media which is linear and isotropic. In this media, basic axes of stress and deformation are the same. Time independent expression between stress and deformation related with basic axes in coordinate system is given as below (Turcotte and Schubert, 1985):

$$\sigma_1 = (\lambda + 2G)\varepsilon_1 + \lambda\varepsilon_2 + \lambda\varepsilon_3 \qquad (1)$$

$$\sigma_2 = \lambda\varepsilon_1 + (\lambda + 2G)\varepsilon_2 + \lambda\varepsilon_3 \qquad (2)$$

$$\sigma_3 = \lambda\varepsilon_1 + \lambda\varepsilon_2 + (\lambda + 2G)\varepsilon_3 \qquad (3),$$

where, λ and G elasticity modules of he media or Lame parameters (G is also called as shear parameter). According to linear and isotropic properties of the media, $(\lambda + 2G)\varepsilon$ stress occurs with the effect of ε deformation in the same direction. The other two $\lambda\varepsilon$ stresses occur in the opposite parallel directions.

The deformation elements are obtained from (1)-(3) equations as given below:

$$\varepsilon_1 = \frac{1}{\frac{G(2G+3\lambda)}{G+\lambda}}\sigma_1 - \frac{\frac{\lambda}{2(G+\lambda)}}{\frac{G(2G+3\lambda)}{G+\lambda}}\sigma_2 - \frac{\frac{\lambda}{2(G+\lambda)}}{\frac{G(2G+3\lambda)}{G+\lambda}}\sigma_3 \qquad (4)$$

$$\varepsilon_2 = -\frac{\frac{\lambda}{2(G+\lambda)}}{\frac{G(2G+3\lambda)}{G+\lambda}}\sigma_1 + \frac{1}{\frac{G(2G+3\lambda)}{G+\lambda}}\sigma_2 - \frac{\frac{\lambda}{2(G+\lambda)}}{\frac{G(2G+3\lambda)}{G+\lambda}}\sigma_3 \qquad (5)$$

$$\varepsilon_3 = -\frac{\frac{\lambda}{2(G+\lambda)}}{\frac{G(2G+3\lambda)}{G+\lambda}}\sigma_1 - \frac{\frac{\lambda}{2(G+\lambda)}}{\frac{G(2G+3\lambda)}{G+\lambda}}\sigma_2 + \frac{1}{\frac{G(2G+3\lambda)}{G+\lambda}}\sigma_3 \qquad (6)$$

If it is assumed that $E = \frac{G(2G+3\lambda)}{G+\lambda}$ and $\nu = \frac{\lambda}{2(G+\lambda)}$, equations (4) to (6) can be stated as:

$$\varepsilon_1 = \frac{1}{E}\sigma_1 - \frac{\nu}{E}\sigma_2 - \frac{\nu}{E}\sigma_3 \qquad (7)$$

$$\varepsilon_2 = -\frac{\nu}{E}\sigma_1 + \frac{1}{E}\sigma_2 - \frac{\nu}{E}\sigma_3 \qquad (8)$$

$$\varepsilon_3 = -\frac{\nu}{E}\sigma_1 - \frac{\nu}{E}\sigma_2 + \frac{1}{E}\sigma_3 \qquad (9),$$

where, E and ν are Yung module and Puasson coefficient, respectively and define elastic property of media. E, G and ν values for some materials are given in Table 1.

Table 1. Elasticity values of some materials.

Material	ρ, gr/cm^3	E, 10^{11} Pa	G, 10^{11} Pa	ν
Clay	2.1-2.7	0.1-0.3	0.14	
Sand	2.2-2.7	0.1-0.6	0.04-0.3	0.2-0.3
Lime	2.2-2.8	0.6-0.8	0.2-0.3	0.25-0.3
Dolomite	2.2-2.8	0.5-0.9	0.3-0.5	
Marble	2.2-2.8	0.3-0.9	0.2-0.35	0.1-0.4
Basalt	2.95	0.6-08	0.3	0.25
Granite	2.65	0.4-0.7	0.2-0.3	0.1-0.25

If deformation occurs in one direction, one of the deformation elements is different from zero. In this case, $\varepsilon_1 \neq 0$ ($\varepsilon_2 = 0$ ve $\varepsilon_3 = 0$), from the equations (1) to (3), defining the relationship between stress and deformation, the following equations;

$$\sigma_1 = (\lambda + 2G)\varepsilon_1 \qquad (10)$$

$$\sigma_2 = \sigma_3 = \lambda\varepsilon_1 = \frac{\lambda}{\lambda + 2G}\sigma_1 \qquad (11),$$

from the equations (7) to (9), the following statements;

$$\sigma_2 = \sigma_3 = \frac{\nu}{1-\nu}\sigma_1 \qquad (12)$$

$$\sigma_1 = \frac{(1-\nu)E\varepsilon_1}{(1+\nu)(1-2\nu)} \qquad (13) \text{ are obtained.}$$

The relationships between λ, G and ν, E, defining the elastic property of the media (soil) and assessing the changes of soil mechanical properties, are obtained using the statements from (10) to (13) as follows;

$$\lambda = \frac{E\nu}{(1+\nu)(1-2\nu)} \quad ; \quad G = \frac{E}{2(1+\nu)}.$$

Determining Soil Stress in Erosion Process

The deformation equation in one direction can be used in consolidation and erosion which are opposite processes (Jaeger and Gook, 1976; Turcotte and Schubert, 1985). Generally, initial stress condition of soil surface is normal before erosion. Therefore, basic stresses in h depth of soil are stated as $\sigma_1 = \sigma_2 = \sigma_3 = \rho g h$. As a result of erosion, after soil removed from the h soil layer, upward stress becomes $\bar{\sigma}_1 = 0$. In this case, change in upward stress is obtained as $\Delta\sigma_1 = \bar{\sigma}_1 - \sigma_1 = -\upsilon g h$. When $\varepsilon_2 = 0$ and $\varepsilon_3 = 0$, the statement in (12) becomes as follow:

$$\Delta\sigma_2 = \Delta\sigma_3 = \frac{\nu}{1-\nu}\Delta\sigma_1 = -\frac{\nu}{1-\nu}\rho g h.$$

In this case, vertical surface stress after erosion is stated as below:

$$\bar{\sigma}_2 = \bar{\sigma}_3 = \sigma_2 + \Delta\sigma_2 = \rho g h - \frac{\nu}{1-\nu}\rho g h = \left(1 - \frac{\nu}{1-\nu}\right)\rho g h = \frac{1-2\nu}{1-\nu}\rho g h \qquad (14)$$

If $\nu = 0.25$ (Table 1), vertical stress values of soil after erosion are calculated for the different values of ρ and h using the statement of (14) and given in Table 2.

Table 2. Vertical stress values of soil after erosion (kPa)

ρ,	h, cm								
gr/cm^3	0.2	0.4	0.6	0.8	1.0	2.0	3.0	4.0	5.0
2.50	0.0327	0.0654	0.0981	0.1308	0.1635	0.3270	0.4905	0.6540	0.8175
2.60	0.0340	0.0680	0.1020	0.1360	0.1700	0.3401	0.5101	0.6802	0.8502
2.65	0.0347	0.0693	0.1040	0.1387	0.1733	0.3466	0.5199	0.6932	0.8666
2.70	0.0353	0.0706	0.1060	0.1413	0.1766	0.3532	0.5297	0.7063	0.8829
2.80	0.0366	0.0733	0.1099	0.1465	0.1831	0.3662	0.5494	0.7325	0.9156

As shown in Table 2, vertical surface stress of soil after erosion is linear with particle density and soil depth. Increment in particle density has a lower effect on stress than increment in soil depth. Increment in particle density has a lower effect on stress than increment in soil depth. The stress occurred after erosion causes elasticity in soil and acts negatively soil structural-mechanical properties. Also, the length between connected particles changes due to stress and deformation occurs.

Soil temperature and moisture significantly affect on stress-deformation level. Volume deformation in soil may be especially dangerous when the soil is saturated with water due to increasing pore water pressure in a reduced volume size. There is no danger of erosion of the soil particles if the upward force acting on particles is smaller than the downward force by the gravity (Verruijt, 2011). Therefore, if the shear stress in soil surface is greater than the gravity force acting on the soil particles, erosion can occur especially in saturated conditions. To improve this study, other factors acting on stress processes of soil should be considered. Therefore, coming different research disciplines together is important to make many studies in this subject under different soil conditions such as; cultivation, moisture, temperature, and soil properties.

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Effects of Improvement Practices on Soil Erosion over Gökçeada (Imbros) Rangelands with Dominant *Sarcopoterium spinosum* L.

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Abstract: Mediterranean climate and consequently Mediterranean plant cover is dominant in Gökçeada. Garriques plant cover is the significant plant population of the region. Prickly burnet (*Sarcopoterium spinosum*), hidden among thrones with their little leaves, is the most common variety of these populations and the least grazed variety by the animals. Prickly burnet is also very common over Kaleköy rangeland. Various processes like burning, clipping and grubbing were applied to fight against this variety and a control plot was allocated. Then, reseeding was performed and effects of these improvement practices on soil erosion were determined. A total of ten rainfall simulations were carried out in each plot and consequent runoff and soil losses were investigated. While time to runoff was 267.6 s in rangeland without any process (control), it was determined as 43.6, 42.4, 47.5, 46.1, 49.1, 39.4 s for burned + reseeded, burned + unseeded, clipped + reseeded, clipped + unseeded, grubbed + reseeded, and grubbed + unseeded rangelands, respectively. Runoff observed in burned + reseeded rangeland was 35 times higher than the rangeland without any process. Maximum runoff values in burned + reseeded, grubbed + reseeded, clipped + reseeded and unprocessed rangelands were measured respectively as 3.87, 3.79, 0.67 and 0.17 ml s^{-1}. Significant differences were not observed in sediment concentrations and sediment peak values of plots. Total soil loss was determined as 58.22 g m^{-2} for grabbed + unseeded, 34.18 g m^{-2} for burned + unseeded, 19.14 g m^{-2} for clipped + unseeded and 1.02 g m^{-2} unprocessed rangelands. Results revealed that burning or mechanical means of improvement might cause serious soil losses especially over slopped rangelands. Therefore, soil conservation measures should definitely be taken into consideration during the implementation of rangeland improvement practices.

Keywords: Range improvement, rainfall simulation, runoff, soil loss

Introduction

Rangelands have been one of the most significant nutrient sources for humans since the creation earth. They play critical role for both ecological balance and agriculture and provide beneficial impacts on conservation of soil and water resources. All these effects are closely related to plant cover rates and compositions. Well-preserved rangelands are able to hold large part of precipitation and release it slowly into soil without causing any erosion and consequent soil loss. Increased soil erosion in Turkey is mostly due to improper utilization and resultant vegetation destruction of the rangelands (Koç et al. 1994).

Soil erosion is a natural process. However, runoff and sediment formation may speed up with different land utilizations and management practices. Plants cover, topography and soil conditions are closely related to erosion and runoff (Petersen and Stringham, 2008). Plant cover affects precipitation interception, infiltration, evaporation and hydrological processes and soil water storage. It also increases soil porosity, biological activity and aggregate stability. Impacts of plant cover get more distinctive in time (Garcia-Estringana et al. 2010). The prior condition for rangeland improvement works is not cause soil losses with the improvement implementations (Altın et al., 2005). But a certain amount of soil loss is inevitable in rangeland improvement practices since plant cover is partially destroyed and site disturbance is evident in these processes. For instance, Brown et al. (1985) investigated the effects of methods implemented to control big sagebrush in Nevada (USA) on infiltration rates and soil erosion by using rainfall simulators. Initially, entire improvement techniques decreased infiltration rates and increased sediment yield. Differences were observed among the treatments with regard to site disturbance levels. The greatest effect was observed in plowing-seeding treatment, then in burning-seeding and the least effect in spraying-seeding treatment. A recovery trend was observed in treatments during 2 years of implementation period. Similarly, Kincaid and Williams (1966) investigated soil movements with cleared brush, pitted and seeded to grass implementations over rangelands of Arizona (USA).

Researchers observed higher rates of erosion over lower half of 12-foot long plots than over upper half and indicated that increase in rate and amount of runoff over lower half might cause to have higher rates of erosion over this part. Tromble (1980) measured infiltration and runoff over mechanically treated rangelands located in South-western parts of the USA. Researcher observed higher infiltration rates in control plots than creosotebush-dominant rootplowed and seeded plots. Therefore, objective of this study was set as to investigate the effects of improvement practices, implemented to fight against prickly burnet seriously hindering the grazing of rangeland due to thorny structure, on runoff and soil loss.

Material and Method

Study site

Experiments were carried out over rangelands of Kaleköy Village. The research site is located in North-east of Gökçeada, the largest island of Turkey in Aegean Sea with a surface area of 286 km^2. The island has steep and rugged terrain formations, high hills, deep valleys, stream beds and 5 small earth-dams. Gökçeada is totally composed of senezoic-aged rock formations. The base is composed of flysch unit with sandstone, marl, clay stone, limestone alternation (Ercan et al.1995). There two different Eocene and Oligocene-aged flysch sedimentations in Gökçeada. These units are overlaid by andesite and dacite type volcanic rocks composed of lava, tuff and agglomerates. About 66% of island soils is composed of brown forest soils and 16.50% of noncalcereous brown forest soils (Anonim, 1999).

A total of 6 disturbed (from 0-20 cm depth) and 6 undisturbed (from 0-5 cm depth) soil samples were taken to determine the soil properties of research site before the implementation of improvement processes. Soil analysis revealed that research site had sandy-loam soil texture with slightly alkaline (pH of 7.85), nonsaline (EC of 0.59 dS m^{-1}) and calcareous ($CaCO_3$= %4.72). Organic material content of the soils was 3.08% and dry bulk density was 1.64 g cm^{-3}.

Based on 29 years (1975-2003) data of Gökçeada meteorological station, annual average temperature of the island is 15.1 ˚C, the average high and low temperatures were 18.9 ˚C and 11.9 ˚C, respectively (DMI, 2004). While July is the hottest month with 24.6 ˚C, the lowest temperatures (6.7 ˚C) was observed in January and February. Annual average total precipitation of the island is 737.9 mm.

Maquis formations, composed of slim-stem, hard, sometimes thorny, green-leaved 3-4 m high shrubby plant populations, are common in Mediterranean zone in which Gökçeada is also located. Garig plant covers representing dwarf shrubs is also common in Mediterranean zone and they are formed over poor, barren and shallow soils. Within this plant cover, kermes oak, mock privet, thyme, common sage**,** pink rockrose, prickly burnet and wild liquorice are the dominant varieties (Yılmaz, 1993). Rangelands of Gökçeada have garig characteristics and thorny prickly burnet (*Sarcopoterium spinosum*) is common in dwarf shrub form.

Rangeland Improvement Processes

The research site has a slope of 15-18%. Experiments were set up over 480 m x 150 m = 72 000 m^2 (72 da) land area in accordance with the following design (Figure 1).

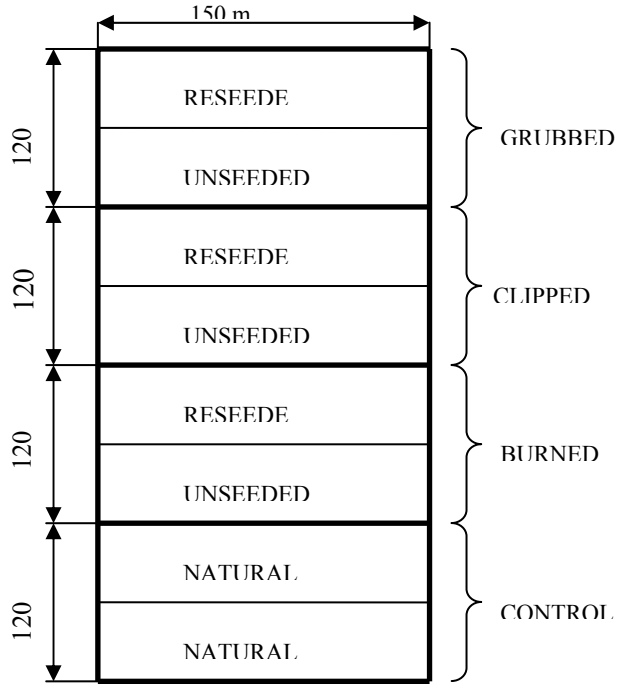


Figure 1. Design of treatments over rangeland site

Clipping, grabbing and burning processes were carried out to fight against prickly burnet. Clipping was performed with shrub clipper and clipped prickly burnets were left over the rangeland. A chisel was used for grabbing. Upper soil was plowed by a chisel at 10 cm depth and almost 70% grabbing was achieved. Grabbed shrubs were removed from the rangeland and burned in an isolated part of the rangeland. Following these processes, rangeland in half of the plots was tilled (except the parts left natural) and following forage crop mixtures were sown and seeds were covered with a harrow. Seeds of alfalfa (*Medicago sativa*), sainfoin (*Onobrychis viciifolia*), salad burnet (*Poterium sangiosorba*), perennial grass (*Lolium perenne*), wheatgrass (*Agropyron cristatum*) and orchard grass (*Dactylis glomerata*) were used for reseeding.

Rainfall Simulation Tests

Simulated rainfall was chosen because it is more rapid, more efficient, more controlled and more adaptable than natural rainfall research (Meyer, 1994), especially in arid and semiarid areas where the rain is highly variable temporarally and spatially. Mini rainfall simulator (Figure 2) designed specifically for soil erosion studies was obtained from Eijkelkamp, Netherland and standardised (Kamphorst, 1987). A total of 10 rainfall simulations were implemented over each range improvement parcel. Simulations were carried out over 0.0625 m^2 plots. The raindrops fall from an average height of 0.4 m over the soil surface. Rain intensity was about 36 cm h^{-1} and kinetic energy 3.92 J m^{-2} (Kamphorst, 1987; Martinez et al. 2003; Romero et al. 2007). The highest intensity measured over the research site was 84 mm h^{-1}. This intensity is needed to compensate for the short falling distance, in order to obtain a realistic kinetic energy of the raindrops. Though the practical use of the absolute values of these measurements is disputable, the results are useful for comparing the erosion rates of different sizes (Romero et al. 2007). Rainfall time was sufficient (6 min) to provide a good statistical run-off curve. Runoff and sediment samples were collected every 60 s. Immediately after each simulated rainfall event, samples of runoff were collected in plastic bottles. These samples were then dried at 105 °C to determine the sediment mass. Time to runoff, mean runoff, maximum runoff rate, runoff coefficient (% runoff/rainfall), sediment concentration, maximum sediment concentration, and total soil loss were determined for each plot (Cerda et al. 2009). The experiments were carried out in the May 2011 when soil moisture values averaged only 7.41%.

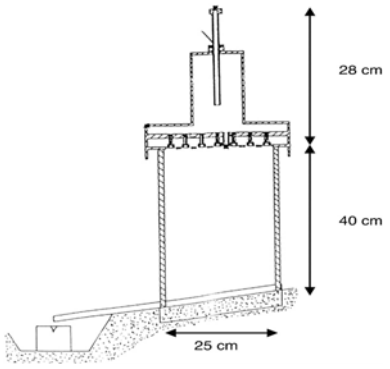


Figure 2. Shape and dimensions of mini rainfall simulator

Plant cover ratio was visually estimated by observing the plant covered parts of the rangeland (Altın et al., 2005).

Statistical Analysis

The data obtained from rainfall simulations (time to runoff, runoff flow, maximum runoff, runoff coefficient, sediment concentration, peak of sediment and total soil loss) were grouped with regard to simulation plots. Statistical analysis was performed by analysis of variance (ANOVA), and the means were subjected to the Duncan test ($p<0.05$) to obtain the main differences between the plots.

Results and Discussion

Significant differences were observed among plots with regard to time to runoff following rainfall simulations. Runoff was observed 267.6 s after rainfall initiation over natural plot. On the other hand, shorter time to runoff values (between 39.4-49.1 s) were observed over the plots with various degree tillage, burning, clipping, grabbing and reseeding processes, but the difference among them were not found to be significant (Table 1).

Table 1. Time to runoff, amount of runoff and maximum runoff (average±standard deviation) over rangeland sites with different improvement processes

Method of improvement	Time to runoff (sn)	Runoff (ml /sn)	Maximum runoff (ml/sn)
B+R	43.6±7.2 **b**	3.13±0.87 **a**	3.87±0.85 **a**
B+U	42.4±11.5 **b**	3.12±1.28 **a**	3.73±1.29 **ab**
C+R	47.5±7.4 **b**	0.45±0.18 **c**	0.67±0.17 **c**
C+U	46.1±6.9 **b**	1.93±0.99 **b**	2.75±1.36 **b**
G+R	49.1 ±25.5 **b**	2.95±0.99 **a**	3.79±1.06 **ab**
G+U	39.4±18.1 **b**	2.98±1.11 **a**	3.66±1.22 **ab**
N	267.6±383 **a**	0.09±0.13**c**	0.17±0.24 **c**
p	0.024*	0.000*	0.000*

* Significant at 5% level.
B: Burning, C: Clipping, G: Grabbing, R: Reseeding, U:Unseeding, N:Natural

Significant differences were observed among the runoff values of the plots. While the lowest runoff was observed in control and clipping + reseeding plots (respectively as 0.09 and 0.45 ml/s), higher values were recorded for plots with burning and grabbing treatments. Runoff was measured as 3.12 and 3.13 ml/s in burned plots and as 2.95 and 2.98 ml/s in grabbed plots. Maximum runoff values exhibited similarities with runoff values. With regard to maximum runoff, the lowest values were observed again in natural and clipping + reseeding plots (respectively as 0.17 and 0.67 ml/s) and

the value was 3.87 ml/s for burned and reseeded plots, 3.73 ml/s for burned and unseeded, 3.79 ml/s for grabbed and reseeded plots, 3.66 ml/s for grabbed and unseeded plots (Table 1). Vegetal cover increases the surface roughness over undisturbed sites and consequently reduces the runoff velocities (Bradford and Wood, 1989). Prescribed burning can reduce infiltration rates and increase erosion as defined below: by destroying soil protecting vegetation and litter; by destroying porosity as a result of organic matter loss and the associated breakdown in soil structure; by clogging soil pores with suspensed material; or by intensifying water repellency in various soil layers (Roundy et al. 1978; Odea and Guertin, 2003**).** Clipping was performed at about 10 cm. Since the residual straw hinders runoff, a smaller value was observed over the plots with this reclamation process than the others.

Although the sediment concentrations among the plots were not found to be significant, the lowest value (1.41 g/l) was observed as expected in natural rangeland with the lowest runoff, and the value was recorded as 2.25 and 3.01 g/l for burned plots, as 3.51 and 3.86 g/l for grabbed plots, 2.44 g/l for clipped and unseeded plots, 4.07 g/l for clipped and reseeded plots. The highest sediment peak (11.19 g/l) was observed in clipped + reseeded rangeland. It was followed by burned + unseeded (7.05 g/l), grabbed + reseeded (5.71 g/l), grabbed + unseeded (5.17 g/l), clipped + unseeded (4.14 g/l), burned + reseeded (2.91 g/l) treatments and natural pasture plots. Significant differences were observed among treatments with regard to total soil loss. While the total soil loss in natural rangeland was 1.02 g/m^2, the value varied between 7.14-58.22 g/m^2 in other plots. The highest soil losses (50.26-58.22 g/m^2) were observed in plots from where prickly burnets were grabbed. Since less mechanical disturbance occurred in clipped plots, less soil losses (7.14-19.14 g/m^2) were observed in clipped plots than the other disturbed plots (Table 2). Wright et al. 1982 indicated 78-93% reductions in soil losses over seeded steep slope (37-61%) plots after a prescribed burning in Edwards Plateau in Central Texas. Ueckert et al. (1978) reported increased sediment load following the burning of tobosagrass over slopes less than 1% and indicated that total soil loss was not significant and sediment load stabilized within 2-3 years.

Table 2. Sediment characteristics and total soil losses over rangelands with different improvement practices and rainfall simulations (Average±standard deviation)

Method of improvement	Sediment concentration (g /lt)	Peak of sediment (g/ lt)	Total soil loss (g/ m^2)
B+R	2.25±1.7	2.91±2.11	35.08±33.32 **ab**
B+U	3.01±1.92	7.05±10.20	34.18±21.94 **ab**
C+R	4.07±2.18	11.19±9.24	7.14±5.39 **bc**
C+U	2.44±2.60	4.14±2.91	19.14±22.63 **bc**
G+R	3.51 ±0.90	5.71±1.30	50.26±24.25 **a**
G+U	3.86±3.33	5.17±3.45	58.22±54.21 **a**
N	1.41±2.3	2.65±4.2	1.02±1.43 **c**
p	0.212	0.076	0.001*

* Significant at 5% level.
B: Burning, C: Clipping, G: Grabbing, R: Reseeding, U: Unseeding, N: Natural

Plant cover ratios of burned + reseeded, burned + unseeded, clipped + reseeded, clipped + unseeded, grabbed + reseeded, grabbed + unseeded and natural rangeland plots with rainfall simulation were respectively found to be 54.4, 48.0, 87.8, 78.3, 54.4, 41.3 and 91.4%. Runoff and soil loss regularly were not decreased with an increase in plant cover ratio. This impact varies also based on canopy structure, vegetation height, density, being annual or perennial, root systems of plant (Garcia-Estringana et al. 2010). Reseeding was performed in November 2010. The plants were just at seedling period when the rainfall simulations were initiated in May 2011. Since the plants were not tall enough and their roots did not penetrate deep enough into soil, they were not resistant to erosion in this period. Therefore, a significant difference between reseeded and unseeded plots was not observed with regard to sediment peak, sediment concentration and soil loss.

Rangeland soils were not touched in any means in natural plots. A certain soil disturbance occurs in other plots with improvement processes. Therefore, less runoff and soil loss were observed in natural plot than the other plots. Choudhary et al. (1997) investigated soil erosion by rainfall simulations after corn harvest over fields with 3 different soil tillage (moldboard plow, chisel and no-tillage). Researchers observed the highest soil erosion and runoff in moldboard plow and it was followed by chisel and no-tillage. Splash soil was almost 2.5 times higher in moldboard tillage than chisel and no-tillage. Baker and Laflen (1993) reported 75-90% less soil erosion in no-tillage than moldboard tillage. Since a better plant cover is created with reseeding in clipped and reseeded plots, runoff and soil loss decreased in these plots compared to other improvement plots.

Conclusions

In this study, effects of rangeland improvement practices like burning and mechanical fights against prickly burnet and reseeding on soil erosion were investigated. The highest runoff and sediment and consequently the soil loss were observed over the plots with grabbing and burning treatments. While less soil loss observed in clipped plots, the lowest value was seen in natural plot without any improvement practice. Since rainfall simulations were performed 7 months after reseeding and seeds were not able to sufficiently cover the site, effects of reseeding for soil loss conservation were not able to be observed. In conclusion, plant cover and soil, burning and mechanical rangeland improvement practices with different levels of disturbance cause serious soil losses especially in high slopes. Over such rangelands, improvement practices should definitely take soil conservation measures like strip cropping into consideration.

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The Effects of Soil Moisture Content and Tractor Travel Speed on Compaction in Clay Soil

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Abstract
Agricultural soil compaction is one of the major problems in field management. Compaction is important factor in decrease yield. Because development large tractors and increase tractor passes on fields in lately years. In this study investigated impact of the travel speed (for M.F. 285 tractor) in two level (low and high) and soil moisture content in three levels (PL, 0.8PL and 0.6PL) on clay soil. Dry bulk density (BD) and penetration resistance (PR) were applied as response variables for soil compaction. These variable measured in three depth (0-10, 10-20 and 20-30 cm).
Result show that soil moisture content and travel speed have significant effects on compaction. Compaction affected with moisture content in two depths (0-10 and 10-20 cm) and travel speed in one depth (0-10cm) respectively. Significant effects on PR and BD were nearly absent for 20-30 cm depth. Maximum compaction occurs in 10-20 cm depth and in deeper layer is not significant impact because of M.F. 285 tractor has a low weight.
Keywords: Compaction, Travel Speed, Moisture, Penetration Resistance.

Introduction
Development of mechanized farming has impacted all industrialized nations of the world. With improved tillage efficiency and increased tractor power and size, the severity of soil compaction has also increased (Keller et al., 2002). Excessive compaction causes undesirable effects that can reduction in crop yields, soil quality and disturbed soil structure. Compaction increase water runoff and reduction root growth and plant development rates. The previuose study shows that clay soils and silt soils are more sensitive to compaction than sandy soils (Fisher and Binkley, 2000). Gomez et al. (2002) stated that the highest bulk density and the lowest porosities after machine traffic were located on clay soils. Smith (2003) indicated that the clay content also has an important influence on the increase of penetration resistance after machine traffic. Soil compaction has been recognised as a severe problem in mechanized agriculture. Both topsoil and subsoil compaction have an influence on many soil properties and processes, and thus also on crop yield (Shafiq et al., 1994).
The objectives of the present study were to investigate soil moisture content and tractor travel speed on top and sub soil compaction. The experiments were carried out in Iran during spring and summer in 2011.

Materials and Methods
Field tests were performed during spring and summer in 2011. The MF285 tractor 55.9 kW (75 hp) is the main agricultural tractor in Iran and was the tractor used for these study. The MF285 tractor has a mass of 3075 kg. The rear wheel diameter is 96 cm and the front wheel diameter is 64 cm. Rear wheel tire width is 22 cm and the front wheel width is 12 cm. Weight distribution was 60% on the rear axle and 40% on the front axle.
For evaluation of soil compaction, penetration resistance (PR) and bulk density (BD) were measured. Penetration resistance was measured with a penetrometer (Rimik 200 model). The cone had a 108 angle with a cone base cross-sectional area of 1 cm^2. For increase precise, PR was measurement in each treatment with 10 replication.
The experiments were done in clay soil in three different amounts of water content (plastic limit, 0.8 plastic limits and 0.6 plastic limits). Three replications were arranged in a completely randomized design. At this time, soil water contents at 10, 20, and 25 cm below the soil surface and the corresponding PR were measured. Sample bulk densities were calculated based on the volumes calculated from the length and diameter of the section, and dry weights of the soil samples. Different speeds of tractor (3, 5 and 7 km/hr) were imposed on the same track. Treatments were replicated three times in a completely randomized design. Each plot was 30 m in length and 4 m wide. An ANOVA was conducted for each depth and if significant treatment effects were detected.

Results and Discussion

The results show that the PR varied with water content from 0.6 PL to PL and was inversely related to soil water content (Fig. 1). Also the result of data analysis shows that compaction index (PR) affected with moisture content in two depths (0-10 and 10-20 cm) and significant effects on PR and BD were nearly absent for 20-30 cm depth. Similar result was reported that soil strength reduce as soil moisture increases.

The result of investigation of travel speed variable shows that, travel speed in one depth (0-10cm) has significant effect and with increase in depth no seen significant effect. As while the MF285 tractor has a low weight, therefore compaction not occur in sub soil. Results of the present study show that maximum compaction occurs in 10-20 cm depth.

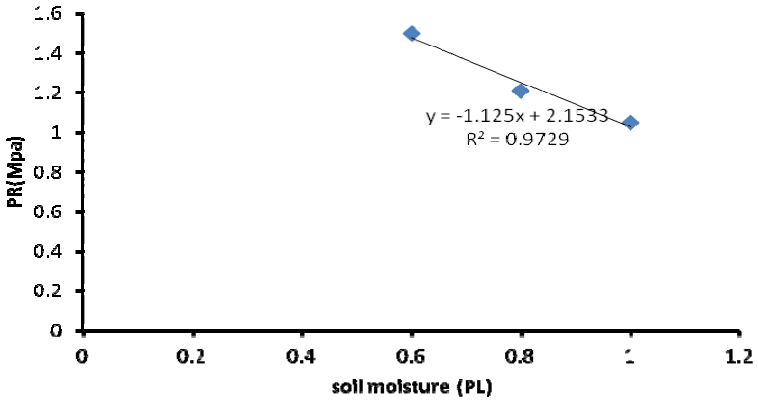


Figure 1. The relationshipe between soil moisture content and penetration resistance (PR) in the 0- to 20-cm depth.

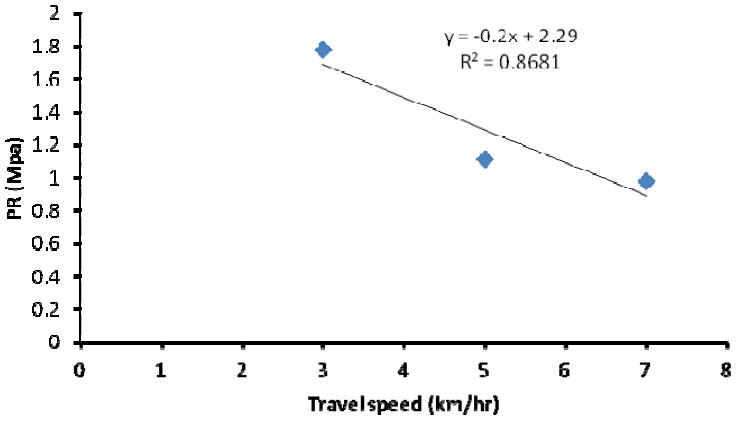


Figure2. The relationshipe between travel speed and penetration resistance (PR).

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Effect of Geometric Parameters on the Narrow Tine Draft Force in Soil Bin

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Abstract: Increased energy use in agriculture causes environmental pollution, water and soil. It will also increase production costs. Due to increased tillage operations in recent years, tillage equipment design and appropriate selection is very important. In this study, in order to achieve the optimal structure and reduce the energy consumption of narrow tillage tools, the effect of rake angle (in three levels 90, 75 and 60 degree) and depth of penetration (in three levels 10, 20 and 25 cm) on draft force and soil accumulation was studied. Experiments in completely randomized design with three replications were conducted.
Results showed that the depth has significant effect on the draft force. Draft force increases with increasing depth. Also accumulation of soil in front of the tine increases with increasing depth. It also increases the rake angle at each depth has significant effect on draft force at 5% level and draft force decreases with decreasing rake angle. Minimum force is related to the treatment with 10 cm depth and angle of 60 degree. The results showed that changes the rake angle, no significant effect on the accumulation of soil in front of the blade.
Keywords: draft force, tine, rake angle, accumulation.

Introduction

Consequently, significant changes have been created in the method of energy consumption in agriculture and have caused much dependence of this matter to oil (Hartili et al., 2005)
The simplest method to evaluate the required energy for tillage is to measure traction force for a tillage tool while running (Ehrhardt et al., 2001). Many researchers have used this method for evaluating and investigating tillage tool's operation. Specific traction of agricultural equipments is variable in different situations and conditions since it is dependent on various parameters like condition and texture of soil, shape and velocity of the equipment, sharpness of tine, operation depth and attachment type (Manuwa 2009) in their investigations found that the width of tine has significant impact on shear forces in which by increasing width of tine, shear forces will increase nonlinearly.
Designers, manufacturers and users of tillage operations cannot make their decisions based on traction force and area of ploughed soil, as there should be considered another component to have better expression of fuel consumption in agricultural soil tillage tools. This index is traction force efficiency.
In the present study, in addition to traction force of narrow soil-tillage tool, the effect of depth change, tool's angle and width of tine has been evaluated for traction force efficiency and the area of ploughed soil.

Materials and Methods

This experiment was conducted in the Laboratory of Soil Mechanics in Mechanics of Agricultural Machinery Department of Urmia University in the summer of 2010. In order to examine the effect of blade's geometry in the magnitude of traction force, factorial experiment was conducted with complete random pattern. Variables were used including width of tine in different levels of (3cm and 6cm), depth of operation in three levels of (10, 25, and 25 cm), and penetration angle of tine in three levels of (60, 70, and 90 deg). The experiments were repeated 10 times.
At first, soil sample was prepared from the depth of 0 to 25 cm and was transported to the laboratory. In aggregation experiment based on ASTM-C131 standard, it was observed that the tested soil included 18.355% of sand, 79.31% of coarse sand, and 6.89% of clay. Soil texture was evaluated to be coarse sand with good aggregation and clay with silt. In this test, internal angle of soil was 20.15° and soil cohesion was 0.003 kg/cm^2. By carrying out the test, external friction adhesion between metal and soil was measured to be 1.06 and δ , the external friction's angle, was assessed to be 30.07 degree.

Data acquisitioning for each repetition was considered to be 3m during soil channel. After finalizing data acquisitioning for each repetition, the amount of ploughed soil and the index of created furrow using tine were recorded. A data logger with the frequency of 30 Hz was used in this study which means recording 30 data in one second. SPSS software was used to analyze the resulted data.

Results and Discussion

By analyzing the variance of traction force, ploughed area of soil, traction efficiency in different levels of operation depth, tine width and cutting angle of tine showed that operation depth, width and angle of cut had 1% meaningful influence on both traction force and area of ploughed soil. The influence of operation depth and cutting angle on traction efficiency was calculated to have meaningful amount of 1% while tine's width didn't have any noticeable impact on traction efficiency. Its reason can be for slight difference in two levels of investigated widths and also it can be caused because of proportional equation of traction efficiency which is result of soil's ploughed area divided into the amount of traction force. Regarding this matter, the process of changes in traction efficiency toward Slimming Factor has been investigated.

The influence of tine's angle and depth on traction and vertical forces in three different depths and three various angles for two tines with the widths of 3cm and 6 cm for soil bin experiments (Figure 1).

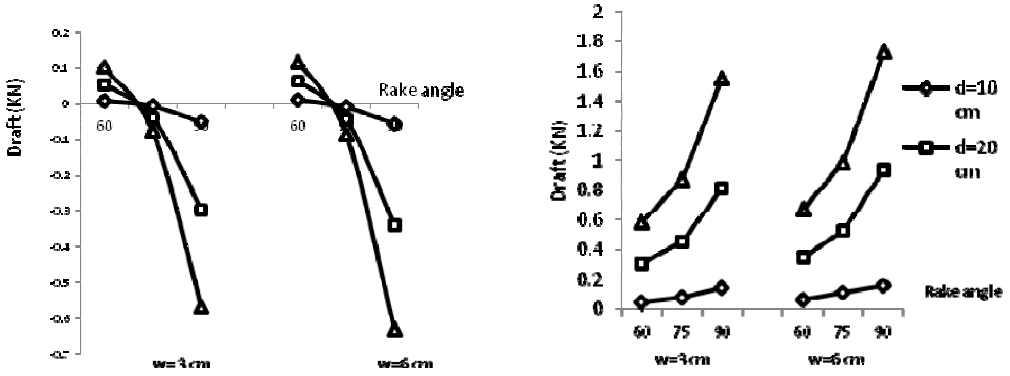


Figure 1. The changes of vertical and horizontal forces toward cutting angle of soil for two investigated tines of in three different depths of soil bin

Horizontal traction force was increasing with increasing of cutting angle while this process was opposite for vertical forces which means by increasing cutting angle, the vertical force would decrease. This descending process would continue until it becomes noticeable that in cutting widths of 75° and 90°, the amounts vertical forces got negative. Change of direction in force was related to increasing of reaction force toward the force of gravity and cut of soil. Considering Godwin's equation, the resulted angle in the point of coincidence between vertical force and horizontal vector is equal with tine's critical angle was $[\alpha]_c^{\circ} = 90 - \delta$. The amount of this angle was evaluated to be 70° in the experiments (Figure 1).

The effect of tine's width on vertical and horizontal forces

The major tip which was observed in all of the figures indicates increasing of horizontal force with increasing of tine's width in all of depths. By monitoring the figures, it can be noticed that the effects of tine's width on horizontal force in the depth of 25cm and cutting angle of 90° is significant.

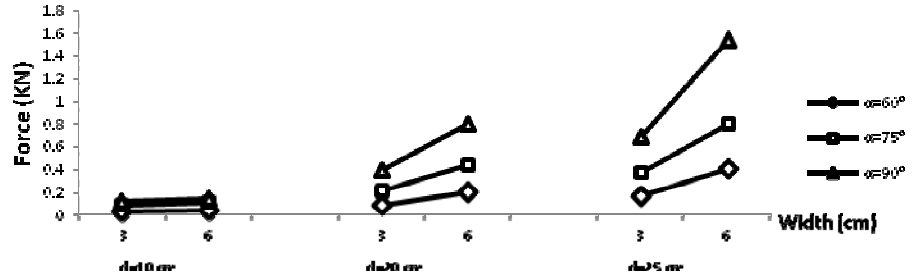


Figure 2. The relation between horizontal force and tine's width in different depths and angles in soil bin

The area of ploughed soil

In order to compare the amounts of ploughed areas tine, Figure 3 was created using data from theoretical and experimental models. It was observed that the diagrams in the tine's width of both 3cm and 6 cm, there was completely similar process except the point that the diagrams of narrow tines were in lower level than diagrams for wide tines.

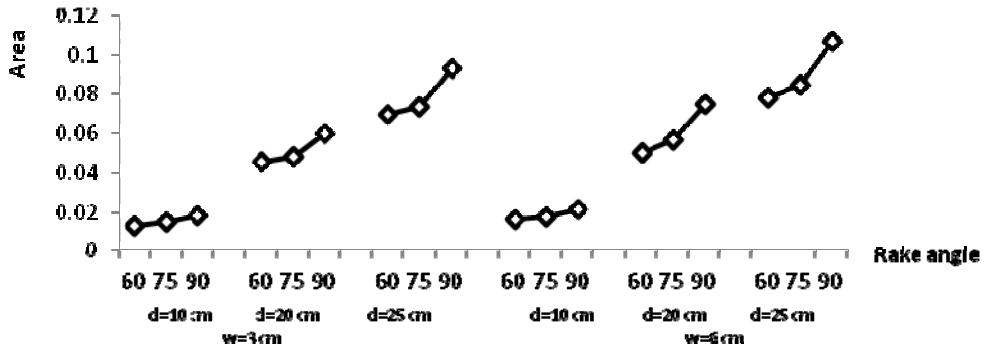


Figure 3. A comparison between theoretical and real areas for tine with two different widths in various angles and depths

It was noticeable that in diagrams for two various tine's widths, the theoretical and real areas of ploughed soil increased by increasing depth. This increase was higher in bigger cutting angles.

Using the data of created furrow in the soil bin, figures (4) were presented showing the condition of creating the furrow.

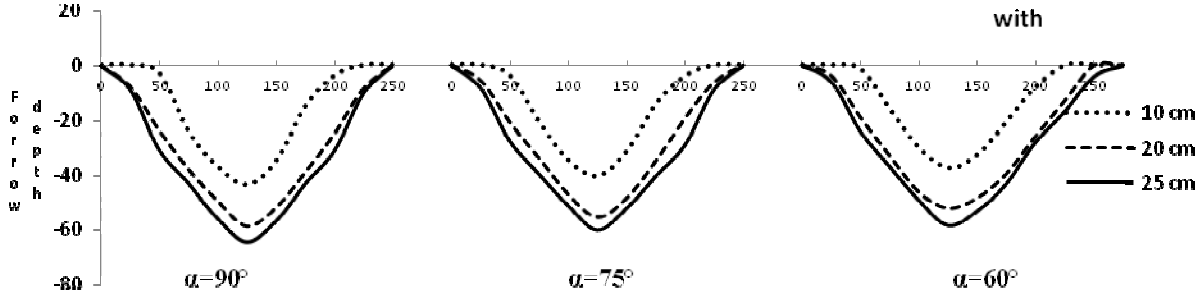


Figure 4. Created furrows by width of 6 cm in different depths and angles

Traction force efficiency

These amounts for the all of treatments of soil bin experiment were measured by traction efficiency percent. In order to compare the results from this experiment with Mc.keys model, figure 5 are presented which demonstrates the process of change in traction efficiency toward slimming factor (d/w).

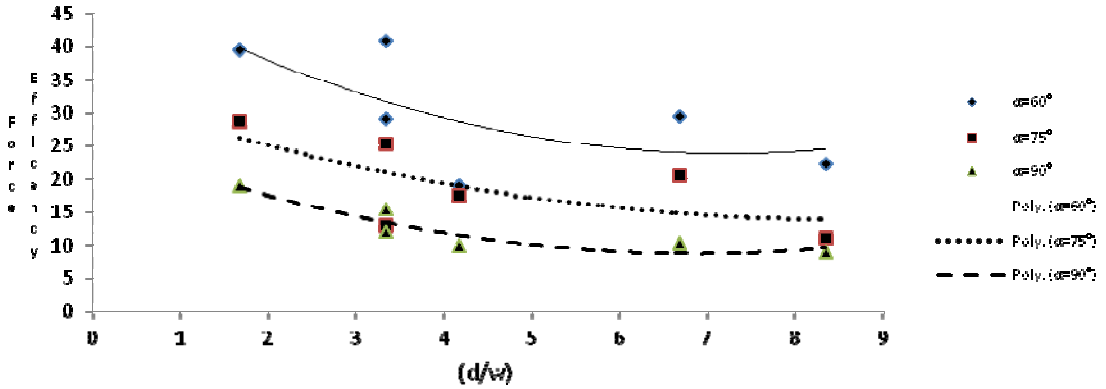


Figure 5. The effects of Slimming Factor on force efficiency

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Models for Estimating Cumulative Infiltration

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Abstract
Infiltration process is one of the most important components of the hydrologic cycle. The ability to quantify infiltration is of great importance in watershed management. Prediction of flooding, erosion and pollutant transport all depend on the rate of runoff which is directly affected by the rate of infiltration. Quantification of infiltration is also necessary to determine the availability of water for crop growth and to estimate the amount of additional water needed for irrigation. Thus, an accurate model is required to estimate infiltration process. In this study, the ability of seven different infiltration models (i.e. Philip, SCS, Kostiakov, Horton, Swartzendruber, Modified Kostiakov (MK), and Revised Modified Kostiakov (RMK) models) to fit infiltration data were evaluated. For this purpose, 95 sets of infiltration data with four-texture classes were utilized. Comparison criteria including Coefficient of Determination (R^2), Mean Root Mean Square Error (MRMSE), Root Mean Square Error (RMSE) were used to determine the optimum model. The greatest amounts of R^2 values were obtained with RMK, MK and Swartzendruber models. The SCS model with two parameters yielded to the lowest R^2. According to the results obtained from mean of RMSE (MRMSE) values, the MK model provided the lowest values, indicating that infiltration was well described by this model. The results of ranking models according to two criteria: RMSE, and MRMSE , indicated that based on RMSE the goodness of cumulative infiltration can be estimated by the RMK, MK, Kostiakov, Swartzendruber, Horton, Philip, SCS models, respectively. But according to the MRMSE statistics cumulative infiltration can be estimated by the MK, RMK, Swartzendruber, Philip, Kostiakov, SCS and Horton models, respectively. Based on the results of ranking model the CSC model obtained the lowest ranking between the all of the models.
Keywords: Infiltration models, Mean Root Mean Square Error, Root Mean Square Error, Coefficient of Determination.

Introduction

Infiltration has an important role in land-surface and sub-surface hydrology, runoff generation, soil erosion, irrigation, etc.
Through the past century, several infiltration models have been developed and categorized as physically–based, semi-empirical, and empirical (Mishra et al., 1999).
Philip Model. Philip (1957) developed an infinite-series solution to solve the non-linear partial differential Richards' equation, which describes transient fluid flow in a porous medium. For cumulative infiltration the general form of the Philip model is expressed in powers of the square-root of time as:

$$I = St^{0.5} + At \tag{1}$$

Where I is the cumulative infiltration (L), S is the sorptivity ($LT^{-1/2}$), t is the time of infiltration (T), and A is a parameter with dimension of the saturated hydraulic conductivity (LT^{-1}).
Swartzendruber Model. Swartzendruber (1987) presented an infiltration model:

$$I = f_c t + \frac{c}{d}[1 - \exp(-dt^{0.5})] \tag{2}$$

Where f_c is the final infiltration rate (LT^{-1}), c and d are empirical constants.
Horton Model. Horton (1940) presented a three-parameter semi-empirical infiltration model expressed as:

$$I = ct + m(1 - e^{-at}) \tag{3}$$

Where C is the final infiltration rate (LT^{-1}). Parameters c, m (LT^{-1}), and a (T^{-1}) must be evaluated using observed infiltration data.
Kostiakov Model. A simple and general form of infiltration model presented by Kostiakov (1932) is:

$$I = \alpha_1 t^{\beta_1} \tag{4}$$

Where α_1 and β_1 are constants and evaluated using the observed infiltration data.

Modified Kostiakov model (MK). Kostiakov was modified by adding the term of ultimate infiltration capacity (α_3) by Smith (1972),as follow:

$$I = \alpha_2 t^{\beta_2} + \alpha_3 t \tag{5}$$

where α_3 is the final infiltration rate (L T^{-1}), and α_2 and β_2 are the same as α_1 and β_1 at the Kostiakov model.

Revised Modified Kostiakov model (RMK). Recently, Parhi et al (2007) revised Modified Kostiakov model and obtained a four parameters model as:

$$I = \frac{\alpha_4}{\beta_3 + 1} t^{\beta_3 + 1} + \frac{\alpha_5}{1 - \beta_4} t^{1-\beta_4} \tag{6}$$

Where α_4, β_3, α_5, and β_4 are parameters to be determined empirically, using measured infiltration data.

SCS Model. Experts of Soil Conservation Service (1974) found that the Kostiakov model did not apply at long time.They have done many experiments and concluded that coefficient of 0.6985 to be added to this model which would work well at all times:

$$I = at^{b} + 0.6985 \tag{7}$$

Where *a* and *b* are constants and evaluated using the observed infiltration data.

The objectives of this study were to test a variety of models with different underlying assumptions to determine which model represents best the soil infiltration. To achieve these objectives, we compared seven models described above. Two comparison techniques were considered to define the best models: the coefficient of determination (R^2), Mean Root Mean Square Error (MRMSE), Root Mean Square Error (RMSE statistic).

Materials and Methods

The infiltration data were obtained by Double Rings method from 95 locations in 5 different provinces with different climates in Iran. The soil of these regions are classified as Mollisols, Aridisols, Inceptisols, and Entisols in soil taxonomy.The infiltration experiments were conducted until infiltration rate reached a constant value for each soil. However, the minimum required time for infiltration measurement was 270 min. The soil texture class of surface horizons were determined as clay loam, silty loam, loam, and silty clay loam.

The RMSE statistic is an index of the correspondence between measured and predicted data and has frequently been used as a means of evaluating the accuracy of models. The mean RMSE (MRMSE) values and mean R^2 values of all soils for each model were calculated. The model having the smallest MRMSE value and highest mean R^2 was selected as best model. RMSE and R^2 statistics were calculated as follow:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N} (I_p - I_o)^2}{N}} \tag{8}$$

$$R^2 = \left\{ \frac{N(\sum I_o I_p) - (\sum I_o)(\sum I_p)}{\sqrt{\left[N\sum I_o^2 - (\sum I_o)^2\right]}\sqrt{\left[N\sum I_p^2 - (\sum I_p)^2\right]}} \right\}^2 \tag{9}$$

Where I_o, I_p, and N are observed, predicted, and number of observed data values, respectively.

All models were fitted to experimental infiltration data using an iterative nonlinear regression procedure, which finds the values of the fitting parameters that give the best fit between the model and the data. This procedure was done using the Matlab7.11 software.

Results and Discussion

A statistic of the estimated parameter values (minimum, maximum, and mean) of the infiltration models is given in Table 1.

R^2 ranged from 0.77 to 1.00 among all of the soils and all of the models (table 1, Fig 1). The greatest amounts of R^2 values were obtained with RMK, MK and Swartzendruber models. The SCS model with two parameters yielded the lowest R^2. Among the models with three parameters, MK and Swartzenduber, had mean R^2 higher than that of Horton model. Among the models with two parameters, mean R^2 was higher for the Kostiakov model than that for Philip and SCS models. The range of R^2 values of each model obtained by curve-fitting is presented in Figure 1. Considering mean R^2, RMK, MK, and Swartzendruber models were selected as the best models for all soils.

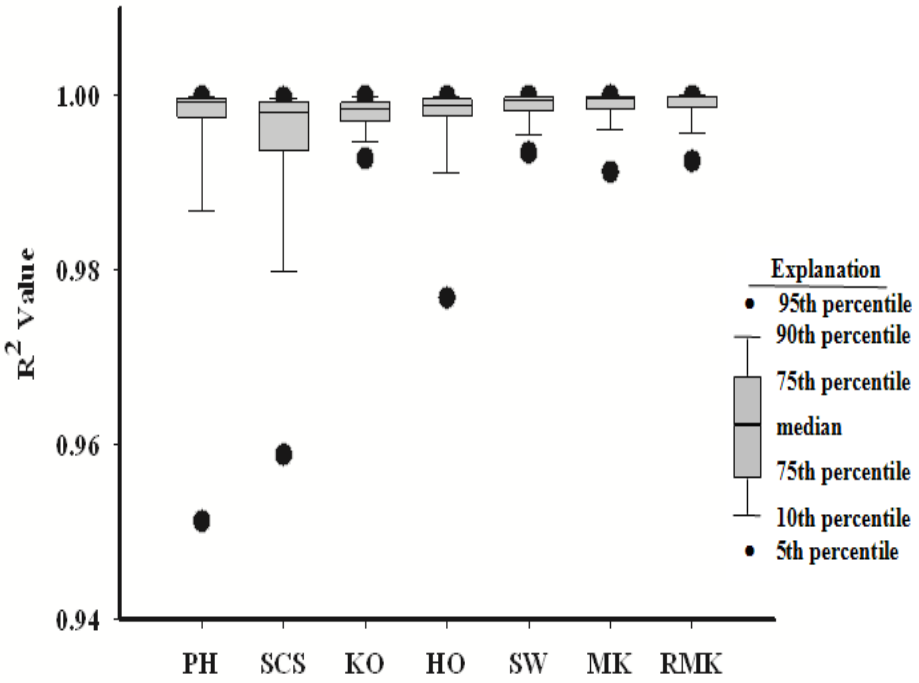


Figure 1. Box plot for R^2 percentiles as the goodness of fit of seven models for all soils. PH = Philip, KO = Kostiakov, HO = Horton, SW = Swartzendruber, MK = Modified Kostiakov, and RMK = Revised Modified Kostiakov models

According to the results obtained from mean of RMSE (MRMSE) values (Table 1), the MK model provided the lowest values, indicating that infiltration was well described by this model. Parlange and Haverkamp (1989), Dashtaki et al (2009), and Araghi et al (2010) reported that the MK model is the best model for quantifying the infiltration process compared to the other infiltration models.

Table. 1 Statistics of optimized parameters of the infiltration models for all soils

Name	Parameters	Minimum	Maximum	Mean
Philip	A	0.000	1.00	0.083
	S	0.000	3.13	0.816
	R^2	0.78	1.00	0.992
	RMSE	0.000	4.52	0.384
Swartzendruber	F_c	0.000	1.00	0.990
	c	0.140	3.38	0.920
	d	0.000	0.68	0.120
	R^2	0.940	1.00	0.998
	RMSE	0.004	4.52	0.321
Horton	a	0.000	1.00	0.110
	m	0.004	34.8	2.200
	C	0.001	58.5	5.250
	R^2	0.960	1.00	0.996
	RMSE	0.00	6.16	0.389
SCS	a	0.004	2.79	0.510
	b	0.354	1.20	0.762
	R^2	0.880	1.00	0.992
	RMSE	0.131	4.20	0.448
Kostiakov	α_1	0.288	1.00	0.762
	β_1	0.042	3.11	0.673
	R^2	0.920	1.00	0.997
	RMSE	0.000	4.20	0.427
Modified Kostiakov (MK)	α_2	0.000	1.00	0.068
	β_2	0.000	0.84	0.457
	α_3	0.000	3.23	0.936
	R^2	0.920	1.00	0.998
	RMSE	0.000	4.20	0.276
Revised Modified Kostiakov (RMK)	α_4	0.000	0.81	0.045
	β_3	-0.997	3.39	0.435
	α_5	0.000	1.60	0.437
	β_4	0.000	2.45	0.445
	R^2	0.910	1.00	0.998
	RMSE	0.002	4.81	0.281

The results of ranking models according to MRMSE and R^2 statistics (Table 1) given in Table 2. The mean RMSE reveals that the correspondence between measured and predicted infiltration is highest for MK model and lowest for SCS model. Also according to the R^2 statistic the goodness of cumulative infiltration can be estimated by the RMK, MK, Swartzendruber, Kostiakov, Horton, Philip, SCS models, respectively. The results of present study indicated that the empirical models had best fit on the double ring data, because they are on the basis of data derived from field experiments without any pre-assumptions. However, Swartzendruber model showed better performance than Kostiakov, Horton and SCS empirical models. Based on the results of ranking model given in table 2 the CSC model obtained the lowest ranking between the all of the models.

Table. 2 Ranks of infiltration models using the results criteria

criterion	PH	SW	HO	SCS	KO	MK	RMK
MRMSE	3	3	6	5	4	1	2
R^2	4	1	3	4	2	1	1

Conclusions

The results of this study indicated that all seven models account for > 90% of the variance (R^2) in cumulative infiltration of majority of soils. Based on the mean RMSE, and R^2 the MK model was the best model for prediction cumulative infiltration and SCS with two parameters was the worst model.

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Solid Phase Fractions of Zinc in Black Earths (Gleyic Chernozems) with Natural and Elevated Level of Metals

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Abstract
Based on the sequential extraction procedure seven solid phase fractions of zinc in agricultural soils classified to black earths (Gleyic Chernozems) was separated. The total content of zinc in several analysed soils was elevated compared to geochemical baseline value for this metal. The total contents of zinc were in the range 22.7-221.0 mg · kg^{-1}. Zinc was mostly found in the residual fraction (27.7-53.1 % of the total in soils with geochemical Zn level and 49.1-55.9 % of total Zn in soils in which elevated levels of this metal were detected). Soil organic matter and carbonates were the significant scavenger for Zn in studied soils. Important role play also amorphous and crystalline iron oxides. The exchangeable Zn was low accounting for less then 3 % of the total in most soils. Soils with elevated metal contents contained larger amounts of zinc in potentially more labile fractions.
Keywords: zinc, speciation, soil, Gleyic Chernozems

Introduction

During the past several decades metals contents in agricultural soils have increased. Application of mineral fertilizers, livestock manure, sewage sludges and pesticides are major source of the accumulated metals, including zinc. Industrial and urban dust transported to the agricultural land might also contaminate soils with heavy metals (Bragato et al., 1998). However, application of phosphorus fertilizers are known to induce Zn deficiency in plants, due to unsufficient solubility of Zn compounds (Norvell et al., 1987). Zinc is an essential micronutrient for plants serving as an enzyme catalyst. In recent years, zinc deficiency in human diet was reported as serious problem (Welch, Graham, 2004). Zinc has a number of critical functions in biological systems, including protection of structural and functional integrity of biological membranes, detoxification of highly toxic oxygen-free radicals and maintenance of protein synthesis (Marschner H.,1995; Cakmak, 2000). There has been little consideration of the factors that modulate the bioavailability and mobility of zinc in very productive black earths (Gleyic Chernozemns) from Kujawy, agricultural region in Poland.

The purpose of the study was to estimate the availability and potential mobility of zinc in plow layer of these soils. Sequential extraction method was applied for the assessment of actual and potential availability of zinc. Trace metals fractionation is a good tool to quantify how strongly trace metals are held in soils and conversely, how easily they might be released to solution.

Materials and Methods

Ten soils selected to represent arable Gleyic Chernozems (WRB, 1999) from Kujawy region (Poland) were sampled from 0 to 30 cm depth (plough layer). The soils were classified as Gleyic Chernozems formed from boulder loam. Long term annual temperature averages:
9 ˚C and rainfall average is 560 mm in the region. For the investigation the following sites were selected (Fig.1): Kruszwica (sample No 1), Janikowo (No 2), Ujma (3), Zakrzewo (4), Kruszyn (5), Osieciny (6), Nowa Wieś (7), Radziejów (8), Gnojno (9), Wierzchosławice (10). Soils were air dried and ground to pass through a 2 – mm mesh. Soil pH was measured in H_2O and 1 M KCl solution using a 1:2.5 w:v soil / solution ratio; organic C was determined by dichromate oxidation.
The concentration of total zinc in soils was determined after the digestion in a mixture of concentrated HF and $HClO_4$, according to Crock and Severson (1980). Plant available zinc was extracted with DTPA solution using Lindsay and Norvell method (1978).
The procedure of Miller et. al. (1986) was adapted to fractionate Zn. Selective extractants with increasing strength of extraction were applied in sequence to determine the following fractions of zinc: F_1 – water soluble and exchangeable, non-specifically adsorbed, extractable with 0.5 M

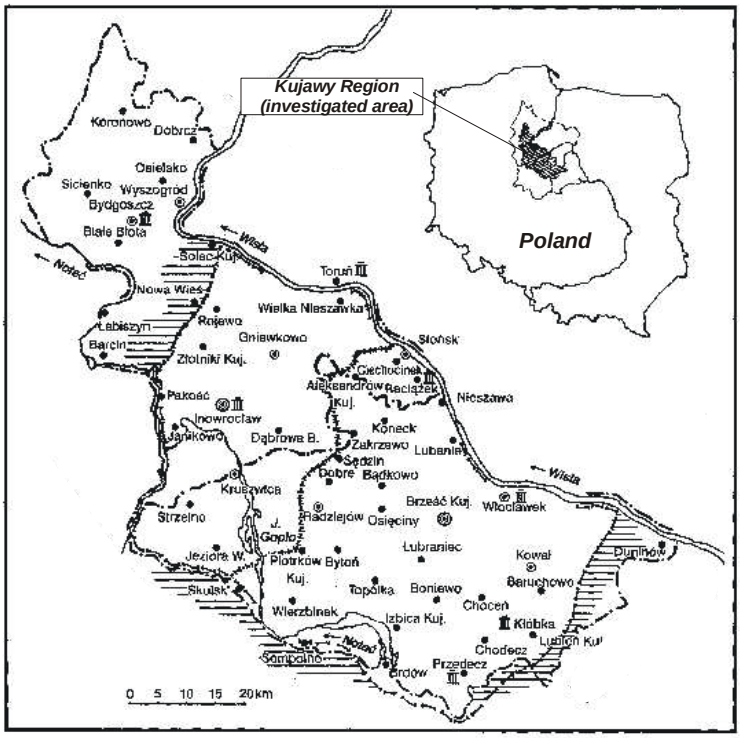


Figure1. Investigated area

$Ca(NO_3)_2$; F_2 – associated with carbonates, extractable with a mixture of 0.44 M CH_3COOH and 0.1 M $Ca(NO_3)_2$; F_3 – associated with Mn oxides, extractable with $NH_2OH \cdot HCl$; F_4 – bound to organic matter, separated by extraction with 0.1 M $K_4P_2O_7$; F_5 – associated with amorphous iron oxides, extractable with ammonium oxalate; F_6 – precipitated or coprecipitated with crystalline iron oxides, extracted with ammonium oxalate in the presence of ascorbic acid; F_7 – residual phase – fraction considered bound within the lattice of silicate minerals, calculated by the difference between total metal and the sum of extractable fractions. Analyses were done in triplicate. The resultant solutions we analysed by flame atomic absorption spectrometry on Philips PU 9100 X spectrometer. The analytical accuracy of AAS was ascertained by standard reference material (Till 3) of known composition.

Results and Discussion

The soils analysed differed in organic matter content (Corg: 9.1-19.3 $g \cdot kg^{-1}$) and contained clay in the range 7-13 % (Table 1). Cation exchange capacity, related to these components was in the range 68.0 – 206.6 mmol (+) $\cdot kg^{-1}$. Soils were neutral or slightly alkaline with pH in H_2O from 7.05 to 7.85, except for the one sample with pH 6.31 (Table 1).

Table 1. Selected physicochemical properties of soils ($mg \cdot kg^{-1}$).

Sample No	pH_{H2O}	pH_{KCl}	Corg [$g \cdot kg^{-1}$]	Clay [%]	CEC [mmol (+) $\cdot kg^{-1}$]
1	7.60	6.68	15.8	14	135.4
2	7.81	7.32	9.1	10	68.0
3	7.85	7.30	16.0	10	148.4
4	7.92	7.49	19.3	10	206.6
5	7.56	7.48	10.7	13	108.7
6	7.58	7.28	16.8	8	130.0
7	7.45	6.80	14.4	9	142.9
8	6.31	5.61	11.1	8	73.1
9	7.05	6.40	13.6	7	85.4
10	7.56	6.85	15.7	10	121.7

Total zinc concentrations were in the range 22.7-216.0 mg · kg^{-1} (Table 2). Other investigation carried out on these soils recorded the mean value of zinc content 33.8 mg · kg^{-1} (Dąbkowska-Naskręt et al., 2006). The background level for this metal in soils formed from glacial till of Vistula glaciation is reported as 33.0 mg · kg^{-1} (Kabata-Pendias and Pendias, 1999).

Table 2. Total contents, DTPA – extractable zinc and fractions of zinc (F_1 – F_7) in studied soils.

No Sample	F_1	F_2	F_3	F_4	F_5	F_6	F_7	DTPA	Total
1	2	3	4	5	6	7	8	9	10
	[mg · kg^{-1}]								
1	2.7	8.5	1.5	14.4	4.4	11.2	41.1	1.19	83.8
2	0.5	2.3	1.3	2.6	2.5	6.9	19.3	0.89	35.4
3	4.6	17.7	2.1	18.3	4.9	5.6	28.1	3.05	81.3
4	0.3	1.9	0.7	3.0	2.4	6.5	7.9	1.67	22.7
5	0.2	1.6	1.2	2.2	0.6	8.4	12.2	0.91	26.4
6	0.6	2.3	0.9	3.6	3.8	5.7	9.0	1.87	25.9
7	0.3	1.6	0.8	2.8	2.7	7.6	13.7	1.11	29.5
8	2.0	3.7	1.3	2.5	4.0	7.2	7.9	3.11	28.6
9	12.5	32.1	3.6	27.2	9.7	12.5	124.4	8.02	216.0
10	1.2	4.5	1.4	4.2	3.3	9.8	30.9	1.46	55.3

Thus, elevated levels of zinc were detected in several studied soils (samples No 1, 3, 9, 10). However it is below the directive limits of the European Union Council for concentration of metals in arable soils, which for zinc is 300 mg · kg^{-1} (Council of the EC, 1986). The excess of zinc in soil can reduce crop yields and may represent a potential hazard to the food chain.

Extraction with DTPA – TEA (diethylenetriamine pentacetic acid, triethylenamine; Lindsay and Norvell, 1978) gives good indicator of the amount of metal available to plants roots.

The content of Zn extracted with the DTPA ranged from 0.89 to 8.02 mg · kg^{-1} (Table 2). Critical level of DTPA – extractable zinc was reported as 0.2-2.0 mg · kg^{-1} (Mortvedt et al., 1991). Higher content of available zinc was found in soils with slightly elevated level of this metal in our study.

Although various investigations have determined plant - available nutrients under different management systems, little information is available on interactive effects of agricultural management on forms and actual and potential availability of micronutrients (Franzluebbers and Hons, 1996; Li et al., 2007).

Selective chemical extraction we applied, allowed to separate individual fractions of zinc (Table 2). The partitioning of metals in soils based upon the procedure of Miller et al (1986). The sequential extraction technique partitions zinc into seven operationally defined fractions: water soluble and exchangeable, bound to carbonates, bound to Mn oxides, associated with soil organic matter, bound to amorphous iron oxides , bound to crystalline iron oxides and zinc in residual form. The results confirmed relatively low mobility of zinc and dominance of residual fraction (F_7) in studied soils (Fig. 2).

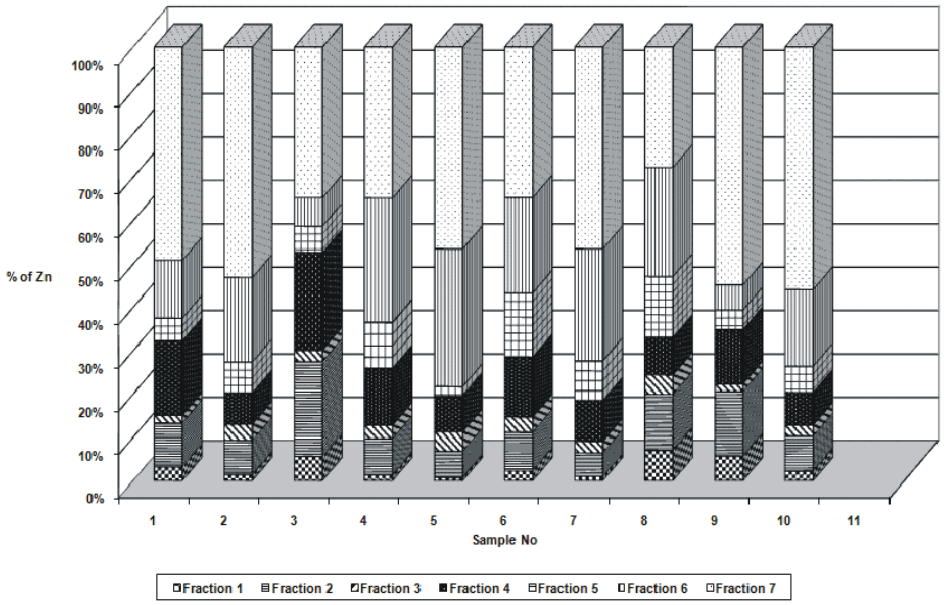


Figure 2. Chemical partitioning of zinc in soils, expressed as percentage of the total contents

The residual fraction, which refers to zinc bound in crystal lattice of primary soil minerals, accounts for approximately three - fourth of the total Zn in studied soils (Table 2). Metal in this fraction is relatively tightly bound and its release to solution is slow. Because the residual pool of zinc is unavailable, the other fractions, presumably more reactive, was called labile. The second abundant fraction was associated with crystalline iron oxides (F_6). Other authors reported that zinc is retained in soils mainly by iron oxides, particularly in soils with low contents of organic matter (Kabata-Pendias, and Pendias, 1999, Krishnamurti, 2008). Metals associated with Fe and Mn oxides are potentially labile and could be released under anoxic conditions upon decomposition of the oxides.

Between 14.7 % and 22.9 % of Zn was recovered as organically bound: (Fig. 2). Organic matter has large influence on Zn availability. Usually, available Zn increase as the amount of soil organic matter increases (Shuman, 1980). Previous study has shown that organic matter forms complexes with Zn (Dąbkowska-Naskręt, 2003). Soil organic matter exerts a direct and indirect impact on the availability of Zn (Li et al., 2007). Processes such as organic matter transformation, soil microbial activities and crop root activities realease organic acids into the soil. This leads to a decline in the soil pH and accelerates the dissolution of non available micronutrients like zinc. Therefore, organic matter plays an important role in enhancing the availability of zinc (Shuman, 1980).

Zinc in the carbonate, specifically adsorbed fraction accounts for 6.1 – 14.9 % of the total – (Fig 2). The pH decrease will lead to release of zinc retained on a matrix by weak electrostatic interactions or coprecipitated with carbonate.

The highest variation in Zn content exhibit second fraction (F_2), which accounts from 1.6 mg · kg $^{-1}$ to 32.1 mg · kg $^{-1}$. Fraction F_2 is called carbonate fraction i.e. zinc associated with soil carbonates. The mobility of this fraction depends on soil pH and this pool of zinc is released into the solution below the pH of 5.0.

Zinc bound to manganese oxides (F_3) was quite low, that is 0.7 to 3.6 mg · kg^{-1}, which was equivalent to 1.7 to 4.5 % of the total contents. Thus, this fraction is of little importance in studied soils.

A very small amount of zinc occurred in the water soluble and exchangeable phase (0.7 – 7 % of total). The exchangeable form (F_1), defined as the fraction bound to the surface of “active”, colloidal soil components is subject to desorption process and is readily available.

In general, zinc availability in the soils is restricted due to fixation of metal to soil components, mainly iron oxides (F_5) and organic matter (F_4).

Comparison of Zn contents in soils with elevated level of metal and soils with geochemical background value showed that the former one contained larger amounts of zinc potentially more labile: water soluble and exchangeable, associated to carbonates and bound to organic matter.

Conclusion

Data from the studies indicate that Gleyic Chernozems are not contaminated with zinc. Intensive agricultural use of this productive soils do not caused the accumulation of this metal. Under the existing conditions labile Zn fractions are scant, particularly in soils with low, on geochemical level, total metal contents. Thus low availability of Zn was observed in most soils studied. In few samples deficit level of available zinc was detected. Significant amounts of zinc was identified as potentially labile: bound to carbonates, organic matter and amorphous iron and crystalline iron oxides.

There is a need to continue the investigation on type of Zn association with these soil components.

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Fractionation of Soil Cadmium in Some Paddy Field Soils of Iran

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Abstract

The objectives of this experiment was to measure cadmium concentrations and its variations with respect to the application of phosphate fertilizers in some areas of Mazandaran-Iran. 40 soil samples (0-30 cm) were collected in the eastern Mazandaran region of Iran for the determination of some physicochemical properties including the levels of plant available phosphorus. A factorial experiment (20×2) have been arranged as completely randomized block design with 3 replication including 2 levels of Cd (0 and 3 µg/g as $3CdSO_4$, $8H_2O$), and 20 soils. Different chemical forms of Cd such as exchangeable, absorbed, organic, carbonate and residual have been fractionated by $0.5KNO_3$, X-H_2O, 0.5 NaOH, 0.05M Na_2EDTA and 4M HNO_3 extractants respectively in order to determine the amount and the composition of cadmium fractions. The extracted cadmium was determined by Atomic absorption and ICP-AES instruments.

The results indicated that the plant available cadmium levels ranged from 4 to 80 µg Cd/kg while the total cadmium concentration varied between 130 and 350 µg/kg. There was a positive correlation between plant available soil phosphorus and the concentrations of soil cadmium, i.e., with increasing concentrations of available phosphorus, the concentrations of available soil cadmium increased. This could possibly indicate the formation of relatively soluble compounds like $Cd(H_2P0_4)_2$ and $CdHP0_4$ with increasing concentrations relative to those of the soil phosphorus levels or relative to those of total soil cadmium caused by the application of phosphorus fertilizers. The major portion of soil cadmium was found as carbonate forms. There was a positive correlation between the concentrations of soil phosphorus and the concentrations of soil cadmium carbonate, while the residual forms of cadmium found mainly in the stable complex fractions of soil at average concentration at 0.08 mg/kg could be considered as the component of the soil matrix. Despite the relatively low rates of increases in soil cadmium levels in the areas studied, the application rates- of P-fertilizers should get close attention in the long term so as to avoid possible development of hazardous conditions.

Keywords: Cd, Cadmium, Paddy fields, Rice, Phosphate fertilizers

Introduction

Nowadays, sustainable agriculture on optimum use of soil and water is noticeable for sustainable development programming seriously. Hazard of cadmium entrancing in food chain (Soil-Plant-Animal) and biological toxicity is very important.

Relative share of phosphate fertilizer, sewage sludge and atmospheric sediment in soil pollution with Cd in western countries are 54 to 58, 39-41, 2-5 percentage respectively (Alloway, 1990). Main chemical forms of Cd concentration in acidic soils as fallows: $Cd^+Cl > CdSO_4 > Cd^{2+}$ and in sodic soils is as fallows: $Cd^{2+} > CdCl^+ > CdSO_4 > CdHCO_3^+$. Also main forms of Cd in oxidation condition are CdO, $CdCO_3$, $Cd_3(PO_4)_2$ and in reduction condition is CdS (Sposito, 1989).

The application of chemical fertilizers should be dealt with most carefully since some compounds like nitrates and phosphates may result in the pollution of underground water resources when used as plant nutrients and some heavy metals such as cadmium may accumulate in crop products along with nitrates at toxic levels. Cadmium-contaminated phosphate fertilizers are one of the most important sources of soil cadmium pollution in modern agriculture. The application of phosphate fertilizers can cause an increase in soil cadmium, no matter how small, and eventually the cadmium levels of crop products would increase along with increased leaching rates in the plowed layer

There are many studies about soil Cd level increasing due to long term application of phosphate fertilizers in many countries. In Australia for the soils under the cultivation of cereals and pastures has been observed increasing about 0.18 and 0.14 µg Cd/g soil. In New Zealand application of 376 Kg P/h as superphosphate during 48 years increased soil Cd from 0.030 to 0.236 µg Cd/g soil (Gray et al, 199) . In north of IRAN (Mazandaran and Guilan Prov.) P and Cd show a positive correlation in paddy fields (khani and Malekoti, 2000).

Material and methods

The objectives of this experiment was to measure cadmium concentrations and its variations with respect to the application of phosphate fertilizers in some areas of Mazandaran. 40 soil samples (0-30 cm) collected in the eastern Mazandaran region of Iran for the determination of physicochemical properties such as the levels of plant available phosphorus. A factorial experiment (20×2) have been arranged as completely randomized block design with 3 replication including 2 levels of Cd (0 and 3 µg/g as 3CdSO4, 8H2O), in 20 soils.

For fractionation of different chemical forms of Cd has been used an integrated suggestive methods of Spositio and et al (1982), Emmerich and et al (1982), Chang and et al (1984) that in fact is an improved form of Stover and et al (1976) procedure.

Different chemical forms of Cd such as exchangeable, absorbed, organic, carbonate and residual have been fractionated by $0.5KNO_3$, $X\text{-}H_2O$, 0.5 NaOH, 0.05M Na_2EDTA and 4M HNO_3 extractants respectively in order to determine the amount and the composition of cadmium fractions. The extracted cadmium was determined by Atomic absorption (AAS) and ICP-AES instruments.

Results

There was no Cd detected in the soils which were extracted by KNO_3, H_2O and NaOH (in untreated samples) as extractants. Average amounts and relative percentage of carbonate Cd were 0.167 µg Cd/g and 66 %. Application of 3 µg Cd/g to soil , increased the average of carbonated Cd and relative percentage in 20 samples of treated soils that they were 1.67 µg Cd/g soil and 47.9% respectively. The rate of applied Cd to carbonated form was about 49% that is significant. The amount range of untreated Cd form in 20 samples was negligible. Application of 3 µg Cd/g soil, increased the average of Cd in residual fraction and relative amount percentage to 1.19 µg Cd/g and 34.3 % (Table 1). The rate of applied Cd converted to residual Cd was 36.9 %.

The results indicated that the plant available cadmium levels ranged from 4 to 80 µg Cd/kg while the total cadmium concentration varied between 130 and 350 µg/kg. There was a positive correlation between plant available soil phosphorus and the concentrations of soil cadmium, i.e., with increasing concentrations of available phosphorus, the concentrations of available soil cadmium increased (Fig1 and Fig 2). This could possibly indicate the formation of relatively soluble compounds like $Cd(H_2P0_4)_2$ and $CdHP0_4$ with increasing concentrations relative to those of the soil phosphorus levels or relative to those of total soil cadmium caused by the application of phosphorus fertilizers. The major portion of soil cadmium was found as carbonate forms. There was a positive correlation between the concentrations of soil phosphorus and the concentrations of soil cadmium carbonate, while the residual forms of cadmium found mainly in the stable complex fractions of soil at average concentration at 0.08 mg/kg could be considered as the component of the soil matrix. Despite the relatively low rates of increases in soil cadmium levels in the areas studied, the application rates- of P-fertilizers should get close attention in the long term so as to avoid possible development of hazardous conditions.

Table 1. Mean (µg/g soil), relative amount and converted Cd chemical forms Cd, by sequential extraction method.

Cd levels	Organic		Carbonate		Residual		Sum
(µg /g)	Mean	Ratio	Mean	Ratio	Mean	Ratio	Mean
0	0.00 b	0.00	0.17 b	66.2	0.08 b	33.8	0.25 b
3	0.596 a	17.4	1.62 a	47.5	1.19 a	34.3	3.41 a
Converted (%)	19.9	-	48.5	-	37.0	-	81.3

*There was no Cd detected by AAS in soils which were extracted by KNO_3, H_2O and NaOH (in untreated samples) as extractants.

*Means in each columns, fallowed by at least one letter in common are not significantly different at 5 % level of probability-using by Fisher's test (F).

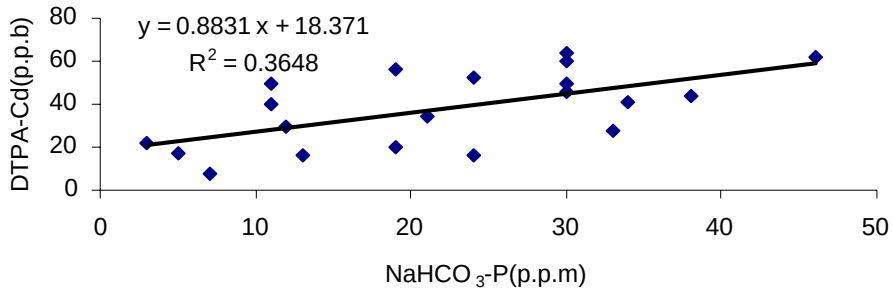


Fig 1. Correlation between NaHCO3-P and DTPA-Cd

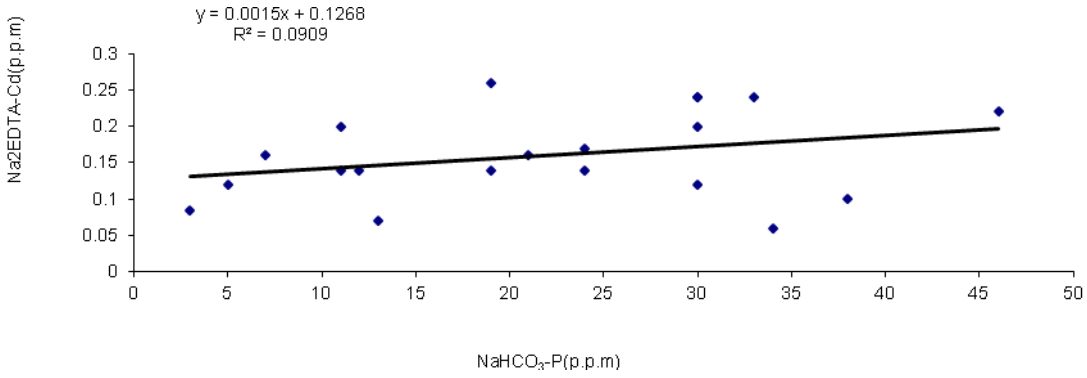


Fig 2. Correlation between NaHCO3-P and Na2EDTA-Cd

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Conservation Tillage and Its Systems

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Abstract
The concept of Conservation Agriculture (CA) is outlined in a series of principles and practices that are promoted. CA is an application of modern agricultural technologies to improve production while concurrently protecting and enhancing the land resources on which production depends. Application of CA promotes the concept of optimizing yields and profits while ensuring provision of local and global environmental benefits and services. Conservation tillage systems cover a broad spectrum of farming methods primarily aimed at conserving and managing crop residue to reduce erosion. In the past, a residue cover of 30% was considered adequate for erosion control and became the goal. Experience and data have shown, however, that truly effective erosion control relies on a situation- and site-specific plan developed by the individual. Because 30% was the former definition of conservation tillage, research data used it as a reference point or standard. Crop residue management is becoming the focus when looking at tillage systems for erosion control. Now 30% is just a point along the continuum and may or may not be the objective for a given situation.
Keywords: Tillage, System, conservation

Introduction
Tillage is important to provide the correct conditions for crop establishment and growth, and in general, requires mechanical manipulation of the soil by equipment that either cuts, shatters, inverts or mixes the soil (Cannell, 1985; Gajri et al., 2002). Tillage is performed in order to optimise productivity by alleviating physical, chemical and biological constraints of soil (Gajri et al., 2002). Current tillage systems can be divided into two broad categories; inversion tillage, known as conventional plough tillage, and non-inversion tillage, known as conservation tillage including minimal tillage and direct drilling (Davies and Finney, 2002). Recent pressure on farm incomes has led to tillage systems being developed to minimise cultivation costs and improve the timeliness of cultivation, leading to improved crop establishment. Conservation tillage systems can now operate at shallower working depths than the plough and at higher forward speeds, increasing the work rate, reducing fuel use and the risk of soil erosion because crop residues remain on the soil surface.
The selection of a particular tillage method depends on many factors that influence successful crop establishment (Carter *et al.*, 2003a). The objective of conservation tillage is to limit the mechanical disturbance of the soil to that required for seed placement, and to create a soil physical environment where, in particular, mechanical impedance and aeration do not restrict root growth and function, and therefore crop yield (Cannell, 1985). A summary and classification of the tillage systems is shown in Table 2 overleaf. Recent changes and amendments to legislation including the Water Framework Directive and the Soil Framework Directive may be key in the implementation and use of conservation tillage regarding the management of soils for structural stability to protect soils from water and wind erosion. This paper aims to review some of the key advantages of conservation tillage systems both in terms of economic benefits and soil protection.

Tillage Systems
Conventional tillage: conventional tillage is a tillage system using cultivation as the major means of seedbed preparation and weed control. Conventional tillage is defined by the *Conservation Tillage Information Center* in West Lafayette, Indiana, USA (CTIC, 2004) as any tillage and planting system that leaves less than 15 percent residue cover after planting, or less than 560 kilograms per hectare of small grain residue equivalent throughout the critical wind erosion period. It is based on mechanical soil manipulation involving a sequence of soil tillage, such as moldboard ploughing followed by one or two harrowings, to produce a fine seedbed and also the removal of most of the plant residue from the previous crop. It embraces primary cultivation based on ploughing or soil inversion, secondary cultivation using discs, and tertiary working by cultivators and harrows, drawn by animals, tractors or any mechanically powered devices. Weeds are

controlled by herbicides and cultivation. The mechanical soil disturbance involved increases the risk of erosion and dust emission (Baker *et al*, 2005).

Intensive tillage; intensive tillage systems involve often multiple operations with implements such as a mold board, disk, and/or chisel plow. Then a finisher with a harrow, rolling basket, and cutter can be used to prepare the seed bed. Intensive tillage systems leave less than 15% crop residue cover less than 560 kg/ha of small grain residue. These types of tillage systems are often referred to as conventional tillage systems but as reduced and conservation tillage systems have been more widely adopted, it is often not appropriate to refer to this type of system as conventional.

Conservation tillage; conservation tillage (CT) is defined by the *Conservation Tillage Information Center* (CTIC, 2004) as any tillage and planting system that covers 30 percent or more of the soil surface with crop residue after planting, to reduce soil erosion by water. Throughout much of the US, the definition of conservation tillage has been maintenance of a minimum of 30% soil cover with crop residues after planting. Other definitions have arisen for special circumstances such as 1,120 kg ha^{-1} of flat, small grain residue equivalents on the soil surface in areas with wind erosion potential. There are many variations of conservation tillage systems covering a broad spectrum of farming methods primarily aimed at based on reducing soil disturbance, conserving and managing crop residue to reduce erosion. They include no-till, ridge-till, mulch-till or strip-till.

Other tillage systems

Tillage systems that leave less than 30 percent crop residue after planting are not classified as conservation tillage. However, these systems may meet erosion control goals with or without other supporting conservation practices, such as strip cropping, contouring, terracing, etc.

Reduced tillage; reduced tillage systems leave between 15 and 30% residue cover on the soil or 560 to 1100 kg/ha of small grain residue during the critical erosion period. This may involve the use of a chisel plow, field cultivators, or other implements.

Tillage rotation; similar to crop rotation, tillage rotation indicates the use of rotation of different tillage systems. For residue management, rotating tillage systems to coincide with crop rotations is an option. For example, a no-till system following soybeans and a chisel or disk system following corn can provide adequate erosion control after soybeans and allows for some tillage in the less fragile and more abundant corn residue. Rotating tillage systems, however, slows the development of improved soil structure and may require investment in more equipment.

Traditional tillage; farmers in the tropics employ several traditional methods of seedbed preparation. Farmers make mounds or ridges with manually-operated hoes or with equipment (usually moldboard plough) drawn by draught animals to dig and turn the soil over, with an effort placed to break the clods and leave a fine tilth. When animal power is used farmers make several runs with the mouldboard plough, while they remain unaware of other equipment like harrows and ridgers. On poorly drained soils, large mounds often 3-4m in conference and about 1m high are constructed. Various crops are grown on top of the mounds and raised beds. Weeds and bush regrowth are slashed manually and left on the mounds as mulch or burnt in situ.

Conservation Tillage Systems

Conservation tillage principles and practices have evolved over the past 50 years which focus upon managing crop residues. Crop residue management is defined by the *Conservation Tillage Information Center* (CTIC, 2004) as a year-round system beginning with the selection of crops that produce sufficient quantities of residue and may include the use of cover crops after low residue producing crops. Crop residue management includes all field operations that affect residue amounts, orientation, and distribution throughout the period requiring protection. Most conservation tillage systems are based on one of the following reduced soil disturbance planting systems: no-till, ridge-till, mulch-till, or strip-till.

No-till or Zero-till; The CTIC defines no-till as a system in which the soil is left undisturbed from harvest to planting except for nutrient injection. Tillage is essentially eliminated with a no-till system. The only tillage that is used is the soil disturbance in a narrow slot created by coulters or seed openers (*Conservation Tillage Systems and Management*, 2000). Planting or drilling is accomplished in a narrow seedbed or slot created by coulters, row cleaners, disk openers, inrow chisels, or roto-tillers. By disturbing only a narrow slot in the residue-covered soil, excellent erosion control is achieved. Compared to other tillage systems, no-till also minimizes fuel and labor requirements. Weed control is accomplished primarily with one or two properly timed surface

applications of pre-emergence or post-emergence herbicides. Recent advancements in herbicides make weed control with no-till easier than it used to be. Early preplant applications, longer-lasting residual herbicides, and a wide variety of postemerge products are helping assure weed control success with no-till.

Ridge-till; Ridge-till is a reduced disturbance planting system in which crops are planted and grown on ridges formed during the previous growing season and by shallow, in-season cultivation equipment. In ridge-till, the soil is also left undisturbed from harvest to planting except for possible fertilizer injection. The ridge beds are established and maintained through the use of specialized cultivators and planters designed to work in heavy crop residues.

Tillage is generally very shallow, disturbing only the ridge tops. Planting is completed in a seedbed prepared on ridges with sweeps, disk openers, coulters, or row cleaners. Residue is left on the surface between ridges. A band application of herbicide behind the planter provides weed control in the row. Crop cultivation also controls weeds between the rows and rebuilds the ridges for the following year. Weed control is accomplished with herbicides and/or cultivation.

A ridge system is an excellent choice for soils that are often too wet. Ridges in the ridge-till system work quite well to provide drainage on poorly drained soils. Ridge-till reduces erosion by leaving the soil covered with residue until planting. After planting, 30%-50% residue may be left, but it is not uniformly distributed. Residue-covered areas between the rows alternate with residue-free strips in the row area. For erosion control, the ridges should be 7.5cm-12.5cm higher than the furrows after planting and that ridges be shaped to shed water to the furrow. For the most effective erosion control, orient ridges approximately on the contour.

Zone or Strip Till; zone or Strip tillage refers to any system in which a seedbed strip is established through a cover crop or crop residue, while still leaving a wide, untilled inter-row area (Plate 3). The*Conservation Technology Information Center*'s definition of no-till includes strip tillage, provided less than one-third of the total row area is tilled. Strip tillage is similar to no-tillage except that a narrow 12.5−13.5cm wide seedbed is established for planting, compared to notill in which a mere slot is opened into the soil for planting. The narrow seedbed in zone tillage is usually created by one or more gangs of fluted coulters mounted on the front of the planter. The loosening of the soil through zone tillage can also make for a more desirable seedling environment. Strip tillage operation removes the residue from the row area and planting with strip-till takes place in the residue free strips.

Mulch-till; mulch-till is a category that includes all conservation tillage practices other than no-till and ridge-till. Mulch tillage has already been described as a tillage system in which a significant portion of crop residue is left on the soil surface to reduce erosion. It is usually accomplished by substituting chisel plows, sweep cultivators, or disk harrows for the moldboard plow or disk plow in primary tillage. This change in implements is attractive because residues are not buried deep in the soil, and good aerobic decomposition is thus encouraged. Weed control is accomplished with herbicides and/or cultivation.

Two tillage practices that fall into this category are zone-till and strip-till. Both of these tillage practices involve tilling a strip into which seed and fertilizer are placed. Although these are popular terms in some areas, they are not official survey categories because they are considered modifications of no-till, mulch-till or "other tillage types." Less than 25% row width disturbance is considered no-till. More than 25% row width disturbance would be considered mulch-till or "other tillage type," depending on the amount of residue left after planting

Economic considerations of switching to conservation tillage

Cultivation costs are directly correlated to the type, working depth and number of operations to produce a seedbed. Conventional tillage systems are generally more costly than for conservation tillage systems because first they require more passes often using several different implements to create a satisfactory seedbed and, second, each pass costs time, labour and fuel. Therefore, it has been found that under conservation tillage systems establishment costs fell by a considerable amount (Table 1); for example, fuel use reduced from 30-50 litres/ha under mouldboard ploughing to 8-10 litres/ha under a direct drilling system.

Studies in the UK have found that work-rates are much improved under conservation tillage systems offering greater flexibility and timeliness for weather dependent operations (Carter et al., 2003b), this allows for soils to be cultivated at the optimum time with regards to soil conditions

that are suitable for working and thus creating a seedbed favourable for crop establishment (Shepherd, 2002). On heavy soils, Knight (2004) reported energy use for conventional tillage was 2826 MJ/ha compared to 1191 MJ/ha and 770 MJ/Ha for minimum and direct drilling respectively. This was because of the greater power requirement and a slower forward speed required when ploughing (Knight, 2004).

Table 1 Typical costs associated with establishment systems (Bailey, 2007) Establishment system (Morris, 2006).

	Cost (£/ha)	Total time (min/ha.)	Typical fuel consumption (litres/ha.)	Fuel cost/h(£/ha) @36p/litre
Plough based	70-105	65-150	30-50	11-18
Solo" Type	55-70	45-70	38-54	14-19
Carier" Type	55-60	24-59	26-28	9-10
Bioseeder" for OSR	30	24	16-18	6-7
Direct drilling	20-30	20-30	8-10	3-4

Tillage System Comparisons

Typical advantages and disadvantages of the tillage and planting systems are shown in Table 2. General fuel and labor requirements are listed in Tables 3 and 4. This information is useful in evaluating a tillage system or combination of systems for various farming situations.

The most important advantage of conservation tillage systems is significantly less soil erosion due to wind and water. Other advantages include reduced fuel and labor requirements. However, increased reliance may be placed on herbicides with some conservation tillage systems. Of the systems compared in *Table II*, the moldboard plow system has the greatest fuel and labor requirements for tillage and planting. Compared to the commonly used disk system, no-till requires less than one-half the fuel and two-thirds the labor.

The labor savings allow a larger area to be farmed without additional help. Even if increased acreage is not anticipated, more timely planting may result in greater yields. In addition, costs for tractors and tillage equipment is less with fewer tillage operations.

Several studies have compared yields from different tillage systems. In eastern Nebraska, as a general rule, yields from all tillage systems are about the same during the first few years. Continued use of a notill or ridge system has resulted in greater yields because of improved soil structure, organic matter accumulation and decreased weed pressures.

With limited soil moisture, all conservation tillage systems out-yield systems which have intensive tillage. This occurs because tillage results in moisture losses, and conservation tillage both reduces the amount of tillage and leaves residue on the soil surface, further reducing evaporation and runoff. Recent advancements in herbicides make weed control with no-till easier than with many conventional tillage systems. Longer-lasting as well as early pre-plant herbicide applications are helping assure success with no-till.

Regardless of the tillage system selected, residue should be uniformly spread behind the combine using either a straw chopper or straw spreader. With larger combines the addition of a chaff spreader may be desirable, especially when harvesting wheat or soybeans. Uniform distribution of residue and chaff reduces equipment clogging, and provides more uniform soil conditions for planting, easier weed control and better erosion control.

Table 2. Advantages, disadvantages and typical field operations for selected tillage systems (Jasa et all, 1991)

System	Typical field operations	Major advantages	Major disadvantages
Moldboard plow	Fall or spring plow; one or two spring diskings or field cultivations; plant; cultivate.	Suited for poorly drained soils. Excellent incorporation. Well-tilled seedbed.	Major soil erosion. High soil moisture loss. Timeliness considerations. Highest fuel and labor costs.
Chisel plow	Fall chisel; one or two spring diskings or field cultivations; plant; cultivate.	Less erosion than from cleanly tilled systems and less wind erosion than fall plow or fall disk because of rough surface. Well adapted to poorly drained soils. Good to excellent incorporation.	Little erosion control. High soil moisture loss. Medium to high labor and fuel requirements.
Disk	Fall or spring disk; spring disk and/or field cultivate; plant; cultivate.	Less erosion than from cleanly tilled systems. Well adapted for lighter to medium textured, well-drained soils. Good to excellent incorporation.	Little erosion control. High soil moisture loss.
Ridge-till	Chop stalks (on furrow irrigation); plant on ridges; cultivate for weed control and to rebuild ridges.	Excellent erosion control if on contour. Well adapted to wide range of soils. Excellent for furrow irrigation. Ridges warm up and dry out quickly. Low fuel and labor costs.	No incorporation. Narrow row soybeans and small grains not well suited. No forage crops. Machinery modifications required.
Strip-till	Fall strip-till; spray; plant on cleared strips; postemergent spray as needed.	Clears residue from row area to allow preplant soil warming and drying. Injection of nutrients directly into row area. Well suited for poorly drained soils.	Cost of preplant operation. Strips may dry too much, crust, or erode without residue. Not suited for drilled crops. Potential for nitrogen fertilizer losses.
No-till	Spray; plant into undisturbed surface; postemergent spray as needed.	Maximum erosion control. Soil moisture conservation. Minimum fuel and labor costs.	No incorporation. Increased dependence on herbicides. Some limitations with poorly drained soils, especially with heavy residue. Slow soil warming.

Table 3. Typical diesel fuel requirements from Nebraska on-farm survey for various row crops and tillage systems (Jasa et all, 1991)

Operation	Moldboard plow	Chisel plow	Disk	Ridge-till	Strip-till or No-till
			Fuel use, gal/ac		
Chop stalks				0.55	
Moldboard plow	2.25				
Chisel plow		1.05			
Fertilize, knife	0.60	0.60	0.60	0.60	0.60
Disk	0.74	0.74	0.74		
Plant	0.52	0.52	0.52	0.68	0.60
Cultivate	0.43	0.43	0.43	0.86(2)[a]	
Spray					0.23(2)[a]
Total	**5.28**	**3.34**	**3.03**	**2.69**	**1.43**

[a]Operation performed two times.

Table 4. Typical labor requirements calculated from machinery management data for various tillage systems (Jasa et all, 1991)

Operation	Moldboard plow	Chisel plow	Disk	Ridge-till	Strip-till-or No-till
- - - - - - - - - - - - - Labor, hr/ac[a] - - - - - - - - - - - - -					
Chop stalks				0.17	
Moldboard plow	0.38				
Chisel plow		0.21			
Fertilize, knife	0.13	0.13	0.13	0.13	0.13
Disk	0.16	0.16	0.16		
Plant	0.21	0.21	0.21	0.25	0.25
Cultivate	0.18	0.18	0.18	0.36(2)[b]	
Spray					0.11(2)[b]
Total	**1.22**	**0.89**	**0.84**	**0.91**	**0.49**

[a]Hr/ac assume 100 hp tractor and matching equipment for average soil conditions.
[b]Operation performed two times.

Conservation tillage in the World

Data presented ten years ago at the 10th ISCO Conference in West Lafayette, Indiana, showed a worldwide adoption of the No-tillage technology of about 45 million ha (Derpsch, 2001). Since then the system has continued to grow steadily especially in South America where the MERCOSUR countries (Argentina, Brazil, Paraguay and Uruguay) are using the system on about 70% of the total cultivated area. More than two thirds of No-tillage practiced in MERCOSUR is permanently under this system, in other words once started, the soil is never tilled again. It is well known that only a few countries in the world conduct regular surveys on CA/No-till adoption. The data presented in this paper is mainly based on estimates made by farmer organizations, agro industry, well informed individuals, etc. The authors have been careful to only include data that seems well founded and reliable. Table 4 shows an overview of CA/No-till adoption in those countries that have more than 100.000 ha of the technology being practiced by farmers and table 5 shows the area under No-tillage and the percent of adoption by continent.

It is estimated that at present no-tillage is practiced on more than 105 million hectares worldwide. As table 5 shows 46.8% of the technology is practiced in South America, 37.8% is practiced in the United States and Canada, 11.5% in Australia and New Zealand and 3.7% in the rest of the world including Europe, Asia and Africa. The latter are the developing continents in terms of CA/No-till adoption. Despite good and long lasting research in these continents showing positive results for no-tillage, this technology has experienced only small rates of adoption.

Table 5. General overview of Conservation Agriculture/No-tillage adoption

Country Area under	No-tillage (ha) 2007/2008
USA	26.593.000
Brazil	25.502.000
Argentina	19.719.000
Canada	13.481.000
Australia	12.000.000
Paraguay	2.400.000
China	1.330.000
Kazakhstan	1.200.000
Bolivia	706.000
Uruguay	672.000
Spain	650.000
South Africa	368.000
Venezuela	300.000
France	200.000
Finland	200.000
Chile	180.000
New Zealand	162.000
Colombia	100.000
Ukraine	100.000
Russia	?
Others	1.000.000
Total	**105.863.000**

Source: Derpsch, R. and Friedrich, T., 2008, unpublished data.

Table. 6. Area under No-tillage by continent

Continent	**Area (hectares)**	**Percent of total**
South America	49.579.000	46.8
North America	40.074.000	37.8
Australia & New Zealand	12.162.000	11.5
Asia	2.530.000	2.3
Europe	1.150.000	1.1
Africa	368.000	0.3
World total	**105.863.000**	**100%**

Conclusion

Conservation tillage has a number of advantages in terms of reducing crop establishment costs and timeliness of field operations, compared to conventional plough based systems. Conservation tillage is relatively popular with farmers when many input costs (including labour, diesel and fertiliser costs) have risen sharply in recent years. There are also potentially some long-term / indirect benefits in switching to conservation tillage based systems when considering the potential improvement in soil structure and stability in terms of organic matter additions and improved water holding capacity and infiltration. These benefits may not be so clear to define in terms of financial value. However when looking at the long-term improvement in soil quality, crop performance will often highlight weaknesses in terms of poor rooting or water-logging / susceptibility to drought in difficult seasons that with climate change has become more frequent. In these conditions improving water infiltration or allowing crop roots to grow to the full profile depth of the soil can make all the difference to a “good” or “poor” crop.

Disadvantages to using conservation tillage systems can include a transition period after switching that can reduce crop yields and lead to an increase in soil strength / compaction due to the soil aggregates naturally re-structuring with smaller pores than that under conventional tillage which routinely increases pore space in the short-term. A shift in the weed spectrum from broad-leaved to grass weeds can occur under conservation tillage and with increasing resistance to many graminicide products cultural control is seen as an important part of grass weed control strategies. In these conditions ploughing is seen as appropriate to loosen the soil, however, this in itself can deplete soil organic matter and lose much of the soil moisture if not consolidated quickly after cultivation and thus create a vicious circle in terms of soil degradation.

Conservation tillage may also work well with forthcoming environmental legislation for preventing further soil degradation and preserving its functions ensuring that both farmers and the wider general public can benefit from improved soil management.

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BMP analyze to Reduce Sediment Load in Maroon Dam Catchment (Iran)

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Abstract
Soil erosion and sedimentation are fundamental water quality and quantity concerns and agricultural fields are known to be major contributors of sediment to surface water. The Soil and water assessment tool (SWAT) model is a flexible, physically distributed model was developed as a river basin scale to quantify and predict runoff and transportation from watersheds and river basins. The present work centered on simulating different scenarios on reducing the sediment that flowed to Maroon (Khuzestan, Iran) Dam Lake from the watershed. The SWAT was applied to estimate more than 5 best management practices (BMPs) effect on reduction of sediment load leaving agricultural area of dam basin. The results reveal that average annual reduction in sediment ranged from 74 to 93% of sediment reduction from the watershed due to different land use management scenarios. Also the area could be protected simply respecting the agricultural best management practices and undertaking soil and water conservation works.
Keywords: SWAT, BMP, erosion and sediment.

Introduction

Nonpoint source pollution is a leading cause of water quality problems in the worldwide (USEPA, 1991). Of all pollutants, fine sediment is the most prevalent and the most difficult to quantify. This is presumably because continuous suspended sediment data collection is expensive and inherently variable. Soil loss in Iran for the period of 1950 to 1990 has increased tremendously from 500 million to 2200 million ton per year, an increase of more than four folds in four decades. Overgrazing, dry farming and deforestation are the major causes of watershed degradation in Iran. It is estimated that the average annual erosion rate of watershed is more than 20 times of acceptable average level in the world.

A number of modeling tools have been developed to assist in watershed sediment yield estimation such that suitable TMDL planning conclusions can be made. These include:

(1) the Soil and Water Assessment Tool (SWAT), (2) Generalized Watershed Loading Functions (GWLF) model, and (3) the Hydrologic Simulation Program Fortran (HSPF) (Borah and Bera, 2004).

SWAT, in particular, has been used extensively for sediment modeling and TMDL planning (Borah et al., 2006). However, very little is used in order to assess the impacts of Best Management Practices (BMPs) effect on reduction of sediment load leaving agricultural area of dam basin urban development scenarios and the benefits. The purpose of this paper is to present an eighteen-year simulation (1994-2011) for the Maroon River in the Persian Gulf area in order to assess the impacts of different Best Management Practices (BMPs). During simulation process monthly suspended sediment loads and runoff are predicted and compared with observed data to validate the model.

Methodology

Study Area

The Jarahi River flows through the townships of Kohkiluyeh va Boyer Ahmad, Behbahan, Ramhormoz and Mah Shahr. It originates from the mountains of Rah Barik, Sefid and Golgilak, 53 km. northwest of Yasooj. After following a long course, and joining to various rivers, under the name of Maroon, enters the township of Behbahan and then Agajari village.

Maroon dam watershed is a 2700 ha subwatershed of the Jarrahi River watershed located within Khuzestan province in south-west of Iran (Figure 1). Average annual precipitation ranges from approximately 350-mm in the valleys to nearly 1000-mm in the mountains. The distribution of precipitation is typical of mountainous regions, with valleys peaking in the spring and mountain and plateau regions in the winter. Mean temperatures are approximately 23º C, with highs approaching 47.0º C in the summer months and lows of -6.0º C in the winter. Mean annual

streamflow is approximately 48.3 m^3 per second while annual runoff peaks routinely reach 81 m^3 per second.

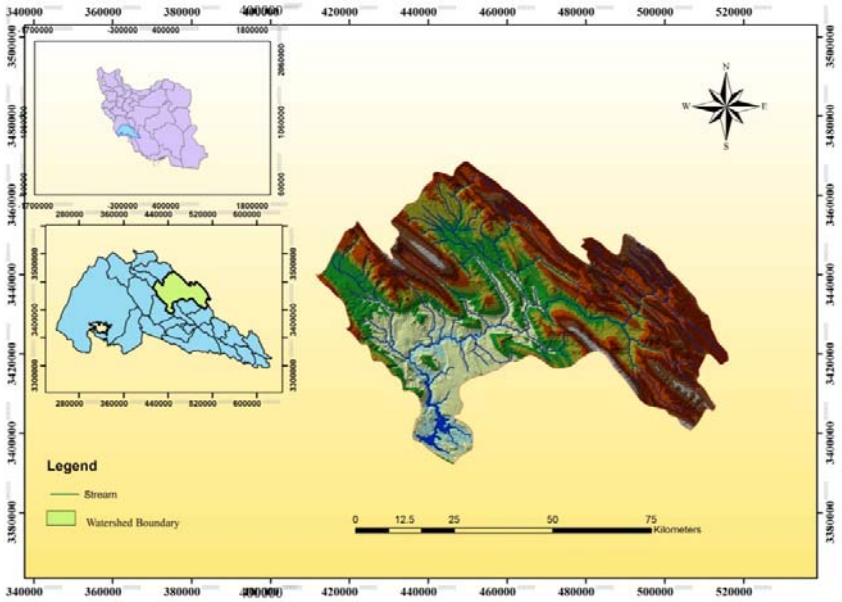


Fig.1**.** Maroon River watershed showing sub-watershed deliniation and hydrography

Source Data

Data used in the modeling was obtained from existing geographical information system (GIS) coverage and meteorological stations as well as from field data. The existing GIS coverage included land cover, digital elevation model (DEM) and stream coverage. Field data collected includes soils data, and stream flow data at the outlet of the watershed. Meteorological data was available from Iran meteorological organization stations established in the maroon dam watershed. Table 1 gives an overview of the model input data.

Table 1. Model data source for the Khuzestan-Maroon watershed

Data type	Scale	Source
Topography	1:25,000	National Cartographic Center of Iran
Plain soil	1:50,000	Khuzestan Water and Power Authority(KWPA)
Mountain soil	1:250,000	Planning and Management Organization of Khuzestan Province
Land use	1:100,000	Natural Resources Organization of Khuzestan Province
Weather	2 Station (monthly rainfall & temperature)	Khuzestan Meteorological Organization and Khuzestan Water and Power Authority(KWPA)
Reservoir	Reservoir Daily inflow and outflow	Khuzestan Water and Power Authority(KWPA)
Stream network	1:50,000	Khuzestan Water and Power Authority(KWPA)
Discharge	1 Station (idanak)	Khuzestan Water and Power Authority(KWPA)

Model Setup

ArcSWAT (SWAT developed with an ArcGIS interface) allows the user to easily import many layers of geographic data and simulate undeveloped lands and various management scenarios. SWAT has extensive input parameters. These include the ability to import large quantities of geographic data and extremely detailed elevation data. The user can also alter soil properties down to the subbasin or hydraulic response unit (HRUs) level, yet there are some physical attributes where the input is more limited. The limitations can sometimes be overcome, but sometimes they must be recognized and planned for accordingly.

The hydrologic cycle as simulated by SWAT is based on the water balance equation:

$$SW_t = SW_0 + \sum_{i=1}^{i}(R_{day} - Q_{surf} - E_a - W_{seep} - Q_{gw}) \quad (1)$$

where SW_t is the final soil water content (mm H_2O), SW_0 is the initial soil water content on day i (mm H_2O), t is the time (days), R_{day} is the amount of precipitation on day i (mm H_2O), Q_{surf} is the amount of surface runoff on day i (mm H_2O), E_a is the amount of evapotranspiration on day i (mm H_2O), W_{seep} is the amount of water entering the root zone from the soil profile on day i (mm H_2O), and Q_{gw} is the amount of return flow on day i (mm H_2O).

SWAT simulates surface runoff volumes and peak runoff rates for each HRU. Runoff is afterwards rooted to obtain the total runoff for the watershed. Water that does not infiltrate becomes surface runoff.

Surface runoff, or overland flow, is the flow that occurs along a sloping surface. The runoff coefficient is the ratio of the inflow rate to the peak discharge rate, q_{peak}

$$C = Q_{surf}/R_{day} \quad (2)$$

where R_{day} is the rainfall for the day (mm H_2O) and Q_{surf} the accumulated runoff or rainfall excess (mm H_2O), estimated using the SCS curve number equation is (SCS, 1972)

$$Q_{surf} = (R_{day} - I_a)^2/(R_{day} - I_a + S) \quad (3)$$

where I_a is the initial abstractions which includes surface storage, interception and infiltration prior to runoff (mm H_2O), and S is the retention parameter(mm H_2O) that varies spatially due to changes in soils, land use, management and slope and temporally due to changes in soil water content.

Peak runoff rate is calculated using a modified version of the rational equation (USDA-SCS, 1986)

$$q_{peak} = (C \times i \times \text{Area})/3.6 \quad (4)$$

Where q_{peak} is the peak runoff rate ($m^3\ s^{-1}$), C is the runoff coefficient, i is the rainfall intensity (mm. h^{-1}),

Area is the sub-basin area (km^2) and 3.6 is a unit conversion factor.

The overland flow time of concentration, t_{ov}, can be computed using the equation

$$t_{ov} = (L_{slp}/(3600 \times V_{ov})) \quad (5)$$

where L_{slp} is the sub-basin slope length (m), V_{ov} is the overland flow velocity (m s^{-1}) and 3600 is a unit conversion factor. The overland flow velocity can be estimated from Manning's equation by considering a strip 1 m wide down the sloping surface

$$V_{ov} = (q_{ov}^{0.4} \times \text{slp}^{0.3})/n^{0.6} \quad (6)$$

where q_{ov} is the average overland flow rate (m3 s^{-1}), slp is the average slope in the sub-basin (m m^{-1}), and n is Manning's roughness coefficient for the subbasin.

The MUSLE equation (Williams, 1995) used to estimate sediment generation is as follows

$$Y = 11.8(Q \times \text{Area} \times \text{pr})^{0.56} K \times C \times P \times \text{LS} \times R \quad (7)$$

where Y is the sediment generation (metric tons); Q is volume of runoff (m^3); pr is the peak runoff rate ($m^3\ s^{-1}$); K is the USLE soil erodibility factor; C is the cover and management factor; P is the support practice factor; and LS is the topographic (slope gradient, slope length) factor; and R is the coarse fragment factor. For each day with rainfall and runoff, sediment generation is estimated by applying Eq. (7) for each HRU in the watershed. The structural design of SWAT application is shown in Figure 2.

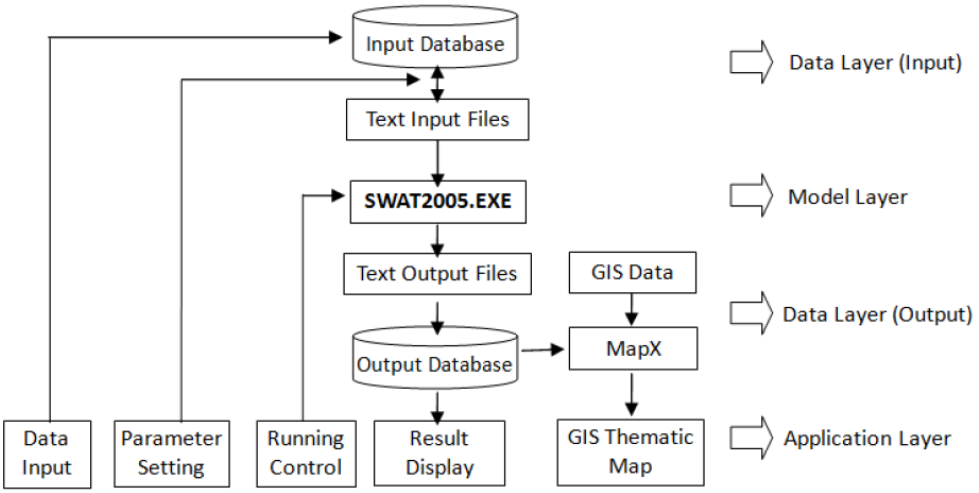


Fig.2. Structural design of the SWAT Application Tool

The Maroon River has historically been a major contributor of suspended sediment to the upper Jarahi River. In 1957, suspended sediment sampling was initiated in Idanak station response to concerns that Maroon sediment was over-grazed. In this study daily sediment discharge data were used in model calibration.

Erosion and Sediment Control BMPs

Sediment control BMPs are most effective when used in conjunction with erosion control BMPs. The combination of erosion control and sediment control is usually the most effective means to prevent sediment from leaving the project site and potentially entering storm drains or receiving waters. Under most conditions, the General Permit requires that the discharger implement an effective combination of erosion and sediment controls.

Erosion Control

Erosion control is any source control practice that protects the soil surface and prevents soil particles from being detached by rainfall, flowing water, or wind. Erosion control is also referred to as soil stabilization. Erosion control consists of preparing the soil surface and implementing one or more of the BMPs, to disturbed soil areas. Erosion control BMPs must be implemented at slopes and disturbed areas to protect them from concentrated flows.

Typically, steep slopes and large exposed areas require the most robust erosion controls; flatter slopes and smaller areas still require protection, but less costly materials may be appropriate for these areas, allowing savings to be directed to the more robust BMPs for steep slopes and large exposed areas. To be effective, erosion control BMPs must be implemented at slopes and disturbed areas to protect them from concentrated flows.

Sediment Control

Sediment control is any practice that traps soil particles after they have been detached and moved by rain, flowing water, or wind. Sediment control measures are usually passive systems that rely on filtering or settling the particles out of the water or wind that is transporting them. In Table 2 some effective sediment and erosion BMPs that are used to Maroon dam basin in SWAT model are shown.

Table 2**:** Sediment and erosion BMPs that are used to Maroon dam basin in SWAT model

BMP code	BMP Name	Description and Purpose	limitation	cost
EC1	Preservation of Existing Vegetation	Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs, and grasses that protect soil from erosion.	Environmental constraints such as nesting season prohibitions reduce the full capabilities of this BMP.	less than the cost of applying erosion and sediment controls
SD1	Silt Fence	A silt fence is made of a filter fabric that has been entrenched, attached to supporting poles, and sometimes backed by a plastic or wire mesh for support. The silt fence detains sediment-laden water, promoting sedimentation behind the fence.	Do not use in streams, channels, drain inlets, or anywhere flow is concentrated.	Range of cost is $3.50 - $9.10 per lineal foot.
SD2	Sediment Basin& Sediment Trap	A sediment basin is a temporary basin formed by excavation or by constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out before the runoff is discharged.	Sediment basins must be installed only within the property limits. In addition, sediment basins are attractive to children and can be very dangerous.	Average, $0.36 per ft3. $200 -$800, $600 average per drainage acre.
SD3	Check Dam	A check dam is a small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or reusable products, placed across a constructed swale or drainage ditch. Check dams reduce the effective slope of the channel, thereby reducing the velocity of flowing water, allowing sediment to settle and reducing erosion.	Not to be used in live streams or in channels with extended base flows.	it depends material costs and executive activities
SD4	Fiber Rolls & Gravel Bag Berm	A fiber roll consists of straw, flax, or other similar materials bound into a tight tubular roll. When fiber rolls are placed at the toe and on the face of slopes, they intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff. By interrupting the length of a slope, fiber rolls can also reduce erosion.	1. are not effective unless trenched 2.may be difficult to remove 3.may not be appropriate for drainage areas greater than 5 acres 4.Installation can be labor intensive	Material costs for fiber rolls range from $20 - $30 per 25 ft roll and Gravel costs range from $20-$35 per yd3.

SWAT requires daily meteorological values, such as precipitation, max and min temperature, wind speed, relative humidity and solar radiation. These data were collected from automatic meteorological stations for eighteen years (January 1994 – December 2011) by the Institute of Meteorology and Water Management. Precipitation, wind speed, temperature and relative humidity were gathered from one station, located in Idanak. Solar radiation data were collected from Behbahan station, which is located close to the research area. The most recent available GIS maps for topography, land use and soils were used. Typical management practices such as crops grown, fertilizer application and tillage operations for different land uses were gathered from state agricultural statistics, the statistical yearbook of Information Center of Ministry of Jahade-Agriculture of Khuzestan and personal communication with some farmers. The simulation period for calibration was 1994–2006 and the validation period was 2006–2011.

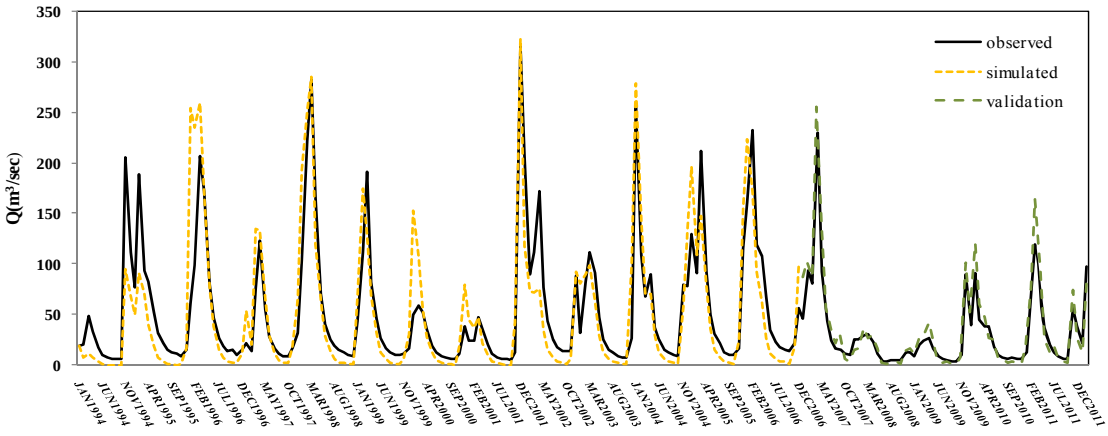


Fig.3. streamflow hydrograph for calibration and validation period

Results

We loaded the collected input data into the model. The whole watershed was divided into 23 subbasins. First, we assumed the most simple HRU classification—dominant soil type, land use and slope, then completed some simulations. The problem of proper calibration is in the availability of specific data about flow and sediment load. Daily measurements of discharge from January 1994 to December 2012 are available. With those values and some manual flow measurements, a discharge curve was constructed. The daily discharge values calculated on the basis of the discharge curve were loaded to SWAT–CUP (Calibration and Uncertainty Programs) and compared with the simulation discharge from SWAT (Figure 3).

Manual comparison of the simulated discharge and observed data was done the accuracy of the simulated data in validation period was tested based on 1:1 line. The result shows good estimation of SWAT (Figure4). Also a relationship between annual sediment and maroon dam inflow is shown in Figure5.

Although the SWAT model is still in calibration phase, we did some simple analyses of sediment reduction management practices. Appropriate sediment and erosion control practices enhance to model some BMPs effects on sediment reduction.

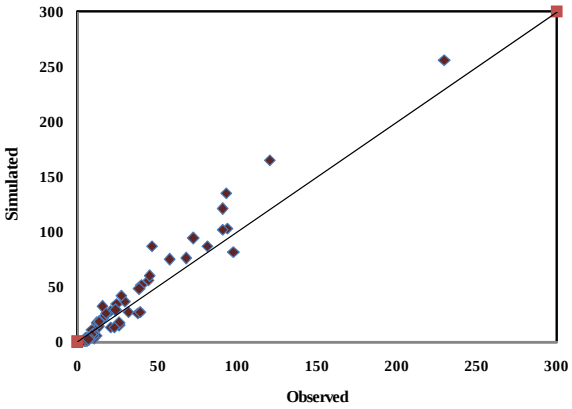


Fig.3. Simulated and observed streamflow in validation period

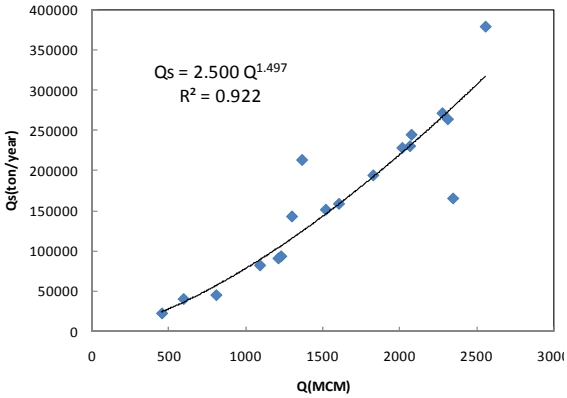


Fig. 4. Relationship between annual sediment and Maroon inflow

Parts of the model interface for data preparation were used to determine sediment in high risk areas and prepare visualizations for educational purposes pertaining to the use of buffer zones as a way to reduce sediment loads to Maroon dam**.** Using the BMPs control, Then sub-catchments with the highest density of potential sediment were picked up (created by SWAT model). The most endangered subcatchments were chosen based on a visual evaluation of the surface flow density map.

The use of SWAT in the preliminary analysis of BMP effectiveness shows that buffer zones on endangered areas are highly effective in the protection of sediment load against inflow. If the width of the vegetated buffer strips is not sufficient, it will not attain the desired effectiveness. Conversely, if the width is too great, it will cause agricultural land waste, deterring farmers' interest in cooperating with environmental preservation efforts. For the above reasons, it is important to set a reasonable width range. According to the results, because of financial problems of government we suggest wider buffer zones in endangered subbasins and narrow ones in other subbasins (Figure. 5&6).

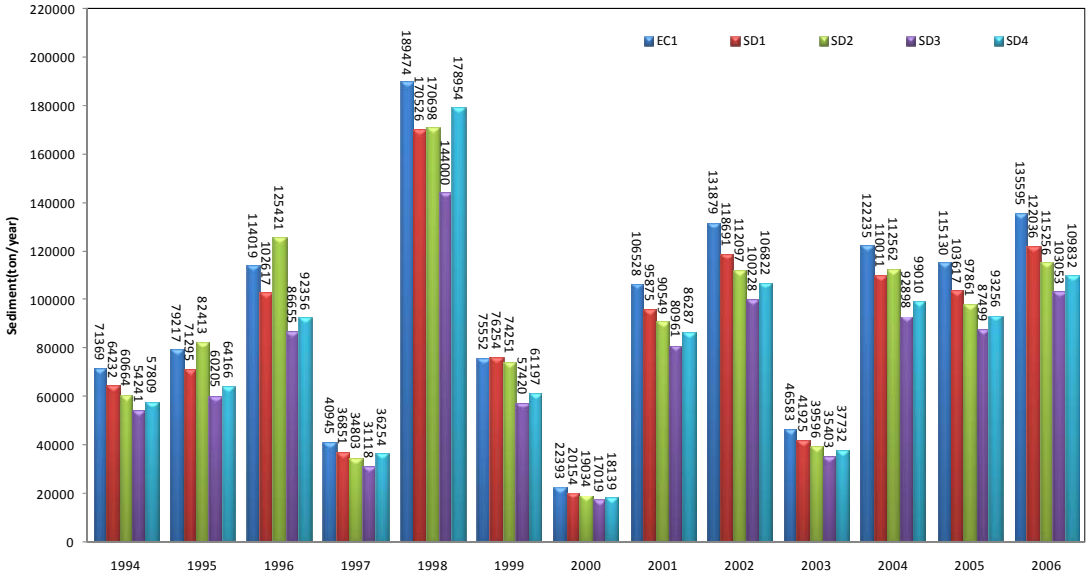


Fig. 5. Annual sediment for Maroon watershed in different BMPs in simulation period.

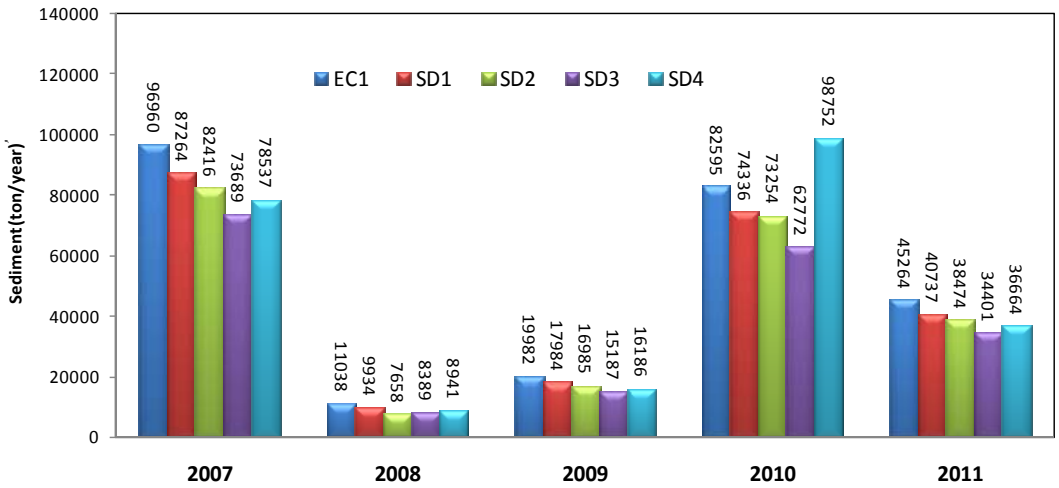


Fig.6. Annual sediment for Maroon watershed in different BMPs in validation period.

Discussion

Sediment control BMPs is most effective when used in conjunction with erosion control BMPs. The combination of erosion control and sediment control is usually the most effective means to prevent sediment from leaving the project site and potentially entering storm drains or receiving waters. Under most conditions, the General Permit requires that the discharger implement an effective combination of erosion and sediment controls.

Some erosion control BMPs can be used effectively to temporarily prevent erosion by concentrated flows. These BMPs, used alone or in combination, prevent erosion by intercepting, diverting, conveying, and discharging concentrated flows in a manner that prevents soil detachment and transport. Temporary concentrated flow conveyance controls may be required to direct run-on around or through the project in a non-erodible fashion.

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Inflow and Sediment Simulation of Maroon Dam Catchment Using SWAT

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Abstract
Hydrological processes and their local scattering have always direct relation to weather, topography, geology and land use of watershed. The use of a universal model to simulate the basin would be very important. Thus, in this research SWAT was used to simulate the watershed basin sediment and inflow. This model has been focused on many investigations due to its widespread consideration of various effective parameters. The study is based on Maroon Dam Basin with an area of 2700 Km^2 which is one of the main sub-basins of Persian Gulf. The capability of model in simulation of runoff and sediment of the basin with collecting a large number of local information and considering the effective parameters in hydrological cycle was examined in this study. The model was calibrated from 1994-2002 period using sufi-2 algorithms and evaluated from 2002-2007 periods. The result showed relatively good fitness between measured and simulated discharge and sediment. The Nash Sutcliffe efficiency and R^2 were about 70% for discharge and 76% for sediment load. Overall, simulation of runoff and sediment is satisfactory by using the SWAT model.
Keywords: SWAT, Inflow, Sediment and Maroon Dam.

Introduction
Soil erosion is a worldwide environmental problem that degrades soil productivity and water quality, causes sedimentation in reservoirs, and increases the probability of floods (Ouyung, 2001). Sediment transport rate is affected by hydrological as well as hydraulic characteristics. Since the former cannot be adequately taken into account quantitatively, a high degree of accuracy in sediment load computations cannot be expected (Garde and Rangaraju, 2000). Watershed management programs frequently fail to reduce sediment yield because either the physical nature of the problem is not properly diagnosed or the economic and cultural conditions leading to accelerated erosion are not addressed and erision control practices are abandoned as soon as government subsidies are removed (Gregory and Fan, 1998). Besides, the development of a comprehensive sediment yield model requires substantial funding, extensive time and expertise, which are often unavailable in developing countries (Mulengera, 1999).
The soil and water assessment tool (SWAT) is a physically based, continuous time model, developed by Dr. Jeff Arnold for the USDA-ARS (Agricultural Research Service) (Arnold et al., 2001), mostly used to predict the impact of land management practices on water, sediment, and nutrient yields over long periods of time (Di Luzio et al., 2002). SWAT model has been used extensively to access water quality and quantity changes in the catchment responding to agricultural management across the US, Canada and other European countries (FitzHugh and Mackay, 2002; Abbaspour et al., 2004; Pandy et al., 2005; Plus et al., 2006; Abbaspour et al., 2007; Mehmet et al., 2009).
In previous studies, it was difficult to account for sediment yield deposition the catchment and to model the individual erosion processes. Therefore, this study aimed at assessing the suitability of SWAT2005 model (Neitsch, 2005) as one of the watershed erosion models in simulating inflow and sediment yield in Maroon Dam mountainous catchment. The model was used to assess its suitability in modeling sediment yield in the data scarce catchments, located in south western of IRAN.

Methods and Material
Study Area
The studied watershed, named Maroon Dam (Idanak station), is in south west of IRAN (Figure 1). The area of the watershed is about 2700 ha and located in a Semi- arid climatic region. Annual average precipitation is approximately 639.0 mm concentrated between November and May. Mean annual temperature is 23^oC.

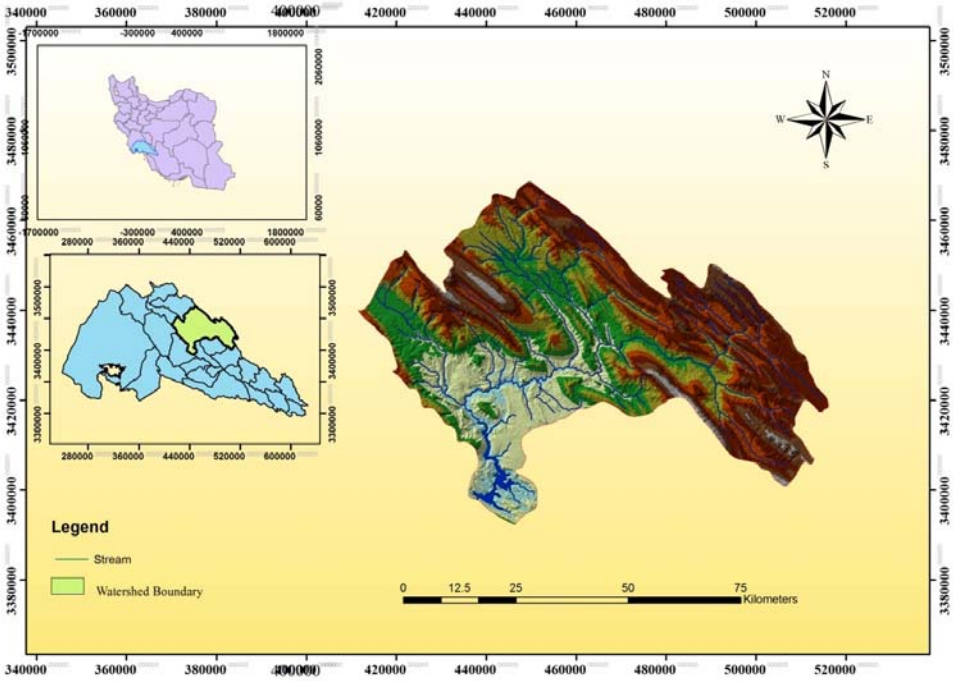


Fig.1. Research site: Dam Maroon watershed

SWAT input data

The basic input data included the digital elevation model (DEM), land use, soil maps and climate data. Data has been collected and processed for daily rainfall, runoff and sediment discharge, and maximum and minimum temperature for the watershed during 1987 to 2006.

The SWAT2005 was used to delineate the boundaries of the entire study area and its sub-basins. The model was calibrated using data in the catchment of Maroon Dam. During the simulation process the inflow and sediment yield was calibrated and then validated.

Results and Discussion

Model calibration and validation are indispensable for simulation process, which are used to assess model prediction results. Calibration was performed by comparing the simulated and observed surface runoff. After achieving a reasonable runoff data, the same parameters were used for calibration of the sediment and further for validation.

River sediment yields were estimated primarily by quantifying soil losses from HRU"s with the Modified Universal Soil Loss Equation (MUSLE) (Neitsch et al, 2005). K_{USLE} is the USLE soil erodibility factor, C_{USLE} is the USLE cover and management factor, P_{USLE} is the USLE support practice factor and CFRG is the coarse fragment factor (Neitsch et al, 2005).

The available measurements of flows and sediments were used for comparison with the predicted results in order to test the SWAT simulation efficiency. Calibration took place in monthly basis at Idanak Station, where inflow data is existed from 1994 to 2006 and sediment measurement data from 1995 to 2006. Figures 2 and 3 represents the graphical comparison between predicted and observed flows and sediment yields in Idanak during calibration and validation periods.

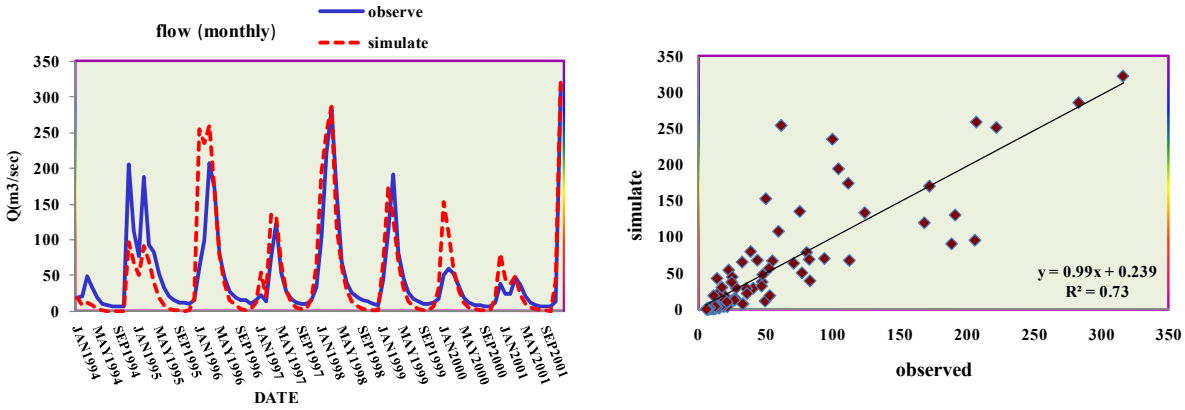


Fig.2**:** observed and predicted flows in Idanak Station during calibration period

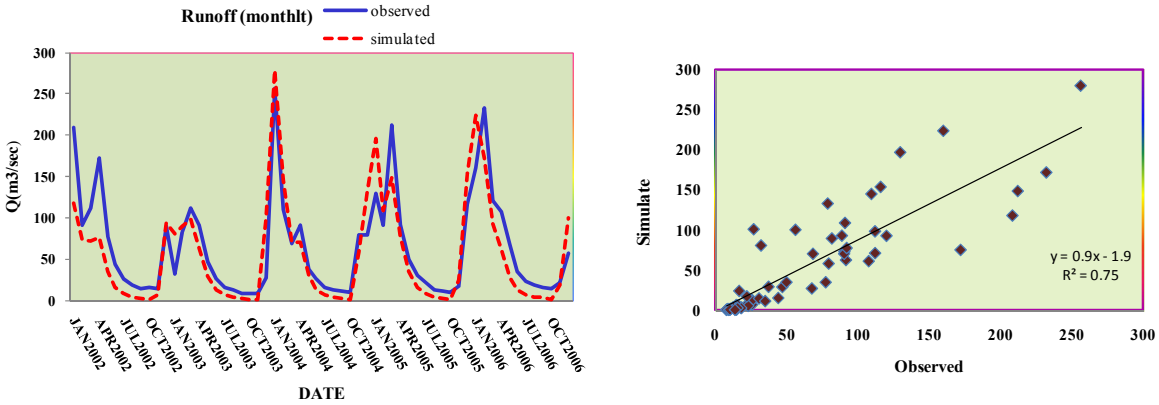


Fig.3**:** observed and predicted flows in Idanak Station during validation period

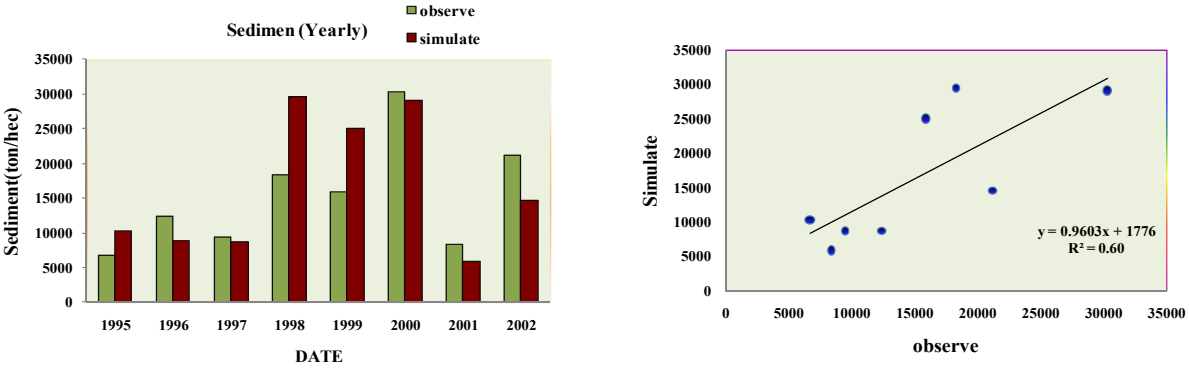


Fig.4: observed and predicted sediment yields in Idanak Station during calibration period

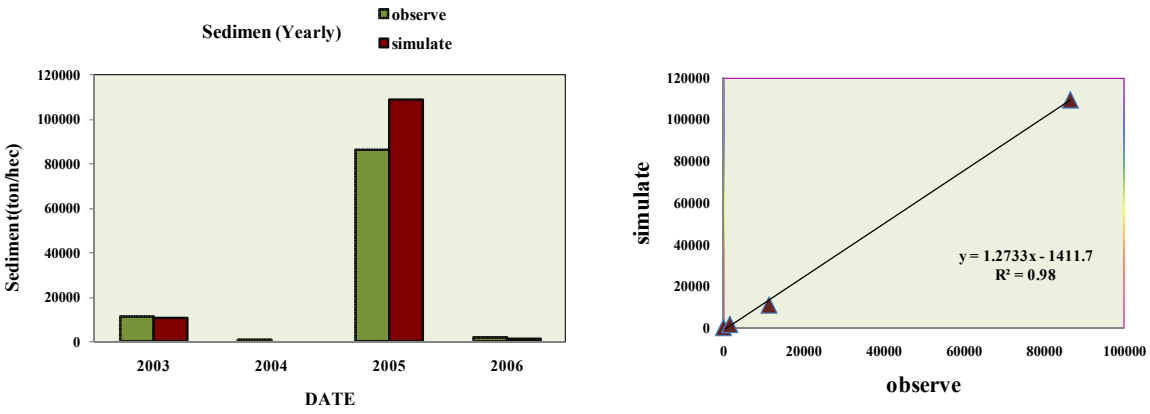


Fig.**5:** observed and predicted sediment yields in Idanak Station during validation period

Different values appeared between the simulated and observed monthly-runoff during the simulation for 1994–2001. The difference might be explained by the measured errors in runoff data, and system errors of SWAT. After reasonable parameter calibration, in validation process, simulated monthly-runoff was in the range of the observed values (Figure.3).
The correlation coefficient and Nash-Sutcliffe coefficient reached 0.75 and 0.70 respectively, which showed the validity of the simulation (Figure.4). Also the correlation coefficient in calibration and validation process during sediment load simulation reached to 0.60 and 0.98 respectively (Figure.5).

Conclusion

In this study SWAT was used to simulate inflow and sediment yield in the Maroon Dam watershed in south west of Iran. Simulated flow and sediment yields were generally in agreement with measured data.
The Auto-calibration Tool in ArcSWAT provides a user-friendly method for specifying various inputs including calibration parameters and desired widths of uncertainty confidence intervals. It also facilitates specification of measured data sets and the desired output parameters and objective functions. The text-based summaries from the three components of the Tool can be used to determine the optimal parameter set for calibration purposes, parameter sensitivity ranges and corresponding objective function ranges. Time series graphs, with or without parameter and model uncertainty bounds, can be created from additional output files to facilitate comparison between the amount of variation in the model results and the measured data.

Acknowledgements

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Relationship between non-exchangeable potassium released by oxalic acid and different forms of potassium in some calcareous soils

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Abstract

Oxalic acid plays an important role in improving the bioavailability of soil nutrients. Study on non-exchangeable potassium (NEK) release is necessary for management, optimum use of soil resources, availability, and supplying power of potassium. The relationships between forms and release characteristics of K as a function of clay mineralogy are important. Therefore, this study was conducted to investigate the NEK release of saturated soil sample by calcium using 0.2 M oxalic acid extractant to 216 h duration and its relationships with different forms of potassium in 7 soil series (alfisols, vertisols, histosols, mollisols, entisols, inceptisols, and aridisols) in Fars province in Iran. These relationships may have use in evaluating potential soil K fertility and prediction of K cycling and plant uptake. Results indicated that in all soils, the rate of potassium release was initially high but gradually decreased to a constant rate. Release rate of non-exchangeable K and NH_4OAc-extractable and HNO_3-extractable K was greater in alfisols, vertisols, and aridisols than other soils. It could be due to the higher contents of illite, chlorite, and smectite and clay contents in these soils. NH_4OAc-extractable and HNO_3-extractable K have a good correlation with total K. Moreover significant correlation was observed between NEK extracted by oxalic acid and NH_4OAc-extractable and HNO_3-extractable K.

Keywords: Non-exchangeable potassium; potassium forms; Oxalic acid; Calcareous soils

Introduction

Soils in arid and semiarid regions are generally well supplied with K and contain large quantities of exchangeable and nonexchangeable K. However, soils that have been intensively cropped are suffering from depletion in plant available K. There are equilibrium and kinetic reactions between the four forms of soil K (soluble, exchangeable, nonexchangeable, and structural or mineral) (Sparks, 1987). Availability of nonexchangeable K depends primarily on the rate at which it can be released into more labile forms (exchangeable and solution) (Onchere et al., 1989). Oxalic acid is one of the lowest molecular weight organic acids exuded by plants and plays an important role in improving the bioavailability of soil nutrients. Oxalic acid might be one of the important factors associated with efficient utilization of soil K by plants (Tu et al., 1999). The mechanisms by which oxalic acid enhances mineral weathering include donating protons to dissolve minerals, forming complexes with metal ions in mineral structures, and reducing some transitional metals (Fe and Mn) to disrupt mineral structures (Kodama et al., 1983). Little information is available on the effect of organic acids on the K release in soil. Therefore, this study was conducted to investigate the NEK release of soil by oxalic acid extractant and its relationships with different forms of potassium in 7 soil series in Iran.

Materials and Methods

The 17 soil samples used in this study were collected from the surface (0–20 cm) horizon of 7 soil order in Fars province, southern Iran (Aridisols, Mollisols, Alfisols, Entisols, Histosols, Vertisols, and Inceptisols). The amounts of K forms in each sample were determined by methods outlined by Helmeke and Sparks (1996). Total K was determined following digestion of soil with 48 % HF and 6 M HCl. Water soluble K was measured in the saturated extract. Exchangeable K was extracted with 20 ml 1.0 M NH_4OAc (pH 7.0) for 5 min. Nitric acid-extractable K was measured by extraction of a soil sample with boiling 1.0 M HNO_3 for 1 h. NEK release was studied by successive extraction with 0.2 M oxalic acid. Two-g of each soil (saturated by calcium) was placed

in a centrifuge tube, and 20 mL of the extractant solution was added to each tube. These tubes were shaken for 1, 2, 4, 8, 48, 96, and 216 h at 25 °C. After each extraction period, tubes were centrifuged and the concentration of K was determined in the clear solution by using a flame photometer (Corning 405), while the soil was mixed with a new portion of extractant, shaken and centrifuged. This procedure was repeated 7 times.

Results and Discussion

Mineralogical analysis of soils indicated that smectite, chlorite, vermiculite, illite and palygorskite were the dominant clay minerals occurred in the studied soils. All soils have mixed mineralogy and similar clay minerals but with different relative abundance.

Amount of different K forms and cumulative NEK release by oxalic acid solution in studied soil orders is shown in Table 1. The cumulative NEK released in 0.01 M malic acid varied from 83 in Histosols to 221 mg kg^{-1} in Vertisols. However, although all the studied soils had mixed mineralogy and similar clay minerals, the relative abundances were not the same. The dominant clay mineralogy of the Vertisols some Alfisols and Inceptisols was smectites and vermiculite. On the other hand, chlorite, palygorskite, and illite were the dominant clay minerals of other soils. The cumulative NEK release in smectitic soils was higher than other soils.

Soil orders	K forms (average)			NEK released by oxalic acid (mg kg^{-1})
	Exchangeable (mg kg^{-1})	Extract with HNO_3 (mg kg^{-1})	Total (mg kg^{-1})	
Vertisols(n=2)	312	1207	8190	221
Alfisols(n=2)	404	1629	8373	214
Entisols(n=4)	176	775	5307	152
Inceptisols(n=4)	199	828	5413	150
Aridisols(n=3)	246	885	5514	169
Mollisols(n=1)	227	832	5337	143
Histosols(n=1)	103	533	3399	83

Following regression equations were obtained between different K forms and cumulative NEK release by oxalic acid.

NEK Released= 8.75 +0.03(total K)	$R^2 = 0.948$	n=17
NEK Released = 51.18+0.12(HNO_3-extractable K)	$R^2 = 0.782$	n=17
NEK Released = 56.84+0.44 (exchangeable K)	$R^2 = 0.842$	n=17
Exchangeable K= - 72.30+0.05 (Total K)	$R^2 = 0.899$	n=17
Exchangeable K = - 17.38+0.27 (HNO_3-extractable K)	$R^2 = 0.962$	n=17
HNO_3-extractable K = - 177.56+0.19 (Total K)	$R^2 = 0.890$	n=17

NH_4OAc-extractable and HNO_3-extractable K have a good correlation with total K. Moreover significant correlation was observed between NEK extracted by oxalic acid and NH_4OAc-extractable and HNO_3-extractable K.

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Calibration of water infiltration model in plant-soil by using laboratory measurements

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Abstract
Solutions of transient water flow can be obtained by numerical modeling, their application may be limited in part as root water uptake is generally considered to be one-dimensional only. The objective of this study was to evaluation accuracy of two-dimensional root water uptake model in the Lysimeter. The root water uptake model was incorporated into a two-dimensional flow model, and parameters of governing equation were optimized, minimizing the residuals between measured and simulated water content data. Tube-time domain reflectometry (TDR) was used to measure soil volumetric water content. Also root density distribution was determined and soil hydraulic characteristics parameters were fitted from measurements. Water content was measured at different points and layers. To calibrate the flow, a genetic algorithm was used. With the optimized parameters of model, simulated and measured water contents during the 90 days period were in excellent agreement. Based on results, R^2 values generally ranging between 0.91 and 0.93 and a root mean squared error (RMSE) of 0.0625 m^3m^{-3}. Finally, Result illustrated that the model is extremely flexible in simulation of soil water content pattern. The 2D root water uptake model has considered the spatial variability of soil water and roots distribution to some extent, which almost reached the reality of field, so the simulated and measured results were almost similar.
Keywords: Numerical solution, Root water uptake, Soil water infiltration, Weighing Lysimeter.

Introduction
There are a variety of models proposed for root water uptake (Feddes et al. 1976; Molz 1981; Jarvis 1989; Gardner 1991; Kang et al. 1994). These models mostly consist of three quantitative descriptions of the atmospheric demand, effective root distribution, and root water uptake efficiency dependent on soil water potential, which is controlled by soil water availability. These models also need an appropriate crop coefficient in the development stage (Kc). The influence of plant root systems on water and chemical movement can be better understood using soil water simulation models, provided that accurate spatial and temporal root water uptake distributions are included (Musters and Bouten 1999). One of the earliest detailed quantitative studies of water extraction by a plant root was presented by Gardner (1964). This microscopic model considered a single root to be equivalent to an infinitely long cylinder of uniform radius with water-absorbing properties. The steady state soil water flow equation was solved analytically assuming radial flow and imposed root water uptake rates. Soil water matric head distributions around the idealized root were calculated. This concept was extended in later papers and proved to be very insightful but lacked practical applicability since the detailed geometry of the rooting system is difficult to measure and is time-dependent. Consequently, most root water extraction terms have been developed using a macroscopic rather than a microscopic approach. Nonetheless, all macroscopic models preserve the essence of Gardner's (1964) insight. One of the earliest studies is to test the suitability of a three-dimensional root water uptake model for the simultaneous simulation of transient soil water flow around an almond tree (Vrugt et al. 2001a). The most common approach for modeling root water uptake in unsaturated flow is based on introducing a sink term, S, in the Richards equation (Whisler et al. 1968; Clausnitzer and Hopmans 1994; Zuo and Zhang 2002; Hupet et al. 2003). The alternative approach referred to as the macroscopic scale or root system model represents the root system as a vertical sink that draws water from each differential volume of the root zone (Gardenas et al. 2005; Simunek et al. 2006; Daozh G et al. 2006).

Soil wetting patterns have been measured and/or analyzed theoretically by a number of authors, several of the more recent ones (e.g. Assouline, 2002; Cote et al., 2003; Skaggs et al., 2004; Gadenas etl., 2005, Lazarovitch et al. 2007, Siyal A.A and Skaggs T.H. 2009) have used numerical models to simulate soil wetting. Not much work has been done focusing specifically on soil properteas within root water uptake model.

The main objective of this paper is to develop a two-dimensional (2D) model of water flow in soil with root water uptake. For this purpose a new water uptake model has been developed and linked to the dynamic model. This model established based on the soil properties. The model has been verified using the spatial and temporal distributions of soil water content measured in the root zone of an apple tree.

Materials and methods

Soil water content was detected using a profile probe (TDR). Soil moisture content was detected with the TDR for each 0.10 m of soil layer to a depth of 100 cm below the surface. During this period, the soil water storage in the profile of 100 cm decreased by 115 mm in depth of water.

In this study, the exponential model of root water uptake (Vrugt et al. 2001b), namely

$$\beta(z) = [1 - \frac{z}{z_m}]e^{-\frac{p_z}{z_m}|z^*-z|} \quad (1)$$

was used as the basis of currently proposed uptake model. In Eq. (1) $\beta(z)$ denotes the dimensionless spatial root distribution with depth, zm is the maximum rooting depth [L], and pz [-], and z* [L] are empirical parameters. These parameters were included to provide for zero root water uptakes at $z \geq zm$, to account for nonsymmetrical root water uptake with depth and to allow for maximum root water uptake at any depth, zmax ($0 \leq zmax \leq zm$).

The proposed model excludes pz and $z*$, but includes four additional parameters:

$$\beta(r,z,t) = C_{ir}\left(1 - \frac{r}{r_m(t)}\right)\left(1 - \frac{z}{z_m(t)}\right)\beta_0 e^{(\rho(r/r_m(t))+\tau(z/z_m(t)))} \quad (2)$$

where $\beta(r, z, t)$ is the root density function[LL^{-3}], C_{ir} is a coefficient representing growing power of root, evaluated with penetrometer tools [-], t is the certain time, r is the radius in radial direction [L], z is the vertical depth [L], $r_m(t)$ is the maximum root development radius [L] in the radial direction at time t, $z_m(t)$ is the maximum root depth [L] in the vertical direction at time t, β_0, ρ, and τ are the empirical parameters that were estimated to be 0.3632, 0.5925 and -0.7519 cm/cm^3 respectively, in accordance with the experiment results. The coefficient C_{ir} shows power of root growth in soil and depends on soil texture and was obtained for several soil textures as given in Table 1. Values of this coefficient show the resistance of soil to penetration and may contribute to estimate soil density and compaction as well.

Table 1. values of C_{ir} for different soil textures

Soil Texture	sand	sandy-loam	loam	silt-loam	clay-loam	silty-clay-loam	sandy-clay	clay
C_{ir}	1	0.95	0.85	0.75	0.6	0.48	0.39	0.3

An analysis of the residual errors, differences between measured and simulated values, was used to evaluate model performance. Finally, fitting results were expressed as root mean square error (RMSE) values in the from:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}[\beta(m_i) - \beta(p_i)]^2}{n-m}} \quad (3)$$

where $\beta(mi)$ and $\beta(pi)$ denote the measured and predicted root density values, respectively, n is the number of measurements and m is the total number of parameters.

The equation of root density (Eq. 2) includes 6 parameters that their quantities were calculated for final solution. The parameters rm and zm were taken 150 and 100 cm, respectively, due to

limited growth of roots during the experiment. In this part, values of τ, ρ, β_O were optimized for C_{ir} values based on the measured data.

The soil of the field is laom-clay with C_{ir}=0.6. The validity of equation of root density was investigated exactly by sensitivity analysis and root distribution changes. For this purpose, different quantities of τ, ρ, β_O in equation (2) were evaluated.

Results and Discussion

For calibration purposes, the two-dimensional flow domain of the root zone of plant was divided into 16 blocks of 80 by 20 cm. The residual volumetric water content values of only 10 of these blocks served as calibration values (e.g. Vrugt et al. 2001a), and those of the remaining blocks were used for validation. Measured and simulated average water content values for all 16 blocks as functions of the considered time are presented in Figure 1 Each graph indicates the position of each block in the two-dimensional plane. Although simulated water contents using the optimized soil hydraulic and root water uptake parameters agree remarkably well with measured water content values, however there are some discrepancies. Figure 1 shows that water content changes at depths of 0-20 and 20-40 cm are more than those of the other soil layers, because of evaporation and root water uptake. Based on results, R^2 values generally ranging between 0.91 and 0.93 and a root mean squared error (RMSE) of 0.0625 m^3m^{-3}.

The aim of this experiment was to better understand the root zone dynamics of water uptake by apple trees in relation to the spatial distribution of soil water, and of the fine roots depend on soil properties. Our goal was to observe how root function is related to root form. This work was also prompted by a desire to test a simple model of water uptake by orchard trees.

New measurement techniques are providing improved means by which we can better observe both the changing spatial patterns of water content in the soil and the changing temporal patterns of water uptake by the roots. In particular, Time Domain Reflectometry for measuring soil water content close to roots, is providing a sharper picture of how root functioning can change rapidly in response to local changes in the water status of the root zone or patterns of root growth(Green and Clothier,1999).

We feel that progress in understanding the role of roots as the big movers of water and chemicals in soil will, in the near future, continue to remain driven by improvements in our ability to observe the link between distribution of roots and the corresponding uptake patterns (Clothier and Green, 1994, Green and Clothier1999). A better observation of the form-function link is key to improving our models of water movement through and beyond the root zone. The measurement-modeling dualism will ultimately improve our ability to predict the fate of any surface applied water (Willingen and Van Noordwijk, 1987).

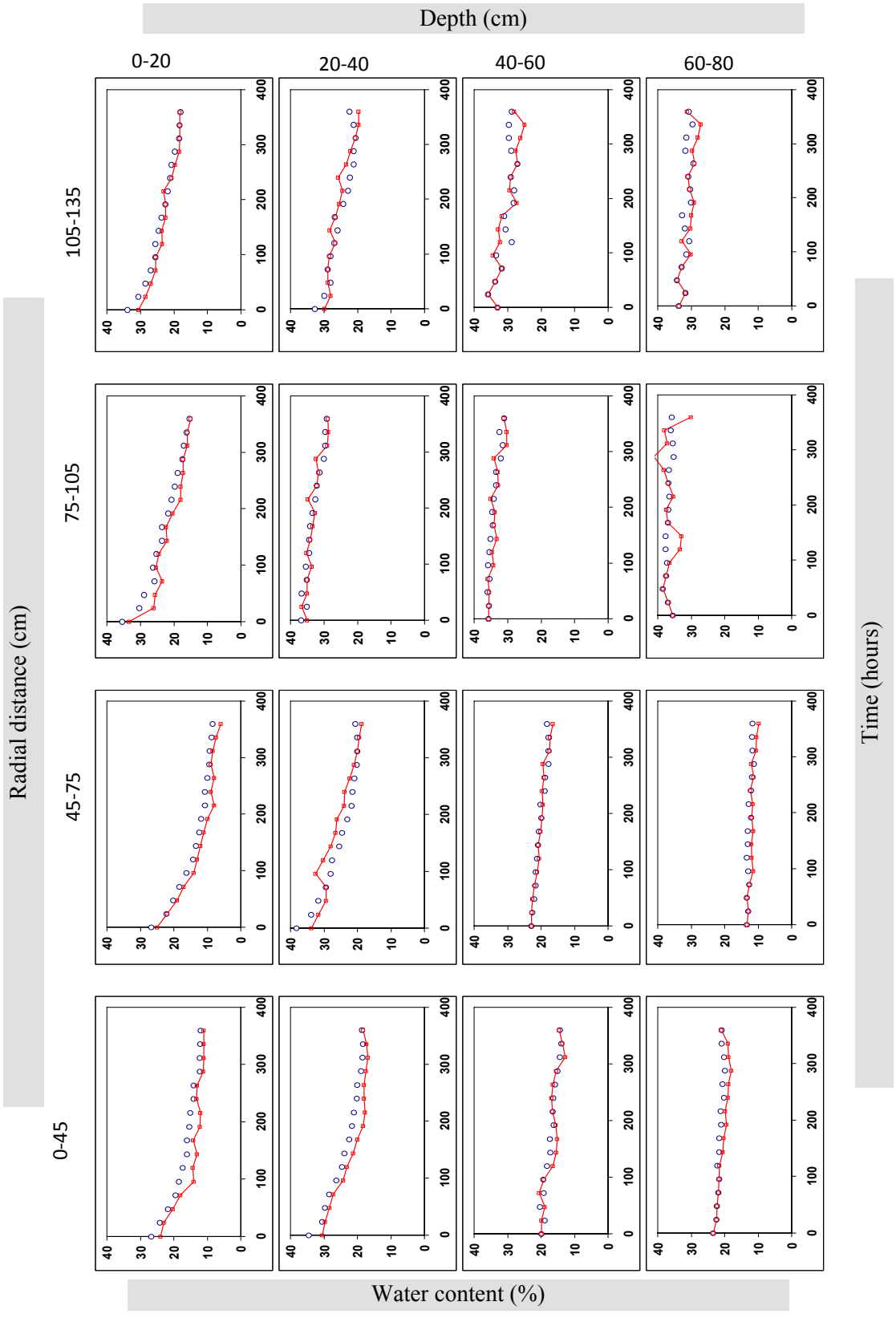


Figure 1 Spatial and temporal variation of measured (∘ ∘ ∘) and simulated(—) volumetric water content values (%) as a function of time across the spatial

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Study of different effects of cultivating methods on the wheat farming on rainfed and soil physical improving condition with soil mulching use

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Abstract:

In order to study, the effects of different tillage methods on the grain yield and soil moisture conservation of wheat crop, and Experiment on the base of split plot arrangement in Heidarlo Agricultural Station at Urmia. Treatments for main plots are as autumn with chisel (P1), Spring Semi mould board flowing (P2) and sub plots are: fallow (A1) spring Harrowing (A2) and herbicide fallowing (A3). Treatment was replicated 3 times. Wheat sardari was uniformly planted in all of plots, and necessary farming practices were applied in rain fed condition. At the end of each growing season data were collected for wheat yield and soil moisture, The results of analysis of variance showed that soil cultivating methods significantly increased wheat year yield and soil moisture at (k=%1), and the Treatment (P2) obtained the highest yield of wheat (1215 Kg/ha). Also mean comparison of subplots treatments showed that treatment (A2) with (1182 Kg/ha) compared to other treatments increased. Interaction effects of treatments showed that the combined treatments of (P2A2) produced the highest yield: 1339 Kg/ha. Interaction of year × treatment was not significant. Also treatment (P2) increased the soil moisture at (K<%1.) significantly.

Key words: Wheat yield, Available Water, Soil Moisture, Nitrogen

Introduction:

Implementation of different systems with mulch to prevent evaporation during the fallow excessive moisture and reducing soil susceptibility to water and wind erosion are possible. Capillaries with a reduction in force resulting in Dry farming inappropriate tillage, soil moisture stored deep in the roots of crops cannot be a gathering place for the ascent. Should be tried in the tillage of the soil supernatant parts granular diameter is 2-5 cm until the desired result is achieved, the cloudy is getting smaller than this limit will increase wind erosion. The mulches consisting of plant material such as straw mulch reduces soil temperatures are in the form of water vapor out of the soil to prevent. In this study the effects of different tillage managements using soil mulch on yield of wheat was studied in Urmia dry lands The use of machinery to provide better management and physical aspects of soil tillage and improve, maintain and store moisture in increasing yield and ultimately more effective step taken in the interests of dry farming farmers.

Materials and methods::

To investigate the effects of mulch and tillage on soil moisture conservation and finally, increasing the wheat yield in the experimental split plots and three replicates of six treatments in five years of field research station of Urmia was fed. In the experiments on same soil texture, slope (4-6) % and the area (2000 m²) in fallow and plant parts were considered. Fallow plots during the fall and spring chisel plow after field capacity condition as soon as you return the land to carry out routine treatments and in plots without tillage herbicide and cultivator use Routine treatments in the fallow plots and the plots were planted before the flowers green cover. Sardari wheat in the fall and the amount was 120 kg per hectare planted. Fertilizer requirements of the formula for the area and the amount of fertilizer recommended was (N30P30). Main plots included fall chisel plow (P1) and plow back half in the spring (P2) and subplots: no-till (A1) cultivator once in spring (A2) and chemical fallow (A3), respectively.

Table 1 Mean Soil analysis test site during the experiment

Soil properties and year	Soil depth	Sp%	Ec dS/m	pH	T.N.V %	O.C%	N total%	P Ava Ppm	K Ava Ppm	Sand %	Silt %	Clay %
1th.year	0-30	48	0.60	7.7	20.5	0.81	0.018	11.8	440	7.6	43.6	48.8
2th.year	0-30	53	0.48	7.9	20.3	0.94	0.049	7.0	380	8.6	64.0	27.4
3th.year	0-30	53	0.45	7.7	17.3	0.92	0.092	13.2	240	11.0	44.4	44.6
4th.year	0-30	51	0.44	7.8	21.0	0.86	0.086	7.4	310	10.2	48.0	41.8
5th.year	0-30	51	0.48	7.5	20.3	0.80	0.080	8.2	350	6	44	50

According to (Table 1) soil test site (Silt Clay) with moderate organic carbon, moderate to high available phosphorus levels , potassium is high.

Results and Discussion:

1- Effects of treatments on the quantitative characteristics of the product:

The main treatments were significantly different between levels (a = 0.01) and treatment (P2) (half plow back in the spring and in autumn next year fallow cultivation SQL) with an average production of 937 kg per ha was superior. Effect of sub treatments show (Table 2) that the treatment A2 (the once cultivator in the spring) with a production of 1182 kg per hectare compared to the treatments A1 (without plowing) and A3 (the fallow chemical in the spring) are quite significantly outperformed. Although treatments (A1 and A3) together in one group, but the treatment (A3) of treatment (A1) has been rated. Treatment (P2A2) (exercising once a tiller with cultivator in the spring semi-inversion tillage by the plow in the spring), the greatest effect in increasing the yield this treatment produced an average of 1339 kg/ ha been quite significantly superior to other treatments.

Table 2: Analysis of variance the effects of different tillage methods on wheat yield and Soil physical characteristics

No	sourses	Degrees of freedom	Sum of squares	Mean Squared	F value	Probability
1	year	4	8888593.733	2222148.433	58.2784	0.0000
3	Repeated in year	10	1820482.556	182048.256	4.7444	0.0106
4	Main factor	1	1731392.100	1731392.100	45.4078	0.0001
5	Year/main factor	4	1178049.511	296262.378	7.7829	0.0041
-7	Error	10	381298.556	38129.856		
8	Sub factor	2	586801.489	293400.744	12.7173	0.0001
9	Year/sub factor	8	585876.733	73234.592	3.1743	0.0070
12	Main factor/sub factor	2	291961.800	145980.900	6.3275	0.0041
13	Year/ Main factor/sub factor	8	219539.089	27442.386	1.1895	0.3296
-15	Error	40	922840.889	23071.022		
	Total	89	16615836.456		CV%=14.13	

Table 1 compares the average yield per levels of factor B

sub Factor	Yield Kg / ha	Grouping
Secondary processes 1 ((without plow processes	986.9	B
Secondary Operations 2 (once cultivator operation)	1182	A
Operations secondary 3 (fallow chemical)	1057	B
LSD=1% =106.1		CV%=14.2

2-The soil moisture content:

Table 3 Mean effect plowing the main Factor on moisture

Main factor	The moisture average		Groups in the 1%
	0-30	30-60	Possibility level
P1	12.36	12.002	B
P2	14.67	13.924	A
	CV=10.59	CV=13.28	

the average moisture of Main plots showed that Plow with half back (P2) and chisel (P1) had stored soil moisture is quite significant (0-30 cm) And treated with a moisture content of 14.67% compared to plow with half back a chisel plow is superior (a= 0.01). As the moisture stored in the depth (0-30) cm in depth (30-60) cm in main plots of one per cent level had a significant impact and Plow with half back with water restored 13.94% humidity is superior than chisel (a = 0.01) (Table 3)

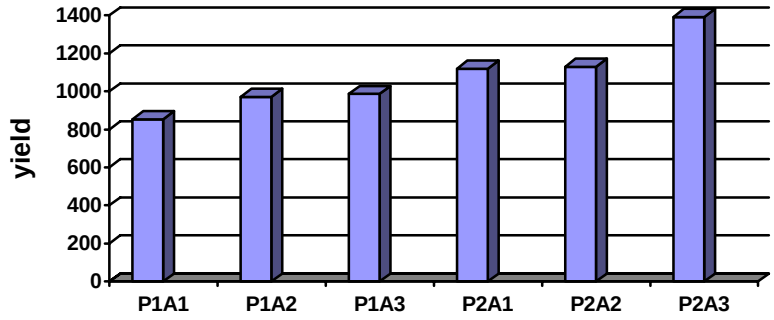


Figure 1 compares the average yield of the main treatments in sub treatments (kg / ha)

Table (4) Mean effects of different tillage managements on the amount of available water each year

Groups in the 1%probablity level	Mean(Fc-Pwp)	Main factor
A	12.153	P1
B	10.387	P2
	CV%=13.41	

The effect of treatments on soil nitrogen :

Effect of different tillage managements on average rate of ammonia-N in 0-30 cm soil depth (Table 5) Corresponding to the type of tillage treatments (P1) and (P2) and the experimental plots and significant effects were observed. But the mean analysis of Nitrate in 0-30 cm soil depth showed that Main plots and subplots were nearly significant interaction effect (a<95%) The highest amount of nitrate nitrogen contained in the 0-30 cm soil depth of treatment (P1A3) with an average of 27/24 mg/ kg soil and Its lowest-related treatments (P2A3), with 8/11 mg /kg soil was measured.

Table 5 - Comparison of the mean rate of nitrate in Soil (mg/ kg soil)

Treatment	P2 A2	P2 A3	P2 A1	P1 A3	P1 A2	P1 A1
Mean	13.07	11.8	14.47	24.27	12.13	17.27
Symbol	B	B	B	A	B	AB
	LSD 5%= 7.861				CV=26/94%	

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Effects of Soil Compaction on Dry land Wheat production

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Abstract

In order to determine the effects of different soil compaction managements on soil characteristics, an experiment was conducted with six treatments and three replications soil compaction was done by light roller (0.89 kg/ cm^2) and heavy roller (1.15 kg/cm^2). To break the plow pan using of subsoiler compared with non-compaction treatment and compaction treatment before and after planting.

The experiment design was complete randomized block. The experiment was carried in Urmiea. The effects of the treatments on the yield of wheat were studied.

The results showed that the effect of different managements on grain and straw yields of wheat and soil moisture was significant ($\alpha = 1\%$). The Subsoiling (T4) was the best treatment, wheat mean grain yield of 1252 kg/ha and mean straw of 3023 kg/ha.

Introduction

One of the most important factors restricting wheat production and distribution of moisture deficiency is inadequate rainfall that Distribution of soil moisture and save it for balance, do the proper tillage is necessary. Intensive tillage systems generally dry lands The amount of residue, Degree of land slope, soil type, rainfall zone, the system of cultivation and use of appropriate machinery and equipment will be realized. Mechanized agriculture striving to raise the yield per unit area tractors and related equipment on farm will lead to and gradually lower layers of soil compacted and air and the permeability decreases and amount of crop reduce ranked. Low rainfall in arid regions and to improve the physical properties of soil tillage and increase soil water storage is one of the important factors which is done intentionally by riper or subsoiler.

Materials and Methods

In this Study the effects of different tillage managements applying and use of agricultural machinery and equipment in agriculture On soil properties and yield of wheat in dry land were examined. The experimental farm for three years with six treatments and three replications in Urmia was performed as a randomized complete block design. The treatments consisted of T1 (custom farmer), T2 (the heavy density of planting), T3 (the light density after planting), T4 (plowing with the breakers), T5 (the heavy density of planting), T6 (the light density of planting). With regard to testing every year, being similar sequence in texture, slope and area was performed. Test plots with a slope of 4 to 6 percent with heavy texture, lack of soil salinity and alkalinity on the dominant soil series and from the haplic calcixerepts group was selected. Before the experiment, the treatments were performed in summer plowing with subsoiler Roller compaction and use of predictive testing was done before planting And farm use and the amount of 120 kg ha Sardari wheat were planted by the row After planting the desired compaction treatments were necessary. Fertilizer formula used in the N30-P30 source was triple super phosphate and urea Phosphorus fertilizer at planting and urea fertilizer 1/3when planting and 2/3 as non-mechanized mode of application in spring of next year as the farm was given. in were time with T-4-D herbicide was used against broadleaf weeds Composite samples to determine fertility and fertilizer application before experiment from 0-30 cm were prepared And routine analysis was conducted on soil samples. To implement the experiment, the compression pressure (kg/cm2 890/0) and compression (kg/cm2 154/1) 230 cm in length and width of the roller wheel diameter of 50 cm were prepared for use in implementing the plan. Roller weight of 246 kg and its volume is 452 liters to discuss the pressures we use the formula P =f/s Rolling into the arc cross section for the formula L = r. ש Used And for setting the desired weight to the pressure for compaction of heavy (high rollers), approximately "460 liters of water And the compression style (light Roller) about

240 liters of water it with Roller and filling and empty of half water And compaction pressure required to supply and were applied.

Results and discussion

Table 1 Mean soil test results

depth	SP	Ec	pH	TNV	OC	Pava	Kava	Sand	Silt	Clay	Fe	Mn	Zn	Cu
	%	dS/m		%	%	ppm	ppm	%	%	%		Mg/kg		
0-30	51	0.45	7.8	19.3	0.86	7.4	310	10.2	48.0	41.8	5.38	3.39	0.24	2.48

Table 2: Comparison of treatments on average grain and straw

Treatment	Grain Yield Kg/ha	α= 5%	α= 1%	Straw Yield Kg/ha	α= 5%	α= 1%
T1	792	C	C	2020	C	C
T2	1079	B	B	2581	B	B
T3	899	C	C	2219	C	C
T4	1252	A	A	3023	A	A
T5	1060	B	B	2603	B	B
T6	869	C	C	2171	C	C
CV=11.08%		LSD 105.8	LSD 142.1	CV=8.8%	LSD 207.3	LSD 279.1

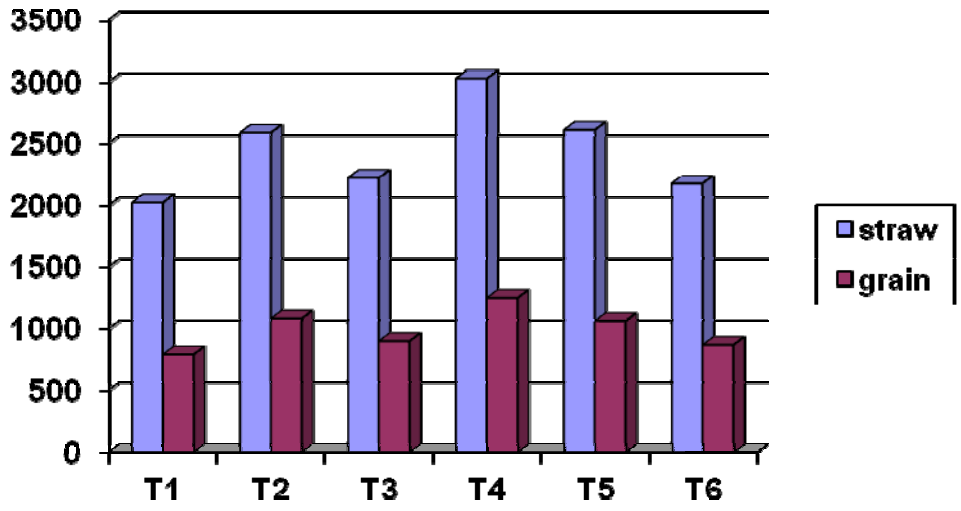


Fig 1: Effect of treatments on wheat grain and straw weight (kg/ha)

Statistical analysis of experimental treatments on wheat grain and straw showed that using the subsoiler treatment with a mean grain yield of 1252 kg and 3023 kg/ ha straw had the highest production. Effects of treatments on 0-30 and 30-60 cm soil moisture was significant at 1% level And 4th (T4) experimental treatments (use of subsoiler) with 17.76 percent by weight of soil moisture is high compared to other treatments.

Table 2: Average effects of treatments on soil bulk density gr/cm³

CV	T6	T5	T4	T3	T2	T1	Treatment
5.84%	1.3	1.267	1.233	1.256	1.289	1.3	bulk density gr/cm³

Considering the bulk density of soil treatments was not statistically significant, but the lowest of the 4 treatments (T4) was (use of subsoiler) with a mean of 1.233 gram per cubic meter /cm. highest bulk density was related to the treatment of rollers (Table 2). Clay and silty clay soils that was important in respectively Related with soil bulk density value of 40/1 and 45/1 gram per cubic meter per centimeter exceed do was plant growth will be disrupted.

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The effects of valonia oaks residues on runoff, soil loss and infiltration under laboratory conditions

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Abstract
This study was carried out to determine the effects of valonia oaks residues on runoff, soil loss and infiltration in laboratory conditions with 3 replicated. Six soil samples with loamy sand, sandy loam and clay loam textures were used in this study. Soil samples, which were mixed by valonia oaks residues that its were weighted of 0, 10 and 20% of soils, were placement into an erosion plot, 30 x 45 x 15 cm sized, and under a drain pipe at 9% slope to measure runoff, soil loss and infiltration under laboratory conditions. Simulated rainfall was applied 70 mm h^{-1} on an erosion plot by a rain simulator with Veejet 80100 type nozzle during 60 minutes. According to study, valonia oaks residues decreased runoff and soil loss ($r = -0.747^{**}, -0.629^{**}$; $P < 0.01$) significantly, but no significant effect were found on infiltration.
Keywords: Runoff, soil loss, infiltration, mulch, rain simulatör.

Introduction

Turkey defined as an agricultural country, has been quickly begin to lose its soils which is one of the most important natural resources since the entry into the process of industrialization. Soil surfaces are vulnerable to erosion by cause uses of lands for other purposes, intensive tillage of soils, and destruction of natural vegetations on lands. For these reasons, the result in terms of dimensions and measures should be taken against water erosion. These measures include that using of plant residues (stubble, and mulch) also has an important place. Taysun (1986), found stubble mulch was very effective on preventing erosion than stone cover and PVA (polyvinyalcohol) treatments under simulated rainfall conditions, significantly. Gallagher et al. (1996), found that mulch decreased runoff and soil loss under simulated rainfall conditions, significantly. Brandt and Wildhagen (1998), applied bush materials as mulch on soil surface and than applied simulated rainfall on soil surface. It was found that, bush materials as a mulch decreased infiltration than controls, significantly. Kwaad et al. (1998), found that corn mulch were effective on decreasing soil loss, but mulch were not effective on decreasing runoff in natural and simulated rainfalls experiments conditions. Edwards et al. (2000), reported that mulch were decreased soil loss at 50% rates, and increased infiltration at 5% rates. Lacey (2000), applied wood wastes on parcels sloped 21% and sized 20 x 5 m, by spread on soil surface or by mixed soils. He reported that, wood wastes were decreased runoff and soil loss 80 – 90% and 95% at rates, respectively.

Materials and Methods

In research, valonia oaks residues and 6 soil samples (50–80 kg), has different physical and chemical properties, were used as experimental materials. Soil samples and valonia oaks residues were dried at normal atmospheric conditions under the laboratory conditions. A part of experimental soils, air-dried were passed through a 2 mm sieve (Richards 1954) to be used in some physical and chemical analyses, and other part of experimental soils were also passed through an 8 mm sieve for erosion research (Mollenhauer and Long, 1954). Texture (Bouyoucos, 1962), pH, (US Salinity Lab. Staff, 1954), dispersion rate (Middleton, 1930), erosion rate (%) (Akalan, 1967), lime (%) (Schlichting and Blume, 1966), soluble total salt (%) (Soil Survey Staff, 1951), and organic content (Black 1965) of the soil samples were analyzed. Aggregate stabilities of the soil samples were analyzed by Yoder's Wetting Sieved Methods (U.S. Salinity Lab. Staff, 1954) and calculated using Kempler's formula (Black 1965). The perforated erosion plots sized 30×45×15 cm under a drainage pipe (Taysun 1986; Abrahim and Rickson, 1989) were used. Erosion plots were filled a 7 cm very coarse sand layers in this experiment, and this layers were smoothed by hand carefully. After a fine cloth (cheese cloth) was lay on the sand layer, erosion plots were filled by 5 cm soil samples

with mixed by valonia oaks residues (0, 10 and 20% of soil samples weights) (Ben Hur and Keren, 1997). The simulated rainfall (70 mm h^{-1}) was applied to erosion plots at 9% slope for 1 hour from a height of 2.50 m (Bubenzer and Meyer, 1965). After starting the simulated rainfall, runoff start times were measurement by using a stopwatch and recorded (Taysun, 1986). During the simulated rainfall experiments, runoff and sediment samples were taken in each 10 minutes and infiltration were collected in during the every 5 minutes.. At the end of the rainfall applications, the runoff containers were left for 24 hours in order for the sediment to settle in the containers. Then the sediment samples were dried in an oven at 105 ^{0}C. Runoff and sediment amounts were recorded and tabulated (Taysun, 1986). A completely randomized experimental parcel, designed with 3 replications was used for statistical analysis of the data. Data were analyzed by using an SPSS statistical package program (SPSS, 1999) in this experiment.

Results and Discussion

Some physical and chemical properties of soil samples in used the experiment are given in Table 2. The experimental soils have different physical and chemical properties. Differences in physical and chemical properties of soils affect soil erosion differently (Akalan, 1967). As a known, dispersion rates and erosion rates are the most important indicates of soil erosion. In the experiment, dispersion rates varied from 19.35 to 53.78% and erosion rates varied from 15.90 to 67.30. It is considered that, soils have no resistance to erosion, when dispersion and erosion ratios are higher than 15 and 10%, respectively (Akalan, 1967).

Table 1. Some physical and chemical properties of soil samples in used experiment.

Sample No	Sand (%)	Silt (%)	Clay (%)	Texture	Skelation (%)	Aggregate Stability (%)	Disp. Ratios (%)	Erosion Ratios (%)
1	86.40	10.00	3.60	LS	12.37	13.79	47.92	32.74
2	52.40	34.00	13.60	SL	11.75	8.61	53.78	50.14
3	54.40	36.00	9.60	SL	31.83	20.99	46.00	53.38
4	78.40	14.00	7.60	LS	42.97	23.65	41.18	33.54
5	60.40	23.60	16.00	SiL	2.70	21.64	51.42	67.30
6	44.88	27.64	27.48	CL	14.58	36.31	19.35	15.90

Sample No	pH	Total Soluable Salt (%)	Lime (%)	Organic Content (%)	C.E.C (cmol kg^{-1})
1	7.89	iz	0.765	0.41	4.675
2	7.79	0.055	1.280	1.19	10.000
3	7.36	0.053	1.016	1.19	10.650
4	7.51	iz	0.677	0.23	6.525
5	7.34	iz	1.810	0.10	19.800
6	7.64	0.078	13.920	3.66	25.275

Runoff, soil loss and infiltration from the experiment are given in Table 2. It is shown that, valonia oaks residues mixed with soils (0, 10, and 20%) were decreased runoff and soil loss, whereas its were increased infiltration, generally. But, these residues were not effective on decreasing runoff in soil no:2, significantly. According to Table 1, soil no: 2 has the lowest aggregate stabilities (Akalan, 1967). According to some research, mulch applied on soil were not effective on runoff (Kwaad et al., 1998). Whereas, mulch were found effective on decreasing runoff by Lacey, (2000).

Table 2. Measured runoff, soil loss and drained water in the experiment.

Treatments (%)		Sample No						
		1	2	3	4	5	6	Mean
Runoff ($mm\ h^{-1}$)	0	29.29 A	33.43 A	31.28 A	31.06 A	37.11 A	36.70 A	33.15 A
	10	28.91 A	32.31 B	24.55 B	20.84 B	29.49 B	17.94 B	25.67 B
	20	14.66 B	32.32 B	12.54 C	10.14 C	18.70 C	21.33 C	18.28 C
$LSD_{0.05}$		0.499	0.380	0.309	0.285	0.306	0.232	7.269
Soil loss ($g\ m^{-2}$)	0	208.45 A	659.16 A	198.30 A	301.26	404.94 A	387.05 A	359.86 A
	10	63.11 B	484.31 B	146.48 B	105.86 B	100.46 B	133.00 B	172.20 B
	20	13.90 C	301.48 C	20.63 C	42.51 C	55.86 C	107.69 C	90.35 B
$LSD_{0.05}$		0.681	0.942	0.650	0.718	0.905	0.667	181.081
Drained water ($mm\ h^{-1}$)	0	13.70 AB	2.08 C	5.68 C	10.61 C	4.77 B	2.06 C	6.48 A
	10	12.00 B	2.65 B	12.98 B	17.05 B	9.02 A	11.73 B	10.91 A
	20	14.51 A	3.49 A	15.64 A	20.58 A	4.40 B	13.90 A	12.09 A
$LSD_{0.05}$		2.326	0.448	0.271	0.364	0.377	0.239	6.770

Valonia oaks residues mixed with soils decreased soil loss compared with controls in this experiment. These findings were supported by some researches (Taysun, 1986; Gallagher et al., 1996). Data were analyzed by using an SPSS statistical package program (SPSS, 1999) in this experiment. The relationships between treatments to runoff, soil loss and infiltration are given in Table 3 and analyses of varience of experimental results are given in Table 4.

Table 3 The relationships between treatments to runoff, soil loss and infiltration in the experiment.

	Treatments	Runoff	Soil loss	Infiltration
Treatments	1.00	-	-	-
Runoff	-0.747**	1.00	-	-
Soil loss	-0.629**	0.763**	1.00	-
Infiltration	-	-0.764**	-0.739**	1.00

Table 4. Analyses of varience of experimental results.

	Resource of variation	df	Sum of squares	Mean square	F(calculated)	F (Table)	
						0.05	0.01
Runoff	Between groups	2	662.76	331.38	9.494**	3.680	6.360
	Within groups	15	523.56	34.90			
	Total	17	1186.32				
Soil loss	Between groups	2	229108.29	114554.15	5.288*	3.680	6.360
	Within groups	15	324931.89	21662.13			
	Total	17	554040.19				
Infiltration	Between groups	2	104.69	52.35	1.729^{ns}	3.680	6.360
	Within groups	15	454.20	30.28			
	Total	17	558.89				

Increasing treatments ratios reduced runoff and soil loss ($r = -0.747^{**}, -0.629^{**}$; $P < 0.01$) significantly (Taysun, 1986; Gallagher et al, 1996). Due to rainfall impact effects, dispersed soil particles filled into macropores of soils (Scheffer and Schachtschabel, 1993). Thus, treatments didn't effect on drained water, significantly. Similar findings were found by Brandt and Wildhagen, (1998). In this experiment, the effects of valonia oaks residues treatments on runoff, soil loss and infiltration were found statistically significant according to the LSD test ($P< 0.05$).

In conclusion, it was found that mulch decreased runoff and soil loss significantly, whereas, mulch decreased drained water, gradually in the experiment. Therefore, plant wastes should be applied on soils by mixing or spreading.

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Optimizing Land Use to Minimizing Surface Runoff by Management

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Abstract
Runoff generated from rainfall is one of the most important phenomenons in watersheds and its control reduces water loss and its damages. Predicting the impact of land use changes on the hydrological response is crucial for water resource management. In the present study, an optimization problem formulated for the Jajrood watershed, Tehran province, Iran to find out the most suitable land allocation to different land uses, viz. orchard, range and irrigated farming targeting runoff minimization. The amount of surface runoff was computed using the Soil Conservation Service (SCS) method in three scenarios of 1) existent land uses with no any change in their land management, 2) existent land uses with some land management and 3) standard land uses and management. Surface runoff, land use and land capability maps were provided as inputs to formulate the objective function and governing constraints in a linear optimization problem. The optimal area of land uses in each scenario was determined by simplex method, as well as, sensitivity analysis was conducted to recognize more effective land use in reducing surface runoff. Results demonstrated that the amount of surface runoff could reduce by 0.39, 36.70 and 73.03 percent in the first, second and third scenarios, respectively, in case of implementing optimal allocation of the study land uses. The results of sensitivity analysis indicated that the area of orchard and irrigated lands are the most sensitive parameters in the constraints of surface runoff minimization problem.
Keywords: Land use management, Linear programming, Optimization, Surface runoff

Introduction
More and more marginal areas in the world have been using for agriculture as land pressure rises. These areas are mostly situated in the arid or semi-arid regions where rain falls irregularly and much of the precious water is soon lost as surface runoff.
The vital resources of almost entire watersheds in Iran have been subject to rapid deterioration in the past few decades resulting from expanding human activities. The Iran Forest and Rangeland Nationalization, Act of 56 (fixing and controlling of governmental national land) was influential in decreasing land use conversion and restoring many of resources. Despite its progress, mismanagement and over exploitation of basin resources still remain as main threats to the basins in Iran (Sadeghi at al., 2008). This is more important than other challenges because of their complex nature and the existence of diverse and diffuse contributing land uses within the basins (Farahpour et al., 2004).
The lack of harmony between environmental conservation and the economic goals are challenges facing land use planners and decision makers in many developing countries (Chang et al., 1995; Gezelius and Refsgaard, 2007). Suitable environmental planning needs special consideration on land use optimization.
Optimizing land use in watershed scale, especially agriculture as one of the significant contributors to the environmental contributors, is consequently essential to achieve sustainable development (Seppelt and Voinov, 2002; Heilman et al., 2003; Wang et al., 2004). Sadeghi et al. (2008) used a goal programming in Brimvand watershed, Iran, to minimize soil erosion and maximize farm production of each land use. The results indicated that the benefit and amount of soil erosion could respectively, increase and reduce 18.6% and to the tune of 7.9, in case of implementing optimal allocation of the study land uses. Nikkami et al. (2008) investigated the effect of land management in the Sohrain Gharacharian floodwater spreading station in Zanjan province, Iran, on the volume of surface runoff on hillslopes. The amount of surface runoff on 0-12, 12-20 and 20-40% slopes reduced 83, 88 and 57% with an average of 76%, respectively.
Nikkami et al. (2009) used a multi-objective linear programming model for three different land use scenarios including existing land uses without land management, existing land uses with some degree of land management, and suitable land uses and land management for minimized soil

erosion and maximized people's net income in an Iranian watershed. The results indicated that in the optimal situation, the area of orchards should be increased by 377%, irrigated farms should be decreased by 73% and dry farming lands should be reduced by 88%. In existing land use some land management implementation, reduces soil erosion by 37% and increases benefit by 206%, while in suitable land uses and management, soil erosion reduces by 53% and benefit increases by 208%.
Considering scarcely documented researches in the area of land use management and protecting watershed resources by applying optimization approaches, the present study has been conducted to optimize land resources allocation to orchard, rangeland and irrigated cropland in the Jajrood watershed in the east Tehran province, Iran, using a linear programming approach to minimize surface runoff.

Materials and methods

The study area shown in Figure 1, is about 187384 ha, located in the south east of Tehran province and a part of Qom province, Iran, between 35º 06´ 34´´ to 35º 48´ 07´´ North and 51º 20´ 30´´ to 51º 55´ 56´´ East. This watershed is characterized by cold winters, hot summer and semiarid climate condition with an average annual precipitation of 265.4 mm. Minimum, maximum and average annual temperatures are 22.8, 9.2 and 16.1 °C, respectively. Maximum and minimum elevations are 2531 and 810 above sea level, respectively. Jajrood watershed consists of different land uses including orchard, irrigated farmlands, rangelands, urban areas and others with the land areas of about 1904, 80909, 66113, 13879 and 24177 ha, respectively.
The land use maps in the studied area were prepared using 2010 Landsat 7 (ETM^+) satellite images. The land use map in standard situation has been prepared based on the present land resource and available land capability studies (Office of Engineering and Studies, 2008). The amount of runoff was calculated by SCS method (Soil Conservation Service, 1972), for each precipitation and their total was considered as annual runoff in each sub basin. After combination of land use and runoff map in GIS environment, the amount of runoff was determined for each land use in cubic meter per area unit.

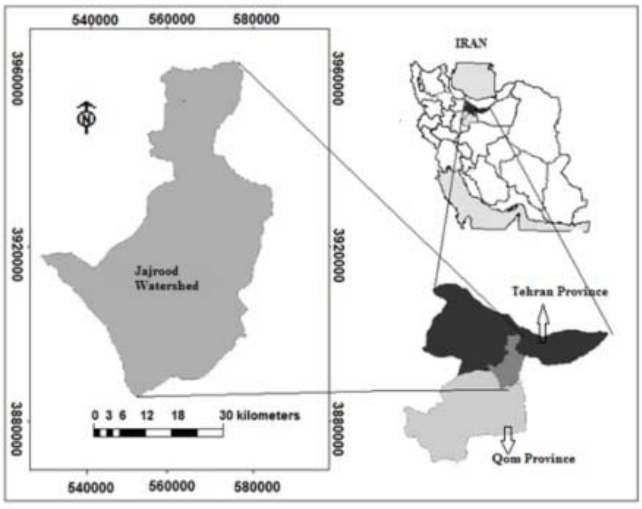


Fig.1_ General schematic view of Jajrood watershed, Iran

Based on linearity of objective function and constraints, a linear programming model was applied for three different scenarios of land use and land management. Scenario1) Existent situation of land uses and land management; Scenario 2) Existent land uses with some degree of land management; Scenario 3) Optimum land uses with proper land management.

The general form of runoff minimization problem can be expressed as:

$$Min(Z) = \sum_{i=1}^{n} C_i X_i \quad (1)$$

Subject to:

$$\sum_{i=1}^{n} X_i = B \quad (2)$$

$$X_i \geq 0 \quad (3)$$

Where: Z is the total annual runoff (m^3), C is the amount of annual surface runoff per area unit (m^3 ha^{-1}), X is the area of each land use (ha), B is the total land area (ha) and n stands for numbers of land uses. The objective function of the surface runoff minimization problem for mentioned three scenarios were formulated as:

$$Min(z) = C_1X_1 + C_2X_2 + C_3X_3 \quad (4)$$

The above objective function was then subjected to the following constraints:

$$X_1 \geq B_1 \quad (5)$$

$$X_1 \leq B_2 \quad (6)$$

$$X_3 \geq B_3 \quad (7)$$

$$X_2 \geq B_4 \quad (8)$$

$$X_1 + X \leq B \quad (9)$$

$$X_1, X_2, X_3 \geq 0 \quad (10)$$

$$X_1 + X_2 + X_3 - B_6 \quad (11)$$

Where: X_1 ،X_2 and X_3 are areas of orchard, range and irrigated farm, respectively. C_1 ، C_2 and C_3 are annual runoff per area unit (m^3 ha^{-1} yr^{-1}) of orchard, range and irrigated farm, respectively. B_1 is the minimum area of orchards (ha), B_2 is the maximum area of orchards (ha), B_3 is the minimum area of irrigated farms (ha), B_4 is the minimum area of ranges (ha), B_5 is the maximum area of orchards plus irrigated farms (ha) and B_6 is total area of orchards, ranges and irrigated farms. Because of not being able to make changes in the use of urban, rock and badlands, these areas were deleted from land use optimization model.

Results and Discussion

Tables 1 to 3 indicate the area of each land use and computed surface runoff in each scenario. The amount of surface runoff in scenario 3 was computed using the results of Nikkami et al. (2008).

Table 1- Computed surface runoff in scenario 1, Jajrood watershed, Iran

Land use	Area (ha)	CN	Runoff (m^3 yr^{-1})	Runoff (m^3 ha yr^{-1})
Orchard	1904.27	61.08	7426.653	3.9
Range	66113.63	77.37	6271538.942	94.86
Irrigated farm	80909.53	83.73	1763827.754	21.8
Total	148927.43		8042793.349	

Table 2- Computed surface runoff in scenario 2, Jajrood watershed, Iran

Land use	Area (ha)	CN	Runoff (m^3 yr^{-1})	Runoff (m^3 ha yr^{-1})
Orchard	1904.27	50.34	4455.9918	2.34
Range	66113.63	74.9	3701702.144	55.99
Irrigated farm	80909.53	81.28	1410253.108	17.43
Total	148927.43		5116411.243	

Table 3- Computed surface runoff in scenario 3, Jajrood watershed, Iran

Land use	Area (ha)	CN	Runoff (m^3 yr^{-1})	Runoff (m^3 ha yr^{-1})
Orchard	10603.58	49.52	11769.9738	1.11
Range	59166.57	70.19	1468514.267	24.82
Irrigated farm	79157.28	79.81	612677.3472	7.74
Total	148927.43		2092961.588	

The objective function of the runoff minimization problems for each scenario was formulated as follows:

Scenario 1:

$$Min(z) = 3.90X_1 + 94.86X_2 + 21.80X_3 \quad (12)$$

Scenario 2:

$$Min(z) = 2.34X_1 + 55.99X_2 + 17.43X_3 \quad (13)$$

Scenario 3:

$$Min(z) = 1.11X_1 + 24.82X_2 + 7.74X_3 \quad (14)$$

Scenario 1 and Scenario 2, were then subjected to the following constraints. Considering no limitation for water availability for all land uses, the maximum allowable area of 1904.27 was contemplated for orchard as:

$$X_1 \geq 1904.27 \quad (15)$$

The surface area of existing orchard is 1904.27 ha, but it could be increased to 6946.89 ha. The reason is that the areas of irrigated farms with slope classes more than 5% could be changed to other land use especially orchards.

$$X_1 \leq 6946.89 \quad (16)$$

Considering the slopes below 5% and very deep soil (>100 cm) (Rastegar, 1992), the maximum area of 79157.28 ha could be designated for irrigated farming.

$$X_3 \geq 79157.28 \quad (17)$$

Government regulation (Iranian forest and rangeland nationalization, Act of 56) required that the rangelands should be legitimately no less than 66113.46 ha in this watershed.

$$X_2 \geq 66113.63 \quad (18)$$

Total area of orchard and irrigated farms could not be more than 86556.08 ha due to limitation of water sources for these two land uses.

$$X_1 + X_3 \leq 86556.08 \quad (19)$$

The next constraint is the sum areas of the three land uses of orchard, range and irrigated farm that should be equal to the allocable area of 148927.26 ha.

$$X_1 + X_2 + X_3 = 148927.43 \quad (20)$$

The last constraint is the non-negative variable declaration

$$X_1, X_2, X_3 \geq 0 \quad (21)$$

Scenario *iii* was subjected to the following constraints:

Considering no limitation for water availability for all land uses, the maximum allowable area of 1904.27 was contemplated for orchard as:

$$X_1 \geq 1904.27 \quad (22)$$

The next constraint indicates the maximum area of orchard based on land capability studies.

$$X_1 \leq 10603.58 \quad (23)$$

Considering the slopes below 5% and very deep soil (>100 cm) (Rastegar 1992), the maximum area of 79157.28 ha could be designated for irrigated farming.

$$X_3 \geq 79157.28 \quad (24)$$

The fourth constrain is minimum area of ranges based on land capability studies should not be less than 59166.57 ha.

$$X_2 \geq 59166.57 \quad (25)$$

Total area of orchard and irrigated farms could not be more than 86556.08 ha due to limitation of water sources for these two land uses.

$$X_1 + X_3 \leq 86556.08 \quad (26)$$

The next constraint is the sum areas of the three land uses of orchard, range and irrigated farm that should be equal to the allocable area of 148927.26 ha.

$$X_1 + X_2 + X_3 = 148927.43 \quad (27)$$

The last constraint is the non-negative variable declaration

$$X_1, X_2, X_3 \geq 0 \quad (29)$$

Table 4- Result of land use optimization in scenario 1, Jajrood watershed, Iran

Land use	Allocated area (ha)	Runoff (m^3 yr^{-1})	Runoff (m^3 ha yr^{-1})
Orchard	3656.52	14260.428	3.9
Range	66113.63	6271538.942	94.86
Irrigated farm	79157.28	1725628.704	21.8
Total	148927.43	8011428.074	

Table 5- Result of land use optimization in scenario 2, Jajrood watershed, Iran

Land use	Allocated area (ha)	Runoff (m^3 yr^{-1})	Runoff (m^3 ha yr^{-1})
Orchard	3656.52	8556.2568	2.34
Range	66113.63	3701702.144	55.99
Irrigated farm	79157.28	1379711.39	17.43
Total	148927.43	5089969.791	

Table 6- Result of land use optimization in scenario 3, Jajrood watershed, Iran

Land use	Allocated area (ha)	Runoff (m^3 yr^{-1})	Runoff (m^3 ha yr^{-1})
Orchard	7398.8	8212.668	1.11
Range	62371.35	1548056.907	24.82
Irrigated farm	79157.28	612677.3472	7.74
Total	148927.43	2168946.922	

The surface runoff minimization in the Jajrood watershed was solved with the help of LINGO software, which is capable to solve linear problems using the simplex method.

The results indicated that after applying land use optimization, the amount of surface runoff has decreased in all three scenarios. In scenarios 1 to 3 the annual surface runoff reduction was 31365.27 m^3 yr^{-1} (0.39 %), 2953848.12 m^3 yr^{-1} (36.70 %) and 5873846.427 m^3 yr^{-1} (73.03%), respectively (table 4 to 6).

In addition results showed that there was no serious change in irrigated farming and rangeland areas whereas the orchard area with a very small quantity of land occupancy has been increased from 1904.27 to 7398.60 or by 3.88 times. Moreover, ranges and irrigated farms should be reduced from 66113.46 to 62371.38 ha and from 80909.53 to 79157.28 ha, respectively.

It is environmentally as well as economically preferred that some uses, to be changed to orchards, since the steep slope areas with high surface runoff rate and less production is traditionally converted to level terraces by the farmers when they develop orchards. It also has to be clarified here that prior to change, the land needs to be precisely surveyed to avoid any hazardous unexpected problem.

The conversion of the existent land uses to optimal solution may not be certainly used in the field and it may be less attractive because of the governing conditions on farmers' life in the study area. Providing the educational and extensional services by the local authorities are therefore seriously required to encourage the farmers too really, obey the laws and keep in line with the optimal solution. The results of the study proved that the linear programming was successfully solved using the LINGO software program (Chamheydar et al., 2011).

The applicability of linear programming in solving optimization problem was proved in minimizing runoff (Yeo et al., 2004; Hargreaves and Hobbs, 2009). In the scenario 1, the amount of runoff has

been decreased due to allocating some parts of rangeland and irrigation farm to orchard after optimization and change in hydrological properties.
Reasons for notable reduction of runoff in the scenario 2 and 3 were allocating some parts of rangelands and irrigation farms to orchard and assuming the application of somewhat managements such as crop rotation, changing irrigation system in the irrigated farm, interdict in the rangelands and planting alfalfa in the orchards.
The results show that the changes in objective functions in all three scenarios are mostly affected by reduction and increasing of resources and are linear. Also, the change of some allocations created much more impact on the optimal solutions performed by the linear programming (Nikkami et al., 2009).
Increasing orchard and irrigated lands area resulted in a severe decrease for runoff. In the scenario 1, 2 and 3, increasing rangelands increased runoff severely because of rangelands have the most amount of surface runoff per area unit. Considering the existent limitations, if the total land uses area increases, due to increasing of rangelands area the runoff increased severely.

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An Investigation on the effect of aquifer management on the quality and quantity of range (product, density, soil conservation, soil cover and plants canopy cover) in kuhdasht aquifer

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Abstract
Water is one of the important vital gifts that if it was utilized irregular and irrational, it would be changed to catastrophic flood. Water floods cause to destroy foundation of ecosystem which is soil as well as to contaminate around of deposition environment which could be a threat for men and environment; so both accurate management practices and inattention to water could change it as a gift or a calamity. Aquifer management is one of the most important management methods which utilize and manage water sources. Due to being new subject, there is need for research, monitoring and assessment. The study was conducted in aquifer of Kohdasht and adjacent rangelands by using of quadrates 1 m^2 and systematic method by measurement of canopy cover factors of rangelands, Product forage, litter, stone and gravel, soil cover and fresh and multiplying of plants in level of quadrates. To measure production and utilization, clipping and weighting method was used up concerning each species and palatability classes. Besides, field survey method for providing floristic list and species diversity was used. At last, repetition of these activities was done out of aquifer so that to compare and investigate the effect of these function on plants cover. Most of these factors show the difference at the level of 1 and 5% inside and outside of aquifer level. For example, there are significant difference at canopy cover percentage between inside (82.75%) and outside (29.95 %) of aquifer. Also, there are difference of 1 % related to pasture production which are 1347 kg/ha and 212 kg/ha for inside and outside of aquifer, respectively. In addition, we can see these differences in soil cover, density and per cent of stone and gravel. However, results didn't show significant difference at litter contents. From diversity point of view, genome was richer in aquifer compared to outside of aquifer. Predominance of desirable species was one of the mentioned aquifer characteristics.
Keywords: vegetation, quality, quantity, range, aquifer

Introduction
Essential and vital human demand of water led to make great concern in their mind on supplying of water issues so that they had to dig Qanats or academically use aquifer management with increasing permeability of the soil and aquifer levels. Moreover, the vast areas of Iran are located at arid latitudes. On the other hand, the large majority of Lorestan province is located in Iran-Turan climate and arid forests sub-region on critical climate classification (Mobarakiyan, 1994). Therefore, optimum utilizing of water is very special concern in this region. Consequently, Kuhdasht aquifer, with 3000 ha effective area in east of Kuhdasht (45600 ha) and mean annual precipitation of 440 mm, considered as an examination station for underground substrates supplying functions. Although, the impact of this function on various critical factors like vegetation cover of rangelands as an effective source of changes was markedly mentioned so as to investigate quantitative and qualitative affects on rangelands indices in this paper.

Material and methods
The study was undertaken in the delineated station of aquifer and adjacent regions by using of random- systematic method and an area of 1 m^2 for each plot with sampling of canopy cover, pasture production, litter, stone and gravel, bare soil and fresh and multiplying of plants factors in level of plots. Then, clipping and weighting method was used up concerning each species and palatability classes. After that, the samples were put in autoclave at 70 ° C takes 24 hours. To estimate production, dry matter was calculated, and field survey method was used for floristic list and species diversity along five transects (100 m) and four plots in each transect as well as repetition of these activities out of mentioned aquifer. In order to compare and investigate on the effects of activities on plants cover, Analysis of variance (ANOVA) by *Mstatc* software was

carried out. Range condition and range condition trend were determined by using of inventive method of American Forestry Association and rating approach to vegetation cover and soil as called form No.2 respectively (Moghadam, 1999). Also, regarding to taken coefficient of classes of palatability and multiplying at production in each class, herbage mass was computed.

Results

Investigation on effects of aquifer on canopy cover

The results of analysis of variance of canopy cover (table 1) showed that there is a significant difference at the level of 1 % at canopy cover percentages between inside and outside of aquifer basin. In addition, comparison of means with Duncan test indicated that the average of canopy cover with 82.75 and 29.95 percent for inside and outside of aquifer basin showed significant difference at the level of 1 and 5 % respectively. Results of analysis of variance of this factor are given at following (Table 1).

Table 1. Analysis of variance of canopy cover in and out of aquifer

Sources	df	MS	F
repetition	19	9.95	2.5
Canopy cover	1	27878.4	727.99**
error	19	38.29	
total	39		

Investigation on the effect of aquifer on pasture production inside and outside of aquifer basin

Assessment of results of ANOVA of production showed that there is a significant difference between total productions inside and out of aquifer at the level of 1 and 5 %. Also, means comparing with Duncan test indicted that the average of production with 137.42 and 21.17 g/ m^2 for inside and out of aquifer basin showed a significant difference at the level of 1%. Results of analysis of variance of this factor are given at (Table2).

Table 2. Analysis of variance of production inside and outside of aquifer

Sources	df	MS	F
Repetition	4	251.16	585.0
Production	1	33782.83	78.63**
Error	4	429.63	
Total	9		

Investigation on the effect of aquifer on species density inside and outside of aquifer basin

To investigate density of species, palatable species *Viciea villosa* and *Astragalus spp.* were selected as key species, and were counted at the level of plot (1 m^2) inside and outside of aquifer basin. The results of ANOVA of density data showed that there is a significant difference at the level of 1 % inside and outside of basin. Moreover, comparison of means of density with number of 27.75 and 1.85 showed a significant difference at the level of 1 and 5 % between inside and outside of basin (Table 3).

Table 3. Analysis of variance of key species density inside and outside of aquifer basin

Sources	df	MS	F
Repetition	19	30.65	1.04
Density	1	6708.1	228.45**
Error	19	29.36	
Total	39		

Investigation on the litter condition inside and outside of aquifer basin

There isn't a significant difference between litter contents with mean of 5.25 and 5.65 inside and outside of aquifer basin respectively (Table 4).

Table 4. Analysis of variance of litter in and out of aquifer basin

Sources	df	MS	F
Repetition	19	11.94	1.25 ns
Litter	1	1.6	0.16 ns
Error	19	9.55	
Total	39		

Investigation on the stone and gravel condition inside and outside of aquifer basin

The results showed that stone and gravel significantly were affected at the level of 1 %. The average of stone and gravel were 22.05 and 5.35% inside and outside of basin, respectively. Duncan results illustrated that content of stone and gravel was higher out of aquifer basin about 16.7% (Table 5).

Table 5. analysis of variance of stone and gravel inside and outside of aquifer basin

Sources	df	MS	F
Repetition	19	72.86	1.76 ns
Stone and gravel	1	2788.9	67.49 **
error	19	41.32	
total	39		

Investigation on bare soil content inside and outside of aquifer rangelands

The ANOVA results showed that bare soil significantly was affected at the level of 1 %. In addition, comparison of means implied that bare soil percentage out of basin was higher (42.35 %) compare to inside of basin with 6.65 % at the level of 1 %. The results are given at (Table 6).

Table 6. Analysis of variance of bare soil inside and outside of aquifer rangelands

Sources	df	MS	F
repetition	19	107.89	1.388 ns
Stone and gravel	1	12744.9	163.94 **
error	19	77.74	
total	39		

Discussion

With superficial regard to aquifer and outside of aquifer can be estimated that the aquifer management has had significant and positive impacts on rangelands. It converted *Astragalus spinosa-Euphorbia* type (with very poor condition and negative trend) to collection of palatable legumes like *Astragalus spp-Vicieae villosa-Medicago spp- As.dictyophysus-Astragalus homosus-Lensse orvensis- Lathyrus-Onobrychys spp- Trifilium* (with good condition and positive trend).Also, It minimized the presence of spurge. Besides, soil color was changed from grayish white to brownish gray which indicates increase of organic matter in aquifer. On the contrary, there are significant changes respect to statistical results and analysis. For example, canopy cover percentage of class 1 species in aquifer (38.5%) compared to out of aquifer (3%) indicated that aquifer management is an opportunity for revealing capacity of basin. With attention to production in aquifer (1374 kg/ha) compare to out of aquifer (211.7 kg/ha) implied that not only did aquifer management improve soil and plant condition but also it impacted livelihood of rural people and livestock. However, biomass differences got less due to involving annual growth (desirable

samples). But, plants biomass was involved, so undesirable samples were considered. Exclosure made increase production with significant differences. Due to the fact that herbage mass and livestock were calculated for pasture production, good production is related to quality and rehabilitation rangelands in aquifer.

From erosion and soil conservation point of view, means differences were at the level of 1 % and bare soil and stone and gravel percentage were less inside of aquifer. In aquifer, suitable Vegetation covers resulting in increasing soil permeability as well as considering of underground substrate.

But what is remarkable is the lack of significant difference between litter percentages in two basins. The reason is that it seemed litter were higher in aquifer, although litter contents were high out of the basin due to the dead biomass, presence of invaluable plants from soil conservation point of view and grass production like *Acanthus* and *Acanaceous* family. Because *Acanthus* wither on June and in summer by monsoons were harvested and transported to other places, and rangeland soil related to out of aquifer due to loss of vegetation is exposure to precipitation and splash erosion (ghadiri, 1994). Moreover, sequential droughts cause withers vegetation out of aquifer. Anyway, with investigation on differences in two basins inferred aquifer is effective on rangelands rehabilitation and improvement. Also it minimized water problems and enhanced condition, trend and production of rangelands. On the other hand, aquifer management introduced compilation of mechanical and biological functions as an effective mechanism for improving rangelands condition as well as quantity and quality factors of rangelands.

In conclusion, regarding to mentioned differences in this paper and positive trend and good condition of aquifer, poor condition and negative trend outside of aquifer, density that was higher about 15 times and others factors considering, it could be inferred that aquifer with supplying of underground substrates significantly impacted on rangeland condition. Therefore, it suggested improving storage functions consist of mechanical practice in aquifer up to capture precipitation and reduce plants water problems resulted in improving rangeland condition.

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Resistance Of Soils To Anthropogenic Stress In Oilfield Kenkiyak

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Abstract:
The soil surface in Kenkiyak deposit is represented by light chestnut and floodplain soils that are subject to oil pollution, causing big changes in soil properties, which sometimes lead to their degradation. Soils are contaminated by spills or releases of layer fluid consisting of crude oil, gas, oil, wastewater, groundwater and drilling solutions, and on the surface the bituminized crusts are formed, which further degrade and disintegrate. Oil content (NP) in soil samples only in some samples (51,4-990 mg / kg soil) does not exceed the MPC, but mainly the pollution reaches 1425-464500,9 mg/kg. of soil.
Effect of granule metric composition on the share resistance of soil in mechanical impact is the main factor in determining the degree of sustainability of the soil to technogenic loads. According to the content of physical clay in the soil the 70% of deposits refer to light and only 30% to heavy. Consequently, medium and heavy soils, granule metric composition are more sustainable to various anthropogenic influences. In the exploitation of the deposit the anthropogenic load exceeds the capacity of soils performance of their ecological functions. Mechanical soil disturbance is associated with the overload of small buffer soils by technology, exploration, construction and maintenance of the infield and trunk gas pipelines. The dimensions of the land area allocated in the deposits to the wells is 2.5 ha. But these standards are not kept. Thus, the total area of the deposit is 3728.9 ha, there are 2490 wells in this area, therefore, there is 1.5 ha of land. Decrease in the area of the norms under the well is 60%. The close location of the wells leads to widespread oil-contaminated of soils within the field.
Conducted studies show that in terms of the content of physical clay the light-chestnut and floodplain soils of the deposit can be classified as **resistant, moderately resistant and nonresistant** to the human made stresses.
Keywords: light chestnut, floodplain soil, oil pollution, sustainability, granulometric composition.

Chemical and Biological Sand Fixation and Air Dust Control by Some Polymers and Cyanobacteria

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Abstract

Wind erosion and related air dusts are the most important sources of atmospheric pollution in arid zones. The main objective of the research was to compare the efficiency of some water soluble polymers and Nostoc cyanobacteria in soil particle flocculation and wind erosion control. The experiment was performed as a completely randomized design including 11 treatments and 3 replications. Two concentration levels of four synthetic water soluble polymers, and soil inoculation with *Nostoc SP* at two moisture levels (FC and 80 % FC) were compared with the control. One and four percent of Polyacrilamid polymer were sprayed to the soil surface for crust formation. On the other hand, 1 and 6 percent of three other polymers (Karacoat NA58, Acrylic resin EXP 174, and water soluble vienyl acetate) were added to the surface of soil columns. Micrometer and penetrologer were used to measure the thickness and the degree of cementation, respectively. Both the crust thickness and resistance to penetration provided by the treatments were significant ($P<0.01$). The highest (8.13 Cm) and lowest (0.66 Cm) crust thicknesses were provided by Karacoat NA 58 and vienyl acetate, respectively. The most penetration resistance (0.902 MPa) was obtained by 6 % concentration of Acrylic resin EXP 174 polymer. Nostoc cyanobacteria created the lowest resistance to penetration (0.176 MPa). Results of the crust thickness showed that 80% FC level of cyanobacterial inoculation, 4% of Polyacrilamid spraying and addition of 6% Karacoat NA58 were the most efficient treatments comparing to the control treatment.

Keywords: Air dust control, arid zone, cyanobacteria, polymer, surface crust.

Effect of Municipal Sewage Sludge Application on Microbial Biomass and Activity of Soils

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Abstract

In this study the effects of municipal sewage sludge application on microbial biomass and activity of agricultural lands were determined. For this purpose the sewage sludge that stabilized with lime were taken from IZSU-Çiğli Waste Water Treatment Plant of İzmir Metropolitan Municipality and were applied in 5 different doses (1, 2, 3, 4, 5 t da^{-1}) to İzmir Menemen Plain soils. The studies were carried out for 24 months and the effects of sewage sludge application on microbial biomass, CO_2-production, enzyme activities of dehydrogenase, alkaline-phosphatase and β-glucosidase, and N-mineralization were investigated.

The results showed that the application of sewage sludge, especially 5 t da^{-1}, significantly increased the microbial biomass-C, CO_2-production, N-mineralization, the activities of dehydrogenase, alkaline-phosphatase and β-glucosidase. The levels of the increases were between 19 to 35%, 14 to 58%, 32 to 125% and 24 to 102% for microbial biomass-C, CO_2-production, N-mineralization and enzyme activities respectively. The positive effect of the applications on microbial biomass and enzyme activity of the soils were attributed to high organic matter content of the sewage sludge. The fact that the heavy metal level of the sewage sludge was under the highest limit allowed by the Soil Pollution Control Regulation (SPCR) and the sewage sludge was applied one time were play a great role on these increases.

Keywords: Municipal Sewage Sludge; Microbial Biomass; Soil Enzymes; N-Mineralization.

SOIL GENESIS AND CLASSIFICATION

ORAL PRESENTATIONS

Effect of Salinity Regime on the Playa Surface Types

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Abstract
There are many playas in desert regions of Iran that their areas varies from several hectares to several thousands hectares. Most these playas are markedly dry playa. Virtually every process and feature of landforms in such as playas can be directly or indirectly related to the ground-water regime (depth and composition) and salinity regime. Result of these controls is appeared in the various types of playa surface. Additionally processes of accumulation and deflation (wind erosion) appear to be locally controlled by the nature of the groundwater. The study area is located in Semnan province and called Damghan playa (Haj Ali Gholi playa) with area of 239000 ha. The surface of mentioned playa has different forms that called landform or geomorphology facieses. According to studies on topography maps, aerial photos and satellite image and also field observation selected a transect from mountain front to playa in south part of mentioned playa. Field samples were made at dry period. Geomorphologic studies in Damghan playa showed that playa unit is formed from 2 types and 4facies. Digging Profiles done on the geomorphologic facieses. Studies showed that morphogenesis of geomorphology facieses closely related to salts of ground water. Outer facieses of playa (Nebka and puffy surface) have suitable texture within 1-2 m of the ground water table and hence within the capillary fringe. Some soil horizons are not saline (EC<4 ds/m) and the entire soil not sodic. Unlike the soils on the puffed surfaces are saline and sodic. These particularly control by sulfate zone. Inner and center facieses of playa affected by ground water level, and characterize chloride zones of maximum groundwater discharge. Development of these Facieses is determined by the salinity regime of the groundwater and by the discharge as controlled by piezometric levels. Facieses of this section is including wet zone and kavir. All of their soils are saline and sodic.
Keywords: Playa, Geomorphology facieses, Wet zone, Chloride zones, Nebka, Puffy surface

Introduction
In the desert regions of Iran there are many playas (more than 60 playa), that area of them varies from several hectares to several hundred hectares (figure1). These playas are known Kavir (salty desert), Shagh, Dagh (clay pan). All of these playas are divided in two types including dry playa and humid playa. In arid playa, geomorphologic properties (playa surface types or landforms) are more affected by surface water region and wind erosion. While in humid playa, geomorphologic properties are more affected by ground water properties especially level of water table and mineral combination. Damghan playa is one of the humid playa of Iran.

Materials and Methods
General description of the study area
The studied area is located on the south of Damghan town in the center of Iran and its boundary is approximately in coordinates 54° 27′ to 55° 30′ eastern longitudes and 35°, 47′ to 35°, 58′ northern latitudes (Figure 2).The area of Damghan watershed is about 239000 ha, and playa area is 46600 ha, its altitudes is varied from 1051 to 1350 m above the sea level, consequently the average elevation is 1150 m from sea level; the climate is arid with the average rainfall 148 mm.
General slop of this area is less than 15%, but major parts of the study area are covered with topographic slope less than 5%.

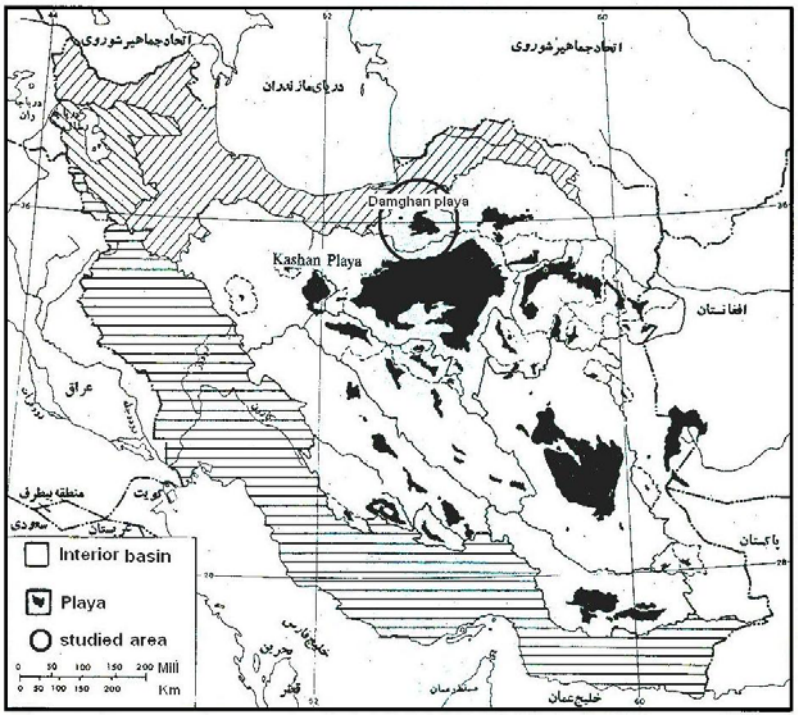


Fig 1: Interior basins and playas of Iran, from Krinsley, 1970

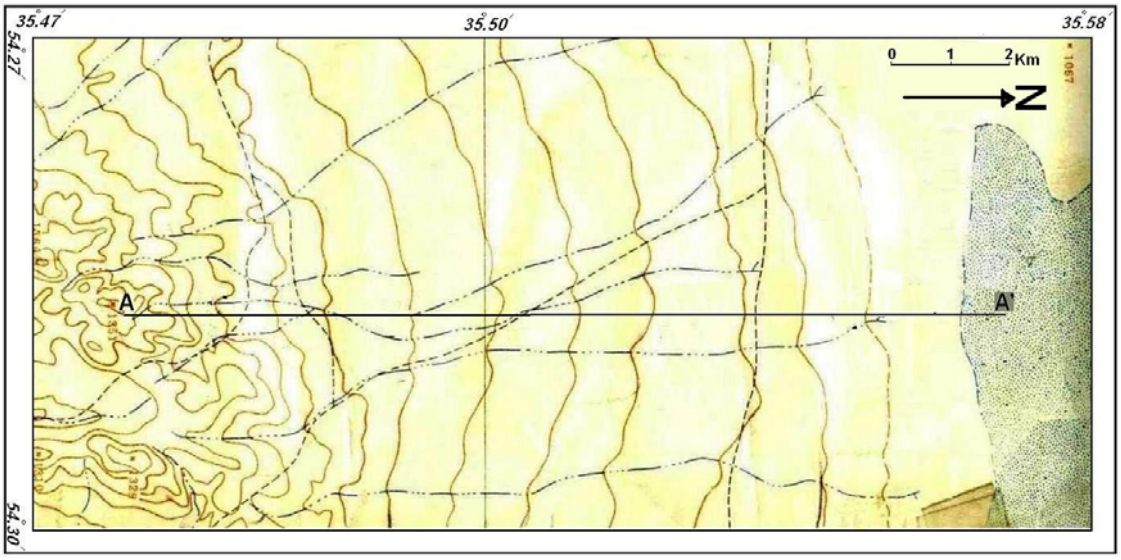


Fig.2. Topographic condition of study area

Material

This study was done based on following documents:

1. Topography maps (scales 1:50000, 1:250000), in order to prepare region base map and determination of physiographical characteristics.
2. Geologic map (scales 1:100000). This map done to study lithology and tectonic characteristics and relations of these in shaping studied region.
3. Aerial photos with scale 1:50000 and 1:20000, for interpretation geomorphologic facieses (land forms) characteristics of the studied region.
4. Preparing geomorphologic map based on aerial photo interpretation, topography maps and geology map.
5. Field observation for complementing geomorphology studies and also profile digging in order to soil sampling.

Methods

Using of mentioned documents, the following method was carried out:

1. Interpretation of aerial.
2. Preparing geomorphologic facieses map based on aerial photo interpretation.
4. Field observation for complementing geomorphologic facieses studies.
5- Studying soil properties.

Results

Geomorphology

Geomorphology studies showed that Damghan playa was consisted of 1 unit (Playa unit), 2 types (clay flat, Kavir) and 4 facies (Puffed lands, lands with solution sinks, Wet zone and Salt crust) (Fig.3, Table 1).

Table 1: Geomorphologic characterizes of Damghan playa

Unit	Type	Facies
1-playa	1-1-clay flat	1-1-1- puffy surface
		1-1-2- Lands with solution hollow
	1-2- kavir	1-2-1- Wet zone
		1-2-2- Salt crust

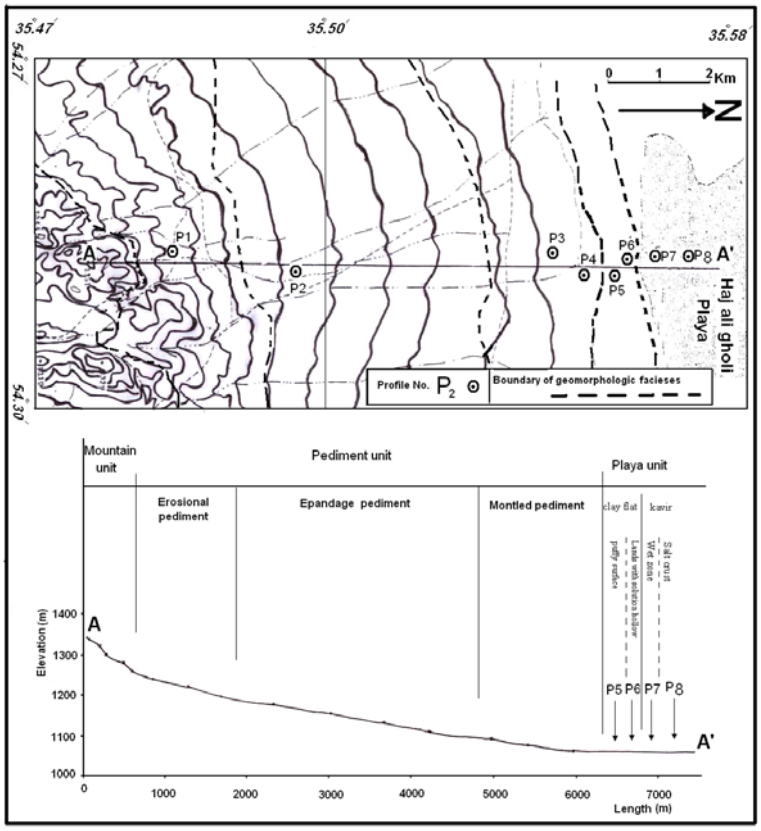


Fig.3. map of geomorphologic facieses



Fig.4. Nebka and puffy surface



Fig.5. soil sampling

Lithology

According to the geological map (Iran Geology Organization, 1991) and sediments of the studied area are related to quaternary age. It includes two units as Clay flat (QC) and Mud sediments (QM) (figure6).

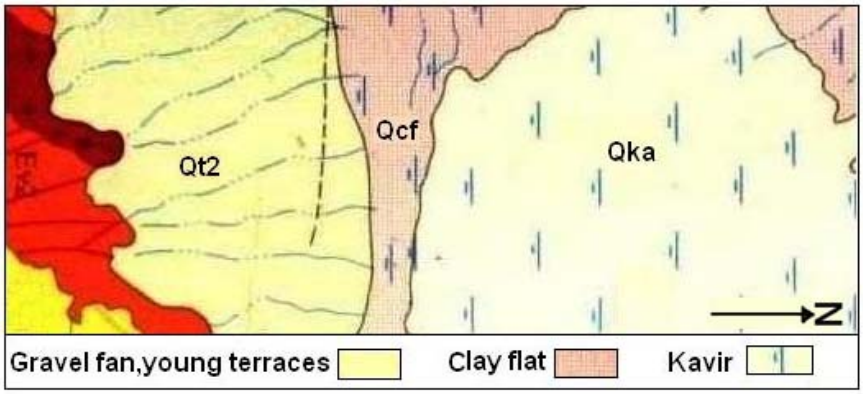


Fig.6: Geologic map

Pedology

These studies carried out on geomorphologic facies (Table2, 3). Laboratory result of soil samples showed that soil types of study area are saline-sodic soils.

Table2. Texture of geomorphologic facies

geomorphologic facies	Profie No.	deep	Texture- %		
			sand	silt	clay
puffy surface	5	0-5	66	24	10
		>5	70	22	8
Lands with solution hollow	6	0-5	26	50	24
		>5	–	–	–
Wet zone	7	0-20	26	42	32
salty clay	8	Salt crust			

Table 3. Chemical properties of geomorphologic facies

geomorphologic facies	Profie No.	deep	chemical properties						
			pH	SAR	ECe (ds/m)	Ca+ Mg	Na (meq/lit)	CO3ca %	So_4ca %
puffy surface	5	0-5	8.04	573.2	192	78	3580	23.8	22.7
		>5	8.15	181.0	102.3	100	1280	22.6	41.1
Lands with solution hollow	6	0-5	7.70	583.6	200.0	94	4000	15.2	34.0
		>5	7.60	193.5	130.6	152	1687	11.4	45.6
Wet zone	7	0-20	7.16	191.7	174.8	368	2600	15.9	50.1
salty clay	8	Salt crust							

Discussion

The three inter-related determinants of the nature of playa surface are the hydrologic, sediment and salinity regimes. The key to this lies in the influence of the wavetable on the playa surface. Virtually every process and feature of playa can be directly or indirectly related to ground-water regime.

In the studied playa, the mechanical analyses (Table 2) indicate that the clay content of samples increases proportionately with increasing distance from the edge of playa to interior of the playa(from 10 to 32 percentage). These variations in granulometry can be influenced on capillary movement of groundwater.

The soil chemistry analyses show which has involved two sets of soil properties, one cation content and the other anion content. Both cation and anion contents depend upon the well-known relationship between the water soluble salts.

The relative solubilities of salts determine zonation of salts on the playa floor that called landforms such as puffy surface, lands with solution hollow, wet zone, salty clay. Each landform also has a vertical layering reflecting the movement of salts in solution. Vertical layering is related to flooding and drying cycle. In drying period (mentioned study) salts with high solution occur at the surface and salts with low solution blow, such as Profiles No.5 (N+ , 3500 meq/lit in surface horizon to 1280 meq/lit in below horizon), and 6.(N+ , 4000 meq/lit in surface horizon to 1687 meq /lit in below horizon), but , in landforms with high moisture such as wet zone which remains moist and soft for much of the time. Contents of water soluble salts decrease in surface horizon (N+ , 2600 meq/lit in surface horizon at comparison with 3500 and 4000).The zone tends to be occupied by halophytic phreatophytes, which are excluded from the centre of the playa by excessive salinity. Based on table 2, calcium sulphates (Gypsum) contents have been increased from outer landforms (puffy surface) toward interior landforms (Wet zone). It would seem that in the lowest part of the playa with shallow watertable, chlorides and sulphates occur at the surface, because of increasing groundwater discharge; sulphates have more mobile and being the most rapidly precipitated of the main constituents of playa waters.

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Ability of Indicator Kriging to map the soil series distribution: A case study in central Iran

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Abstract
There are plenty of various techniques for mapping the distribution of categorical variables, but most of them demand high level of knowledge and technical support. Despite the ability of these techniques to predict the distribution of soil taxa, near to all are involved with prediction of high level soil categories (Soil Taxonomy sub great groups, or FAO great group) only. To use and manage the land resources in higher scales, there are indeed need to have detailed soil data and information which are mostly covered by detailed soil surveys (i.e. soil series map). There are a few studies involving with prediction of soil series in literature. To show whether a simple interpolation method, like Indicator Kriging, can be a benefit in this concern or not, this method was used to map the soil series distribution in eastern part of Isfahan province of central Iran. This method was then compared with a semi-detail soil survey method which has been carried out in the same area with the same model and validation data. The accuracy and purity of the maps were evaluated by error matrix, kappa index and RMSE. These indices were calculated through crossing the predicted and observed values of series via a validation set of data. The crossing between validation and model data resulted in OA=60%, kappa=0.47, RMSE=0.89 for IK and OA=75%, kappa=0.69, RMSE=0.59 for semi detailed method of prediction. As the validation results show, the accuracy of IK predicted map is lower than semi-detailed soil survey map and prediction error of IK method is considerably higher therefor it's better to use this method for reconnaissance studies.
Keywords: DSM, Soil Series, Indicator kriging.

Introduction

Traditionally, boundaries are drawn around similarly classified observations to construct choropleth soil maps. These maps are then regarded as predictors of the unknown classes at unvisited locations. Usually, in such studies, the boundaries of map units on a choropleth map are determined in the field or from aerial photographs and additional information such as geology, vegetation and topography. However, the way that the boundaries are drawn remains to some extent intuitive. Most of the data generated in a soil surveying programs are routinely recorded qualitatively, being either ordinal or nominal (Bregt et al., 1992). The quality of choropleth maps can be investigated by taking sufficient additional random observations. Apart from its partial subjectivity, the classical method of predicting categorical data from choropleth maps has other drawbacks. The map purity, a measure of the quality of the map, can be obtained only by additional sampling. Furthermore, the map purity which is thus obtained is spatially invariant within one map unit and independent of the number of borings taken and the classes found at the observations. However, if a class is predicted at an unvisited location, the uncertainty of this prediction should be larger if the surrounding observations all belong to different classes. This uncertainty should decrease when more borings are placed around the location of the prediction. The classical method, i.e. predicting categorical data by making choropleth maps and assessing the map purity afterwards, does not account for these effects.

To overcome on subjectivity of prediction and assess the uncertainty of prediction at each point the pedometric approaches are introduced. It is difficult to interpolate qualitative data using traditional geostatistical methods because these techniques generally focus on the description and prediction of quantitative variables. There are plenty of various techniques for mapping the distribution of categorical variables, but most of them demand high level of knowledge and technical support. Despite the ability of these techniques to predict the distribution of soil taxa, near to all are involved with prediction of high level soil categories (great groups, in Soil Taxonomy or FAO methods) only. There are a few investigations trying to map the soil series in literature. Using a simple and efficient method

to map the soil series is important for variability matching of disciplines in environmental processes through the amalgamation programs. One of the most familiar techniques for such mapping is the indicator method which is introduced by Journel (1983). The indicator approach is used to describe the spatial variability of categorical soil data. Indicator kriging is used to obtain conditional probabilities of soil data classes at un-sampled locations (Bierkens and Burrough I 993a, b). This paper uses indicator kriging (Journel, 1983) as a method for estimating the conditional probability of occurrences of soil series found at the observation points. The estimated conditional probabilities are then used to predict the unknown classes at unvisited locations.

Objectives of the Study

The objective of this study is using IK to map the distribution of soil series in Hassan Abad area in central Iran. Then the results are compared with a semi-detail soil survey method which has been carried out in the same area.

Material and Methods

Study area

The Hassan Abad area with 7789 hectares is located on south east of Isfahan, 130 Km far. The region has hot and arid climate with 84 mm annual rainfall which falls in winter. The annual evaporation is extremely higher than annual rainfall. Soil moisture and temperature regimes are Aridic, Thermic consequently.

Geomorphic stratification

Aerial photos were interpreted using the bases presented by Zinck (1988). The delineation was imported to Ilwis and attributed with the legend defined on categorical bases of Zinck. The area comprises of some little mountains, alluvial fans and differently evolved bajadas (younger ones near mountain and elder ones far from the mountain front). All of parent material of these landforms is brought from Cretaceous Limestone Mountains being placed in south of studied area.

Sampling

The sample points were designed to be on nods of a 1000 m grid in stratified land units. In some central places, where soil surface was more undulating, the nods were 500 m apart. One hundred and twenty profiles were excavated, described and all genetic layers sampled. Genetic and morphologic characteristics of soil layers were all identified and noted. The samples were air dried and sieved for physic- chemical analyses.

Traditional soil mapping

Electrical conductivity and soil reaction values of all soil samples, texture of some samples were analyzed. Complete physico-chemical analyses, the amount of Gypsum, Lime, and Organic matter were measured in laboratory for representative samples. Anion, cation, SAR and ESP were measured in saline samples. The soils were classified using American Taxonomy (Soil Survey Staff, 2010) Using analytical data and based on field observations, the soil series were distinguished, mentally delineated and mapped in ilwis GIS.

IK mapping of soil series

As the classified soil profiles indicate, there are nine different soil series in study area. At first the transformed indicator files were defined for each soil series. Each point in these files gets zero if the target series is not assigned and gets one if is assigned. Experimental indicator variograms were computed for indicator data of soil series; therefore each series would have a separate indicator that had its own variogram. The individual indicator variograms were modeled in ilwis GIS. Indicator kriging requires a variogram model for each indicator, which can be problematic as mentioned above. It is also computationally intensive if there are many indicators because each has to be kriged separately, and finally the predictions have to be post-processed to ensure consistency of the estimated local probabilities. In this case, predictions of the individual indicators can be made by ordinary kriging using the model parameters of the appropriate indicator variogram with the binary data for that indicator. The result is a map of the probabilities that a particular indicator (soil series) is present or

absent. The whole procedure is defined by Carry and Oliver (2007). After prediction of all series in study area the values of probabilities were normalized for all nine series then combine them to produce the soil series map of the study area.

Validation

The accuracy and purity of the maps (kriged and traditionally produced soil maps) were evaluated by error matrix, kappa index and RMSE. These indices were calculated through crossing the predicted and observed values of series via a validation data set.

Results and discussion

The soils were classified in nine soil series in study area (Table 1) by traditional approach. Off course these were considered the basic series to be predicted in un-sampled points in IK approach.

Table 1- Family and soil series classification of soils distinguished in study area.

Physiography	Soil Survey staff (2010)		No. of Soil Series
	Soil Family	Sub groups	
Young gravely alluvial sloping landforms	Loamy -skeletal, Mixed, Thermic	Typic Torriorthents	1
Gravely undulating bajadas	Loamy-skeletal, Carbonatic, Thermic	Typic Haplocalcids	2
		Calcic Haplosalids	3
		Typic Calcigypsids	4
	Loamy-skeletal, Gypsic, Thermic	Gypsic Haplosalids	5
	Fine-loamy, Gypsic, Thermic	Gypsic Haplosalids	6
		Typic Haplogypsids	7
		Typic Calcigypsids	8
	Fine-loamy, Carbonatic, Thermic	Calcic Haplosalids	9

After transforming the absence (0) or existence (1) of each soil series in sampled points, the experimental indicator variograms were computed for indicator data of soil series in Ilwis GIS. The prediction of soil series were done by Ordinary Kriging. Figure 1, as an example, shows the posted indicator data (0, 1) of series No. 2, traditionally delineated soil series and IK predicted probability values of series No. 2 to be present in all pixels (the values have a color legend). The fitted models on experimental indicator variograms with the parameters are presented in Table 2.

Table 2- Fitted models on experimental indicator variograms with the parameters

Soil Series	Nugget	Sill	Range (m)	Fitted model
1	0.3	1	7000	Spherical
2	0.6	1.15	7000	Spherical
3	0.9	1.02	6000	Circular
4	0.8	1.25	9000	Spherical
5	0.8	1.3	8000	Spherical
6	0.8	1.2	8000	Spherical
7	0.6	1.15	6000	Spherical
8	0.9	1.3	8000	Spherical
9	0.3	0.9	8000	Spherical

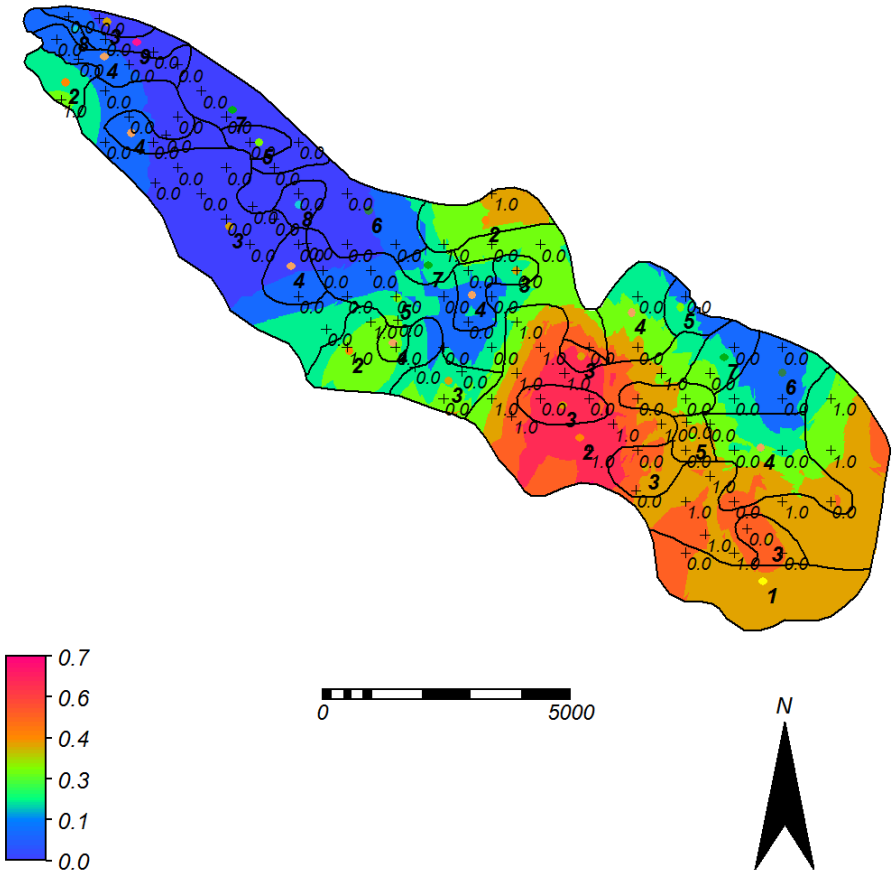


Figure 1- Posted transformed indicator values of Series No. 2 (0 and 1), Series traditionally delineated polygons and numbers, IK predicted probability values of presence and absence of Series No. 2 in study area.

Predicted distributions of soil series do not have the same scale of legend values; therefore in combining presses of soil series may arise some difficulties. The probability values based on legends should be normalized to have the same scale. Then the Max command will combine and produce the soil series map. Figure 2 shows the IK predicted soil series map in the study area.
The accuracy and purity of the IK predicted and traditionally mapped soil series were assessed by error matrix, kappa index and RMSE. These indices were calculated through crossing the predicted and observed values of series via a validation set of data (twenty points which did not used for modeling). The crossing between validation and model data resulted in OA=60%, kappa=0.47, RMSE=0.89 for IK and OA=75%, kappa=0.69, RMSE=0.59 for semi detailed method of prediction. As the validation results show, the accuracy of IK predicted map is lower than semi-detailed soil survey map and prediction error of IK method is considerably higher therefor it's better to use this method for reconnaissance studies.
Lower values of evaluation processes may be due to; 1- smallness of the data set and sparse sampling of diverse field, 2- All geostatistical model predicted results completely depend on the amount of points present in local search area of kriging procedure. By this, in some less homogene locations, the output will omit the sparse soils. 3- The combining procedure may omit some soils when allocating series to each pixel using the probability values.

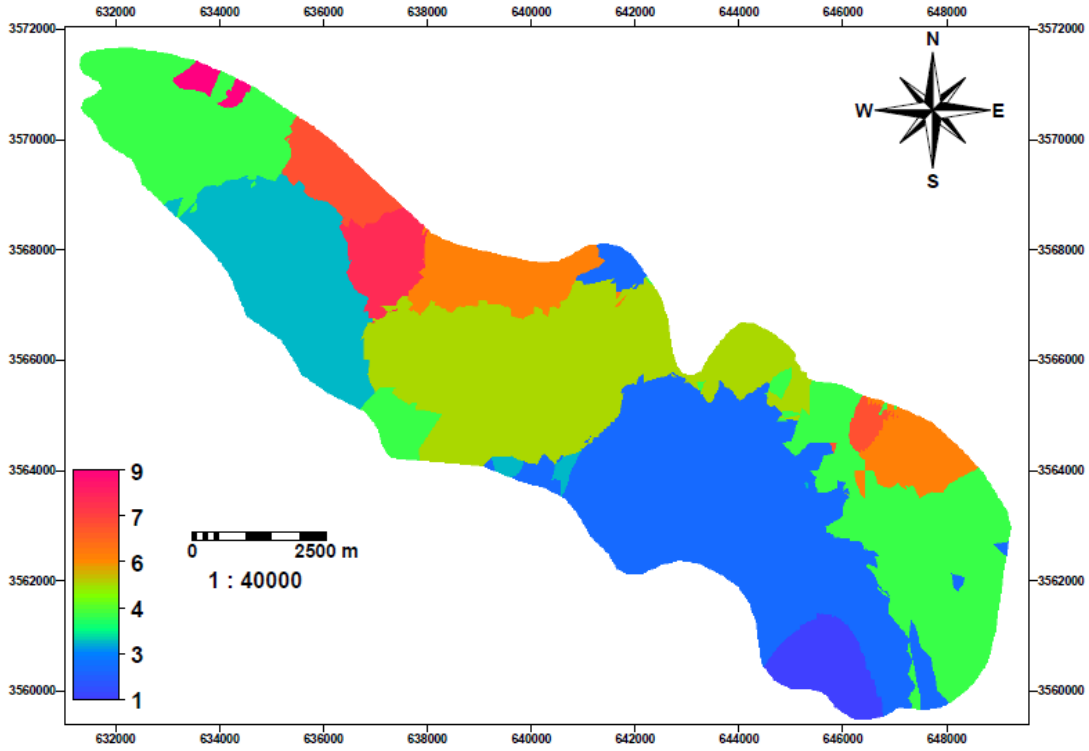


Figure 2- Soil series map predicted by IK in study area.

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Amount Lability of Zinc and sorption its by different soils at the presence of Potassium and Sodium Cations and Phosphate, Nitrate, and Chloride

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Abstract

This study was conducted to investigate the effect of common cations and anions on Zn sorption and lability characteristics. Zinc sorption isotherms were conducted on two acid, two calcareous and two gypsiferous soils in K^+, Na^+, $H_2PO_4^-$, NO_3^- and Cl^- backgrounds solution. The total amount of Zn sorbed within the experimental concentration range was higher in gypsiferous soils than that in calcareous soils and acid soils. Of the two cations, the greatest Zn sorption was in the Na^+ background, followed by K^+ backgrounds. Because of the Na^+, the large hydrated ionic size; it forms only outer-sphere complexes with clay mineral surfaces, whereas K^+ is able to form inner-sphere complexes with mineral surfaces. Zinc sorption was enhanced by $H_2PO_4^-$ as opposed to Cl^- or NO_3^- in acid soils, but it was decreased in calcareous and gypsiferous soils except in the G2 soil. Strong buffering by KH_2PO_4 maintained relative lower pH ranges in its soil–solution mixtures compared with the other electrolytes. Therefore the strong acidity of $H_2PO_4^-$ could dissolve a certain quantity of $CaCO_3$ in these soils, which could not only decrease the total carbonate surface for Zn sorption but also release more Ca ions to compete with Zn for surface sites of aluminosilicate clays. It is also increased H^+ may also compete with Zn for clay exchange sites. The sorbed Zn was partitioned into labile and nonlabile pools by extracting with DTPA-TEA at the end of sorption experiment. The results shown that in all soils total sorbed Zn is nonlabile. About 90% of the total sorbed Zn by all soils was nonlabile. The presence of $H_2PO_4^-$ caused more nonlabile Zn than Cl^- or NO_3^-.

Keywords: gypsiferous soils, DTPA-TEA, sorbed Zn, lability

Introduction

Zinc is considered a trace element in soils. The specific minerals controlling the activity of Zn^{2+} in soils are not known. Since Zn is easily adsorbed by mineral and organic components in most soil types, it normally accumulates in the surface horizons (Kabata-Pendias and Pendias, 2001.).

Zn is one of the elements which are essential in small amounts, but can be toxic in high concentrations (Siegel, 2002). Zn sorption capacity correlates with soil contents of aluminosilicate clays, metal oxides and carbonates (Saha et al., 2001). The effect of major cation and ionic strength on the chemistry of Cd, Cu, and Zn in alkaline sodic and acidic soils has been investigated by Fotovat and Naidu (Fotovat and Naidu, 1998). Increasing ionic strength was found to decrease Zn retention in acid soils but did not have any significant effect in calcareous soils (Shuman, 1986). Additional ionic strength, cation and anion affected in Zn sorption. Wang and Harrell (2005) showed that NH_4^+ and K^+ equally decreased Zn sorption as opposed to Na^+ in acid and calcareous soils; NH_4^+ yielding 4 to 12% more adsorbed Zn in the labile pool as compared to K^+ in acid soils. They showed that the effect of background ions on the lability of adsorbed Zn varied between acid and calcareous soils. There are few studies that link the relationship of Zn sorption with its lability and cation, anion in soils, and its relationship with soil minerals. The objective of this study was to investigate Lability of Zinc and sorption its by different soils at the presence of Potassium and Sodium Cations and Phosphate, Nitrate, and Chloride in soils of Fars and Mazandaran provinces, Iran.

Material and Method

Surface samples (0–15 cm) selected of two acid soils were collected from Mazandaran and two calcareous and two gypsiferous soils were collected from Fars province, Iran.

The two acid soils included Typic Argiustolls (A_1), and Typic Haplustolls (A_2). The two calcareous soils were Typic Endoaqualfs (C_1) and Typic Calciustepts (C_2), and the two gypsiferous soils were Gypsic Calciustepts (G1) and Aridic Haplustolls (G2). The soil samples were air-dried and ground to pass through a 2 mm sieve before laboratory analyses. The chemical characteristics of the soils are presented in Table1.

Table1. Some of the chemical characteristics of the soils.

Soil	pH	$CaCO_3$ Equival. (%)	Org. carbon (%)	Gypsum (%)	K^+ (solution) (meq/100 g)	Ca^{2+}(sol.) (meq/100 g)	Mg^{2+}(sol.) (meq/100 g)	Ferrous Ferric (%)	Zn-DTPA (mg/kg)
Typic Endoaqualfs Calcareous (C_1)	7.4	52.8	1.57	-	Trace	124	32.5	0.26	0.394
Typic Calciustepts Calcareous(C_2)	7.4	55	1.14	-	Trace	82	trace	0.04	0.928
Gypsic Calciustepts Gypsiferous (G_1)	7.45	47.5	0.11	5.62	Trace	18	trace	0.02	0.094
Aridic Haplustolls Gypsiferou (G_2)	7.75	18	0.7	33.5	Trace	144	trace	0.25	0.26
Typic Argiustolls Acid (A_1)	6.62	4.77	5.46	-	0.88	4.4	2.2	2.45	14.3
Typic Haplustolls Acid (A_2)	5.38	2.36	3.08	-	0.05	4.8	1.3	4.03	0.88

Zn sorption isotherms

Two-gram subsamples of each soil sample were placed in separate centrifuge tubes and mixed with 20mL of a different electrolyte solution containing 0, 0.5, 1, 3, 5, 10 mM of $ZnSO_4$. The (preweighed) centrifuge tubes were shaked for 24h on a reciprocating shaker. Four 50-mM electrolyte background solutions were used in this study, $NaNO_3$, KCl, KNO_3 and KH_2PO_4 (Wang and Harrel, 2005). Various amounts of Zn-sorbed in nitrate and in K-salts could reveal the effect of cations (K^+ and Na^+) and anions (NO_3^- and $H_2PO_4^-$), respectively.

The use of 50-mM background solutions was to ensure that effects of cations and anions were evaluated at a dominant and constant ionic strength. After equilibrium, samples were centrifuged and the supernatant was filtered through a Whitman No. 42 filter paper. Two replicates were used for collecting each data point. Zn concentration in the supernatant was analyzed by ICP–OES (inductively coupled plasma–optical emission spectroscopy) at a wavelength of 213.8 nm. In the equilibrium solution the amount of adsorbed Zn was found by calculating the difference between the initial and the final concentration. Zn sorption parameters were obtained by fitting experimental data to the mathematical equations termed adsorption isotherms. Adsorption isotherms most frequently used are Freundlich (Freundlich, 1906) (Eq.1), Langmuir (Langmuir, 1916) (Eq.2) and Temkin (Aharoni, and Sparks, 1991) (Eq.3) equations:

$X= KC^{1/n}$ Eq.(1)

$X= (KbC)/(1+KC)$ Eq.(2)

$X=K_1+K_2 \ln C$ Eq.(3)

Where X is the amount of sorbed Zn (mg kg^{-1}), C is the Zn concentration in the equilibrium solution (mg L^{-1}), and K, n, b, K_1 and K_2 are adsorption coefficients. However, the linear forms of Freundlich and Langmuir isotherms are usually used for fit of the adsorption data:

$\log X= \log K+ n\log C$ Eq. (4) $C/X= (1/Kb) + (1/b)C$ Eq.(5)

(X, n, C, K and b as previously described).

Lability of sorbed Zn

A 20-mL DTPA-TEA solution was added to each centrifuge tube containing Zn-sorbed samples. The tubes were then shaken for 2 h on the reciprocating shaker, the samples were centrifuged, and the supernatant solutions were filtered and analyzed for Zn content by ICP OES (inductively coupled plasma–optical emission spectroscopy). The amount of DTPA extracted-Zn was corrected for Zn

concentration in the interstitial solution based on preweighed tubes, soil weight, and solution weight. The corrected DTPA extractable Zn was designated as the labile pool, whereas Zn unextractable by DTPA was considered as the nonlabile Zn.

Results and discussion

The linear form of the Langmuir equation significantly described the fit of the data for Zn-adsorption in all soil samples (Eq. 5 and Table 2). The data also showed a highly significant fit to Freundlich and Temkin adsorption isotherms equations (Table 2).

Effect of cations on the total Zn sorption

The data presented in Fig. 1 and 2 showed that both cations and anions had a considerable impact on Zn sorption, especially at high Zn concentrations. The total amount of Zn sorbed within the experimental concentration range was higher in gypsiferous than calcareous and acid soils. In the studied soils, the largest Zn sorption was observed in the Na^+ background followed by that in the K^+ background. The differences in total Zn sorption caused by different cations were generally reflected in Langmuir sorption maxima for all soils (Table 2). Large-sized hydrated ions such as Na^+ caused to form only outer-sphere metal-clay complexes whereas K^+ is able to form inner-sphere complexes with mineral surfaces (Sposito, 1984). Similar results have been reported for acid sandy soils and Andepts (Winistorfer, 1995; Arias et al., 2005).
In contrast, Winistorfer (1995) reported that concentration of Cu in acidic soils in the presence of Na was lower than that in water extracts and that the concentration of Zn and Cd were higher in Na extracts. The results of this study (Fig.1) clearly showed that K^+ ions reduce Zn sorption in calcareous soils, although such decrease is relatively small, possibly due to large Zn sorption capacity in calcareous soils.

Effects of anions on the total Zn sorption

The effects of anions on the amounts of sorbed Zn were different in acid, gypsiferous and calcareous soils. In acid soils, the largest Zn sorption was observed with $H_2PO_4^-$ followed by Cl^- and NO_3^-, whereas in gypsiferous and calcareous soils, the $H_2PO_4^-$ decreased Zn sorption, with the exception of the G2 soil. In acid soils oxi-anions such as PO_4^{3-} and AsO_4^{3-} can form inner-sphere surface complexes with iron and aluminum oxides that increase negative surface charges (Bolan et al., 1999). The predominance of Fe and Al oxides in acid soils (Table 1) may explain the greater Zn sorption in the $H_2PO_4^-$ treated in acid soils. Wang and Harrell (2005) state that the strong acidity of $H_2PO_4^-$ could dissolve a certain quantity of $CaCO_3$ in these soils, which could not only decrease the total carbonated surface for Zn sorption but also release more Ca ions to compete with Zn for surface sites of aluminosilicate clays. Increasing H^+ may also be due to the competition with Zn for clay exchange sites (Zhu and Alva, 1993). All these could constitute the cause for low total Zn sorption observed for calcareous and gypsiferous soils. Arias et al. (2005) showed that the adsorption of copper and Zn in acid soils depends to a significant extent on pH and CEC. Langmuir sorption parameters showed that in acid soils, the presence of $H_2PO_4^-$ increased Zn sorption maxima as well as the bonding energy value (Table 2). The G_2 soil, which contained lower $CaCO_3$ and higher amorphous oxide-Fe (Table1) have different behavior from other soils. The relationship between the amount of total Zn sorption and the amorphous Fe have been showed by Wang and Harrell (2005). They showed that the regression equation for acid soils with approximately 98.8% of the variation in total sorbed Zn could be explained by amorphous Fe oxide content. Clearly, the integrated effect of very high amorphous Fe oxide content and low $CaCO_3$ content caused an increase, rather than decrease in Zn sorption in the presence of $H_2PO_4^-$ in the G_2 soil. Regardless of the Cl^- and NO_3^- treatments, similar results observed for the Zn sorption in all soil samples by the Langmuir prediction model (Fig. 2 and Table 2). There was no difference in Zn sorption caused by the presence of Cl^- and NO_3^- (Fig. 2). This result was true for both acid and calcareous soils

Table 2.Temkin, Freundlich, Langmuir isotherms parameters and coefficients of determination (R^2) for total Zn sorption by different soils

Soil	Background solution	Temkin†			Freundlich†			Langmuir†		
		K_1	K_2	R^2	n	k	R^2	b ($mgkg^{-1}$)	K (Lkg^{-1})	R^2
Typic Endoaqualfs Calcareous (C_1)	KCl	1574	308	0.97***	1.37	1001.7	0.98***	3333	1	1***
	KNO_3	1300	356	0.97***	2.83	837.1	0.96***	3333	0.25	0.99***
	$NaNO_3$	466	773	0.96***	2.34	612.1	0.80***	5000	0.33	0.99***
	KH_2PO_4	118	388	0.99***	2.87	354	0.96***	2500	0.064	0.98***
Typic Calciustepts Calcareous (C_2)	KCl	284	812	0.98***	0.44	91579.7	0.92***	5000	0.08	0.86***
	KNO_3	500	316	0.95***	2.91	447.1	0.99***	5000	0.03	0.81***
	$NaNO_3$	875	633	0.81***	2.69	742.4	0.98***	2500	0.57	0.99***
	KH_2PO_4	36	317	0.90***	3.17	289.7	0.98***	2500	0.02	0.91***
Gypsic Calciustepts Gypsiferous (G_1)	KCl	640	226	0.64**	0.91	718.8	0.97***	5000	0.5	0.97***
	KNO_3	314	415	0. 77***	1.33	77.2	0.97***	2000	0.032	0.74***
	$NaNO_3$	111	472	0.86***	1.93	306.8	0.92***	2000	0.24	0.85***
	KH_2PO_4	93	57	0.55**	0.90	734.5	0.54**	476	0.27	0.99***
Aridic Haplustolls Gypsiferou (G_2)	KCl	186	471	0.69**	1.85	1.1	0.99***	5000	0.04	0.66***
	KNO_3	1163	684	0.61***	0.55	1.1	0.99***	2500	0.05	0.64***
	$NaNO_3$	1103	746	0.70***	1.52	144.2	0.96***	588	0.02	0.81***
	KH_2PO_4	NS	NS	-	1.02	246.3	0.64**	5000	0.07	0.99***
Typic Argiustolls Aci (A_1)	KCl	235	593	0.99***	0.52	31535.5	0.92**	3333	0.04	0.99***
	KNO_3	633	676	0.98***	1.95	216.1	0.95***	3333	0.03	0.99***
	$NaNO_3$	511	777	0.94***	1.60	170.8	0.97***	5000	0.02	0.99***
	KH_2PO_4	810	785	0.98***	3.06	7337.1	0.97***	5000	0.8	0.98***
Typic Haplustolls Acid (A_2)	KCl	2086	411	0.57**	2.7	862.4	0.59**	129	0.04	0.89***
	KNO_3	143	32	0.95***	1.71	21	0.96***	370	0.06	0.99***
	$NaNO_3$	953	490	0.98***	1.81	81.2	0.99***	1666	0.02	0.97***
	KH_2PO_4	720	159	0.64**	1.04	3163.1	0.66**	4168	0.12	0.99***

† *b* = Sorption maximum; K and k = Bonding energy constant. †K_1= Adsorption coefficients; K_2 = Adsorption coefficients,

† *n* = Adsorption coefficients; NS, **, ***: Not Significant, Significantly at P≤ 0.5 and P≤ 0.1, respectively.

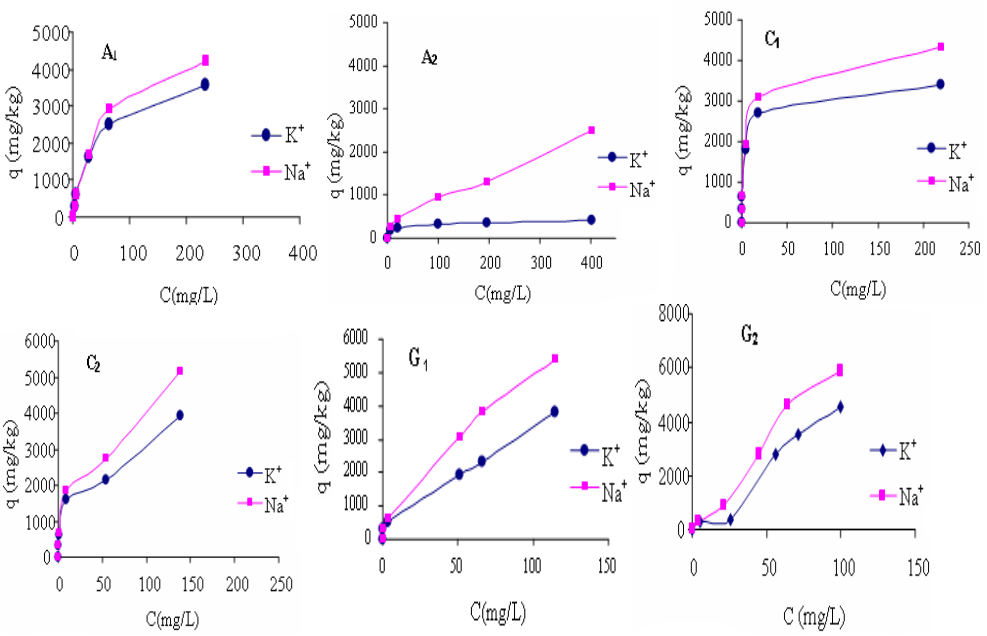


Fig. 1. Zn sorption by two acid (A_1, A_2), two calcareous (C_1, C_2) and two gypsiferous soils (G_1, G2) as affected by different background cations. *C* = Equilibrium solution concentration; *q* = Adsorbed Zn amount.

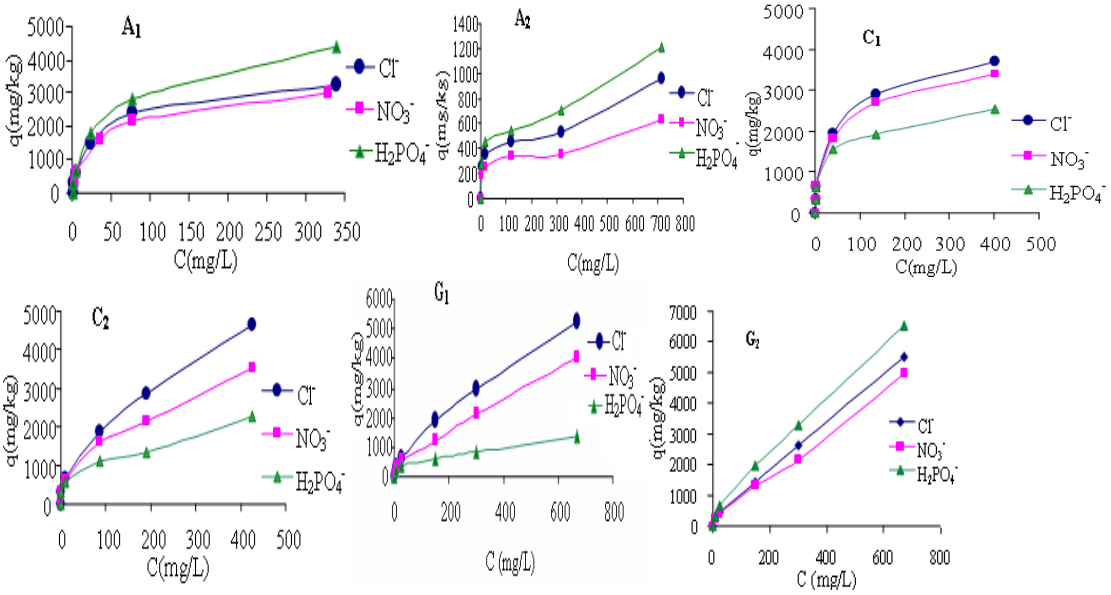


Fig. 2. Zn sorption by two acid (A_1, A_2), two calcareous (C_1, C_2) and two gypsiferous soils (G_1, G2) as affected by different background anions. *C* = Equilibrium solution concentration; *q* = Adsorbed Zn amount.

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Ectomycorrhizal *Russula* Species in Turkish Pine (*Pinus brutia* Ten.) Forests in İzmir

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Abstract
This study has been conducted to determine the distribution of ectomycorrhizal fungi in Turkish pine (*Pinus brutia* Ten) natural forest ecosystems in İzmir Forest Regional Directorate region. A total number of 93 sites were surveyed across the region. Ectomycorrhizal fungi were observed in 75 of these sites. *Russula* species were found in 50 sites which 66.7 percent of the sites having ectomycorrhizal fungi. A total of 31 different *Russula* species were identified in the study sites, some of them are edible. The soil analysis data indicate that sampling sites were suitable for ectomycorrhizal fungi growth (low values in terms of phosphorus, nitrogen and carbonates). With this study, the distribution of *Leccinium lepidum* species was recorded for the first time in Turkey.
Keywords: ectomycorrhizal fungi, forest soils, Turkish pine, Calabrian pine, *Pinus brutia* Ten.

Introduction

Fungi are one of the most important components of forest soils and they strongly affect soil structure, water balance and mineral nutrient availability (Tinker *et al.*, 1992; Marschener and Dell, 1994). Besides fungi themselves or together with other soil organisms are effective on the soil formation processes, they are effective on plant nutrition and health status. Mycorrhizal fungi have an important role on restoration of industrial and mining spoils, tailings or waste hips.

Mycorrhizal associations can be classified to seven groups as (i) arbutoid mycorrhizas, (ii) ectomycorrhizas, (iii) ectendomycorrhizas, (iv) ericoid mycorrhizas, (v) monotropoid mycorrhizas, (vi) vesicular arbuscular mycorrhizas and (vii) orchid mycorrhizas.

Ectomycorrhizal fungi can be found in 90% of the temperate zone trees and each tree may establish an association more than one fungus species at the same time.

The change of the nutritional status on the forest floor can be explained in terms of fungus-plant association succession. As forests are getting older, herbaceous species rich forest floor shaded by large trees, falling leaves (or needles) build up in the litterfall layer, increasing the retention times and this causes litter accumulation. Diversity of the fungi species reaches climax when canopy closure nearly completed. Therefore early mycorrhizal colonies may help plant nutrient uptake from inorganic mineral nutrient pools. However, later occurring fungi cannot utilize large nutrient pools because mineralization value of dead leaves and needles were very low. Such mycorrhizal fungi may exhibit saprophytic characters or may establish some saprophytic associations.

All of the members of Pinaceae family can establish ectomycorrhizas. Also members of the Fagaceae and Betulaceae families, species of *Arbutus* and *Tilia* can establish ectomycorrhizas (Molina and Trappe, 1984).

Ectomycorrhizal fungi commonly observed in acidic soils rather than alkaline soils. However better mycorrhizal formation observed in the soils with low levels of nitrates and neutral pH values. High levels nitrates and limes (calcareous) hinder mycorrhizal growth (Haktanır and Arcak after Kibar and Pekşen, 2007).

Foresters may experience some difficulties and face challenges during the establishment of new forests in some reforestation sites due to the degeneration of some original forest ecosystem characteristics. It is necessary to investigate the reasons behind the loss of some biological and physical characteristics of soils.. As each mycorrhizal fungus build an association with a suitable tree species, every mycorrhizal fungus may not adapt or establish in a given site. For example, mycorrhizal fungi species that would be used in the afforestation sites at the high elevations (mountainous regions should show adaptations to lower temperatures (Moser 1964). Any mycorrhizal fungus cannot adapt every site conditions. In nursery operations, right fungi species from appropriate origin should be selected and should be inoculated to build the right mycorrhizal associations with seedlings (Lehto, 1994).

Turkish pine, also known as Calabrian pine (*Pinus brutia* Ten.), is a medium-size tree, reaching 20–35 meters tall and with a trunk diameter of up to 1 meter, exceptionally 2 meters. The bark is orange-red, thick and deeply fissured at the base of the trunk, and thin and flaky in the upper crown. The needles are in pairs, slender, mostly 10-16 cm long, bright green to slightly yellowish green. The cones are stout, heavy and hard, 6-11 cm long and 4-5 cm broad at the base when closed, green at first, ripening glossy red-brown when 24 months old. They open slowly over the next year or two to release the seeds, opening to 5-8 cm broad. The seeds are 7-8 mm long, with a 15-20 mm wing, and are mainly wind-dispersed. This tree is the most important coniferous forest tree in Turkey. Turkish pine forests can grow on all substrates and almost all bioclimates of the Mediterranean region. They can be found at altitudes of 0–600 m in the northern Mediterranean and 0–1400 m in the southern Mediterranean (thermo- and meso-Mediterranean levels). Optimal development of *P. brutia* forests requires higher rainfalls but accepts a wider range of temperatures (absolute mean minimum temperatures between –5 and +10°C, sub-humid and humid bioclimates) (Fady *et al*. 2003).

Russula is a genus of Russulaceae. *Russula* species, no milky fluid is exuded when the fruitbody is injured. In addition, the flesh can discolor red, yellow, brownish or black. Most species have only complete lamellae, and lamellulae. The pileus is usually brightly colored, either uniformly or with a mixture of different colors, but never concentrically zoned. The pileal margin is glabrous even when young, neither pubescent nor pilose. The lamellar trama in cross section is heteromerous, that is, it consists of mostly subglobose cells.

There were many studies regarding the distribution of the ectomycorrhizal fungi species in Izmir, Turkey (Asbagh and Solak, 2000; Gücin, 1993; Karadeniz and Yaprak, 2011; Solak *et al*., 1999; Solak *et al.,* 2007 and; Yılmaz Ersel and Solak, 2004). The purpose of this study was to determine the ectomycorrhizal fungi species and their distribution in the natural turkish pine (*Pinus brutia* Ten.) forests in İzmir and Manisa provinces of Turkey.

Materials and Methods

Identification of the fungi genera and species was performed by following methods described by Orton (1979), Moser (1983), Philips (1981), Breintenbach and Kränzlin (1984, 1991, 1995, 2000), Harding *et al.* (1996) Kränzlin (2005).

Soil samples were collected from mycorrizal fungi growing sites. The samples were air dried, grounded and sieved by using 2 mm φ sieve (Kacar, 1993). Soil texture was determined by using Bouyoucos hydrometer method (Gülçur, 1974). Total carbonates were determined by using Scheibler calcimeter method (Kacar, 1993). Soil pH values were determined in 1:2.5 soil:water suspension with glass electrode pH-meter (Jackson, 1958). Electrical conductivity (salinity) was determined in 1:2.5 soil:water suspension with using EC-meter (Jackson, 1958). The organic matter content of the soils was determined by following Walkley-Black digestion method (Kacar, 1993). Total nitrogen content of the soil samples were determined by using modified Kjeldahl method with Kjeltech-20 instrument (Bremner, 1960). Phosphorus content of the soil samples were determined by using (depending on soils pH and carbonates values) Olsen method or Bray&Kurz method (Kacar, 1993) analysed and determined. Potassium, calcium, magnesium and sodium contents of the soils were determined by extraction with ammonium acetate and using with Flame-photometer or by Atomic Absorption Spectrophotometer instruments (Jackson, 1958).

Various soil properties were determined by using following sources: Çepel (1985) for soil texture classes, Kantarcı (1987) for soil organic matter, Kacar for (1993) for total carbonates, Soil Survey Division Staff (1993) for pH and salinity, Bremner (1960) for nitrogen, AgSource Cooperative Services (2007) for phosphorus, Hazelton and Murphy (2007) for exchangeable cations. Interpretations were made by using the data obtained from ectomycorrhizal fungi growing sites and the samples collected from this site and the relative distribution rates of the fungi in these sites.

The locations of the sampling sites were determined by using vector based digital maps of natural Turkish pine (*Pinus brutia* Ten.) forests in İzmir Forest Regional Directorate by using databases in ArcGIS and Google Earth.

Results

The species and genera of the fungi samples which were collected from the natural Turkish pine forests in İzmir Forest Regional Directorate region were identified. In this study, species of 390 samples and genera of 160 samples were identified. Thus, 123 different species from 50 different genera were determined.

Russula species were the most common species in the ectomycorrhizal genera which were observed in 31 different sites (see Table 1 and Figure 1 and 2). *Lactarius* and *Tricholoma* genera were the second most common genera observed (each of them has 5 species), followed by *Amanita, Hygrophorus* and *Suillus* (each of them has 4 species) and, *Inocybe* ve *Hebeloma* (each of them has 2 species). However there were 8 samples/taxons of *Cortinarius*, but they could not be identified down to species level. During this project studies, *Leccinium lepidum* was determined as a new record for Turkey.

Soil properties of the sampling sites with *Russula* species were analyzed in the laboratory and following results were obtained:

Soil texture: The particle size distribution of the soils with *Russula* species determined as; 52% sandy loam, 18% sandy clay loam, 8% clay loam and 6% clay. The texture classes found as; 76% of the soils were medium textured, and 16% of the soils were determined as coarse textured soils.

Organic matter: Organic matter content of the soils with *Russula* species ranged from low to high levels of organic matter content. 54% of the soils with *Russula* species determined as soils with low organic matter content, whereas 28% of the soils had mid-organic content and 18 % of the soils had high levels of organic matter content.

Total carbonate: 66% of the soils with *Russula* species did not have any carbonates and, 4% of the sites had very little carbonates whereas, 2% of the sites had mid-carbonate levels, 6% of the sites had high carbonate levels, 18% of the sites had very high carbonate levels and, 4% of the sites had excessive carbonate levels.

Soil reaction (pH): The soil reaction of the soils with *Russula* species ranged from slight acidic to alkaline soils. 36% of the soils were neutral soils and 28% of the soils were mid-alkaline whereas 20% of the soils were slightly acidic soils and 16% of the soils were slightly alkaline soils.

Soils salinity: All of the soils with *Russula* species were determined as 'non-saline' soils.

Nitrogen: The nitrogen levels of the soils with *Russula* species ranged from very low to very high levels of nitrogen. 64% of the sites had very low levels of nitrogen while, 26 % of the sites had low levels of nitrogen and, 16 % of the sites had moderate levels of nitrogen and 8% of the sites had very high levels of nitrogen and 6% of the sites had high levels of nitrogen.

Phosphorus: The phosphorus levels of the soils with *Russula* species ranged from very low to high levels of phosphorus. 86% of the sites had very low levels of phosphorus while, 4% of the sites had low levels of phosphorus and, 4% of the sites had moderate levels of phosphorus and 6% of the sites had high levels of phosphorus.

Potassium: The potassium levels of the soils with *Russula* species ranged from very low to high levels of potassium. 36% of the sites had moderate levels of potassium while, 32 % of the sites had low levels of potassium and, 16% of the sites had very low levels of potassium and another 16% of the sites had very high levels of potassium.

Calcium: The calcium levels of the soils with *Russula* species ranged from moderate to very high levels of calcium. 16% of the sites had moderate levels of calcium while, 42% of the sites had high levels of calcium and, another 42% of the sites had very high levels of calcium.

Magnesium: The magnesium levels of the soils with *Russula* species ranged from low to very high levels of magnesium. 70% of the sites had moderate levels of magnesium while, 26% of the sites had high levels of magnesium and, 2% of the sites had low levels and another 2% of the sites had very high magnesium levels.

Sodium: The sodium levels of the soils with *Russula* species ranged from very low to moderate levels of sodium. 92% of the sites had very low sodium levels while, 6% of the sites had low levels of sodium and, 2% of the sites had moderate level of sodium.

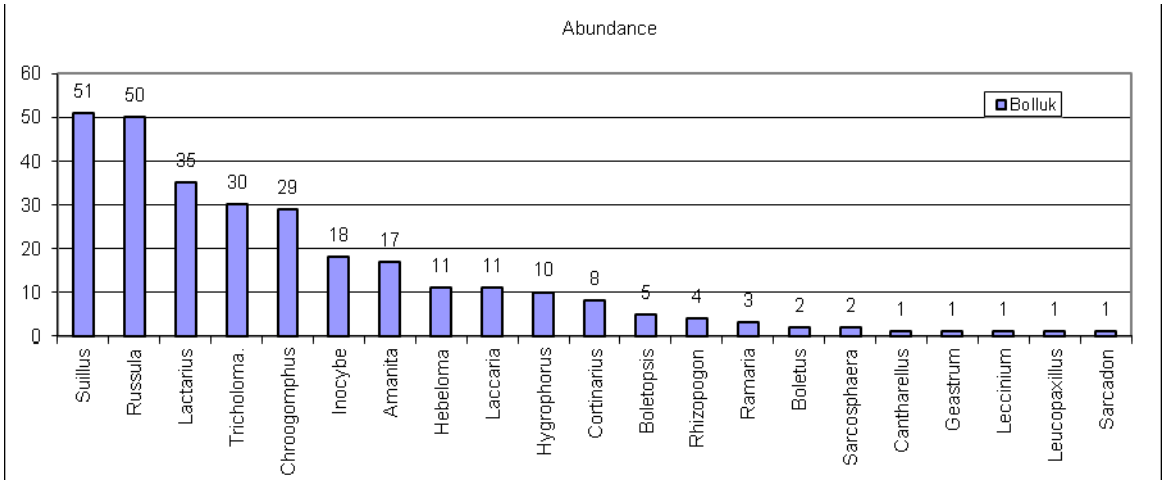


Figure 1. Number of the sampling sites of the ectomycorrhizal fungi genera

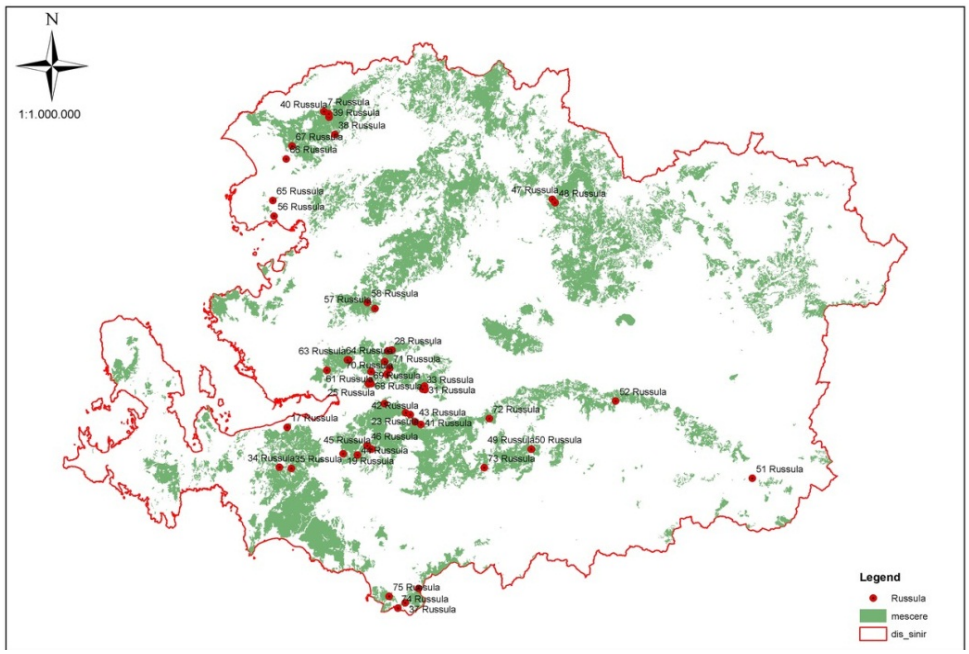


Figure 2. The locations of *Russula* species sampling sites on the natural Turkish pine (*Pinus brutia* Ten.) forests of İzmir Forest Regional Directorate

Table 1. Russula species occurrence locations in İzmir Forest Regional Directorate.

Species	**Location**
Russula aeruginea Fr.	Karagöl ve Dikili-Çağlan
Russula amethystina Quél.	Manisa-Spil Dağı
Russula atrorubens Quél.	Bergama-İncecikler
Russula chloroides var. *chloroides* (Krombh.) Bres.	Sabuncubeli- Yangın Ekibi Binası üstü ve Efemçukuru
Russula curtipes F.H. Moller & Jul. Schäff.	Kemalpaşa-Kiraz mevkii
Russula cyanoxantha (Schaeff). Fr.	Kemalpaşa-Sütçüler Köyü
Russula delica Fr.	Çatalkaya İl Ormanı, Kavaklıdere, Manisa-Karakoca köyü, Manisa- Spil Dağı yolu, Yamanlar köyü üzeri, Karagöl yolu-Dispanser civarı, Karagöl-Emiralem yolu, Çandarlı-Dikili yolu, Dikili-Karaoba Köyü, Çiçekli Kent Ormanı, Meryemana, Efemçukuru köy civarı, Selçuk-Kireçli köyü, Kozak-yangın kulesi yolu, Bergama-Kozak yolu, Kemalpaşa-Karabel, Nif dağı, Gördes-Gürenez ve Ödemiş-Aldağ-Kerpiçli köyü üzeri
Russula densifolia Secr. ex. Gillet	Çiçekli Kent Ormanı, Yakaköy ve Ovacık-Sarılar
Russula emetica (Schaeff.) Pers.	Çandarlı-Dikili yolu
Russula farinipes Romell	Manisa-Karakoca köyü ve Çamlık-Şirince yolu
Russula foetens (Pers.) Pers	Sabuncubeli ve Selçuk-Çamlık
Russula luteotacta Rea.	Sarnıç
Russula maculata Quél. & Roze	Manisa Karakoca köyü
Russula medullata Romagn.	Selçuk-Meryemana
Russula nana Killerm.	Buca-Araplar mevkii
Russula nitida (Pers.) Fr.	Kemalpaşa-Sütçüler köyü
Russula olivacea (Schaeff.) Fr.	Manisa-Avdal Köyü, Yakaköy, Yakaköy üstü ve Selçuk-Kireçli Köyü
Russula olivascens (Pers.) Bres.	Manisa-Sabuncubeli yangın ekip binası üstü
Russula persicina Krombh.	Ödemiş-Aldağ-Kerpiçli köyü
Russula purpurata Crawshay	Ovacık-Sarılar ve Meryemana
Russula queletti Fr.	Manisa Avdal Köyü, Efemçukuru, Bergama-Kozak yolu, Gördes-Gürenez, Ödemiş-Aldağ-Kerpiçli köyü üzeri
Russula rhodopus Zvàra	Sabuncubeli
Russula romelli Maire	Dikili-Çağlan, Dikili-Karaoba Köyü, Bornova-Çiçekli Köyü ve Efemçukuru köy civarı
Russula rosea Pers.	Selçuk-Çamlık
Russula rubroalba (Singer) Romagn.	Manisa-Sabuncubeli
Russula sanguinea (Schumach.) Rauschert	Bergama-Kozak yolu
Russula torulasa Bres.	Karagöl, Çiçekli Kent Ormanı ve Ödemiş-Aldağ-Kerpiçli
Russula unicolar Romagn.	Çatalkaya İl Ormanı
Russula vinosa Lindblad	Ödemiş-Aldağ-Kerpiçli
Russula viscida Kudr.	Manisa-Sabuncubeli
Russula xerampelina (Schaeff) Fr.	Bayındır

Discussion

Genus *Russula* was ranked as first in terms of diversity and second in terms of distribution in the study area. Seventy percent of the soils where *Russula* species were observed had low to very low levels of nitrogen concentrations while 16% of the soils had moderate levels of nitrogen concentrations. Our results are in agreement with Lilleskov's (2001) paper, the sporocarp production was very low when Nitrogen input was very high.

The nitrogen and phosphorus levels of the sampling sites were ranged from low to very low (67% of the soils had very low and low nitrogen content, 89% of the soil samples had very low and low phosphorus content). It was stressed that formation of mycorrhizal associations would be very important in such soil conditions (Molina and Trappe, 1984). Sampling sites In view of soil reactions (pH) of the sampling sites, 18% of them are acidic, 33% neutral and 49% of them are

alkaline. These results have contradicted with the literature knowledge that ectomycorrhizal fungi prefer acidic soils rather than alkaline (Haktanır and Arcak after Kibar and Pekşen, 2007). However, ectomycorrhizal associations' formation would be established better in the neutral soils than in the acidic soils (Haktanır and Arcak after Kibar and Pekşen, 2007). 67% of the sampling sites were very low and low, 11% of them moderate and high and 22% of them were very high and excessive carbonates levels. These results were in harmony as soils with high carbonates (calcareous) levels hinder mycorrhizal formations.

Identifying the ectomycorrhizal fungi species which form beneficial associations with forest tree and shrub species in Aegean region will enable us to understand the extend of the complex relationships in Aegean forest ecosystems. The biological characteristics of the fungi and the impact on the host plant as well as the reason of the introduction / inoculation are very important factors understanding these important symbiotic relationships. Therefore, with isolations from roots or cap, pure fungi cultures can be obtained and these then could be used as inoculation materials. In forest nurseries, natural soils obtained from sites where particular trees or shrubs naturally grow and substrates with fine roots with mycorrhizal fungus can be utilized as an easy way of developing ectomycorrhizal inoculations.

Further research investigating the structure and properties of the mycorrhizal associations will improve our understanding of the role of the mycorrhizal associations in changing forest ecosystems due to environmental and climatic perturbations. Also it is necessary to study the amount of below ground carbon sink provided by forest ecosystems as the concern over Climate change continue to grow.

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EVALUATION OF THE NORTHERN ADANA SOILS ACCORDING TO THE SOIL CONSERVATION AND LAND USE LAW OF TURKEY

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Abstract
Soils will become more important in the future than today. Because population is growing year by year and people needs more living areas on the earth. This research focused on application of the Turkey Soil Conservation and Land Use Law in the Northern Adana. For this aim; study was conducted in 24956 ha area, with 27 soil series developed on 8 different parent materials. Soil Conservation and Land Use Law (SCLUL) map and Land Capability Classes (LCC) map were created by interpreting of the detailed soil map. There are 6 classes of soils in SCLUL; Absolute Agricultural Land (AAL), Specific Crop Land (SCL), Planted Agricultural Land (PAL), Marginal Agricultural Land (MAL), Non-agricultural Land (NAL) and Irrigated Agricultural Land (IAL). SCL, PAL and IAL were evaluated according to the under influence of human factors such as; irrigation, the presence of fruit trees. On the other hand, AAL, MAL and NAL were identified according to permanent soil properties such as; topographic structure of lands, soil depth, etc. Distributions of these classes are 23%, 26% and 51%, respectively. Seven LCC (agricultural areas; I, II, III, IV, and non-agricultural areas; VI, VII, VIII) were identified in the study area and their distributions are 2%, 5%, 20%, 22%, 40%, 9%, and 2%, respectively. As a result, AAL and MAL class land of SCLUL and I., II., III., IV. class land of LCC, in general, have similar permanent soil characteristics as NAL and VI., VII., VIII. class land.

Keywords: Soil Conservation and Land Use Law Map, Land Capability Classes Map

Introduction
Land evaluation is very important for land use. The need for agricultural land is rapidly increasing for various reasons, especially with the increase in the world population (Dingil, et al., 2002). The rapid increase in population leads to a more intensive use of land as well as clearing of virgin areas for cultivation (Repetto, 1987). Soil degradation in many developing countries constitutes a serious ecological and economic problem (Anderson and Thampapillai, 1990). Theoretically all natural resources are renewable, but fossil fuels and minerals are considered non-renewable because their rate of generation is spread over an extremely long time. A specific concern in the management of natural resources is that some of the so-called renewable resources are readily transformed into the category of non-renewable resources through mismanagement (Howe, 1979; Hartwick and Olewiler, 1986). Soils are also considered non-renewable source because they need very long time for their genesis.

First step for protecting of the soils is to classify them. Classification of the Land Capability Classes (LCC) is a good exam for that first step. Klingebiel and Montgomery (1996) have provided a capability classification where Class I represents soils with few limitations on land use, and the severity of the limitations increases progressively so that in the final Class VIII, any form of commercial use is precluded. The capability classification is based on a mixture of land and soil characteristics such as; slope, texture and depth of surface soil and permeability. Such classification may sometimes conflict with the priorities set for national development (Anderson and Thampapillai, 1990).

Classification is a fundamental part of the rational study and management of soil resources, serving as an organizational framework and descriptor of soil properties. Systematic soil classification is also a vehicle for communicating research results and extending the benefits of new knowledge to other locations. Classification in conjunction with soil mapping provides a method for planning agricultural output, makes possible the application of new management techniques, and supports the use of environmentally sound land use practices (Shi, et al., 2006).

Government must use a suitable soil classification system to create their Soil Conservation and Land Use Law (SCLUL) against accelerating of the population. Many countries have laws about

their soil conversations in the world, especially in Europe. Studies of the SCLUL were started in 1998 by Ministry of Agriculture and came into force in 2005 in Turkey.
In this study we aimed to identify the measurable criteria for classes of the SCLUL, to match the limits and features of LCC with classes (AAL, MAL and NAL) of the SCLUL, to constitute new classification of the soil and land properties for classes (AAL, MAL and NAL) of the SCLUL.

Materials and Methods
Definitions of the classes of SCLUL and LCC were applied to 27 soil series on 8 different parent materials in area of 24.956 ha, in northern Adana (Fig. 1). SCLUL has 6 classes (AAL, SCL, PAL, MAL, NAL and IAL) and LCC has 7 classes (I, II, III, IV, VI, VII and VIII). Arrangements of the class were made by using Microsoft Excel-2007 software. LCC were identified according to the Klingebiel and Montgomery, (1961). PAL, SCL and IAL classes of the SCLUL have defined according to human activities (irrigation system) in that field and local adaptations of the specific crops. On the other hand, AAL, MAL and NAL classes of the SCLUL have natural characteristics of the soils and lands (soil depth, land slope, stoniness, etc). We took into account these natural soil and land characteristics and their classes in this study (Table 1). Residual classes of the SCLUL were not considered. LCC also has measurable features of the soils and lands, such as; soil depth, the slope of the land, soil texture and surface stoniness (Table 2). Characteristics of mapping soil units were classified in classes of the LCC. We evaluated descriptions of the LCC and SCLUL units to find out measureable scale for SCLUL.

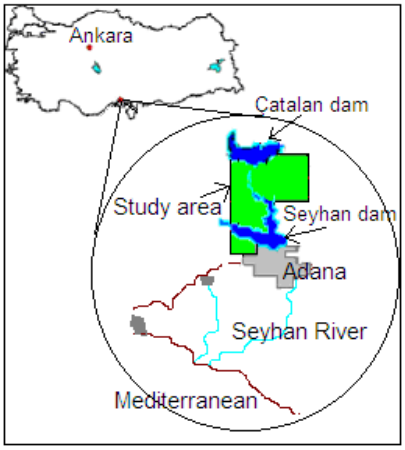


Fig. 1. Location of the study area.

Table 1. Descriptions, land types and units of the SCLUL.

Units	Land types	Descriptions
AAL	Absolute Agricultural Land	There is no any limitation for crop production according to the regional average and physical, chemical and biological features of the soils. There are no or less topographic limitations of the lands. Suitable lands for agricultural use.
MAL	Marginal Agricultural Land	This kind of the lands have traditional soil tillage farming because of soil and topographic limitations, excluding special product farmlands and planted lands.
NAL	Non-agricultural Land	Bare rocky areas without soil, permanent snow-covered fields, coastal sand dunes, reeds and marsh, military, industrial, tourism and housing areas.

Table 2. Units and descriptions of the LCC.

LCC	Description
I	There are no or less limiting factors of the soils for using of the agricultural use. This kind of the soils can be easily cultivated, deep soil depth (>120 cm), well drained, close to uniform flat terrains (Very permeable soils and have gently sloping lands can be classified in this class).
II	Gently sloping (B; 2-5%), mild risk of the water and the wind erosion or its effects, less than ideal soil depth (90-120 cm), mild salinity and alkalinity (2-8 dS/m-mmhos/sm), non suitable soil structure and tillage, infrequent flood damage, wet condition in soil.
III	Moderate slope (C; 5-15%), medium risk of the water and the wind erosion or its effects, frequent floods that damage crop production, slowly permeable sub-soil, wet conditions, shallow soil depth (60-90 cm), low productivity can be corrected easily, medium salinity and alkalinity (8-16 dS/m-mmhos/sm), bad weather conditions.
IV	Steep slope (D; 10-15%), severe water and wind erosion or its effects, shallow soil depth (30-60 cm), low water-holding capacity, more frequent floods that damage crop production, permanent wet soil condition after the drainage, salinity and alkalinity (>16 dS/m-mmhos/sm).
V	This kind of the soils usually have close to uniform flat (A; 0-2%) terrains, wet conditions, effect of frequent floods or stoniness problems. If limiting factors of these soils are improved, they can be classified in IV, III, II or I. class of LCC.
VI	Steep or very steep slope (D, E; 10-30%), severe erosion or its effects, stoniness and rocky (15-40%), shallow soil depth (0-30 cm), salinity and alkalinity (>16 dS/m-mmhos/sm), severe climatic conditions.
VII	Very steep slope (E; >30%), excessive erosion, very shallow soil depth (0-15 cm), more stoniness and rocky (40-80%), wet soil conditions, severe salinity and alkalinity (>16 dS/m-mmhos/sm), adverse climatic conditions and other limiting factors.
VIII	Severe climatic conditions, erosion or its effects, saturation with water continuously, stoniness and rocky (>80%), low water-holding capacity, severe salinity and alkalinity (>16 dS/m-mmhos/sm).

Results and Discussion

Scientific area is mostly using LCC to determine soils classes, on the other hand; SCLUL is used to classify the soils for agricultural studies/decision of the government in Turkey. When Ist class of the LCC is covering in minimum (2%), VIth class of the LCC is covering in maximum (37%) of the study area (Table 3). Suitable lands for agriculture (AAL and MAL) and non-suitable (NAL) lands are occupying 54% and 46% of the studying area, respectively. Descriptions of the SCLUL for each class (AAL, MAL and NAL) don't have measurable features to be classified; they have relative features particularly AAL and MAL (Table 1). There are limits about soil and topographic in AAL and MAL. But it is not clear what minimum and maximum values of those limitations are. On the other hand, classes of the LCC have measurable limitations for slope, soil depth, salinity-alkalinity and stoniness-rocky, etc.

AAL; MAL and NAL of the SCLUL have similar soil and land characteristics with I.-II.-III.; IV. and VI.-VII. classes of the LCC, respectively. Consequently, mentioned classes are evaluated together in this study. Limitations of the LCC can easily be used for SCLUL classes. For example; minimum value of the I. class and maximum value of the III. class can create minimum and maximum limits for the AAL of the SCLUL. In the same way, minimum and maximum values of the IV. class for MAL and VI. and VII. classes for NAL in this study. It is a quantitative approach for limitations of the classes for SCLUL (Table 4).

Table 3. Areas (ha) and percentages (%) of the LCC.

SCLUL	LCC	Area (ha)	Area (ha)	Percentage (%)	Percentage (%)
AAL	I	6677	541	25	2
	II		1204		5
	III		4932		18
MAL	IV	7581	7581	29	29
NAL	VI	11958	9779	46	37
	VII		2179		9

Table 4. A quantitative limitations of the classes for SCLUL.

SCLUL	Soil depth (cm)	Slope (%)	Salinity (ds/m(mmhos/sm)	Stoniness (%)
AAL	*Max* : 120	*Min* : 0	*Min* : 0	*Min* : 0
	Min : 60	*Max* : 10	*Max* : 8	*Max* : 5
MAL	*Max* : 60	*Min* : 10	*Min* : 8	Min : 5
	Min : 30	*Max* : 15	*Max* : 16	*Max* : 15
NAL	*Max* : 30	*Min* : 15	*Min* : 16	*Min* : 15
	Min : 0	*Max* : <	*Max* : <	*Max* : <

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The relationships between certain characteristics of soils developed on volcanic material and mycorrhizal spore numbers

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Abstract
Studies conducted on the number of mycorrhizae in volcanic soils are very limited around the world and there are not any studies conducted on the topic in our country. For this purpose, a study was carried out on Erenler Volcanism, which is located in the west of Konya. In the study, a total of twenty seven horizons were defined in five different profiles, each of which contains andesitic parent materials. It was endeavored to determine the relationships between certain parameters of the soils that were sampled from the horizons and mycorrhizal spore numbers.
When the total number of mycorrhizae existing in the horizons determined in a total of 5 profiles - two of which were opened in pasture and three in forest areas – were compared, it was found out that the number of spores in forest areas was more than the number of spores in pastures. This was attributed to the fact that the existence of plant roots in forest areas was higher compared to pastures. The highest number of mycorrhizal spores was recorded in the forest soil, while the lowest number of mycorrhizal spores was recorded in the pasture soil. In each profile, the highest number of mycorrhizal spores was obtained from plant roots and different depths of horizon A, where ventilation is high, and the number of mycorrhizal spores showed a decrease as the depth increased. The correlation carried out in the study also revealed a negative relationship between the number of spores and horizon depth for all values and a positive relationship between the number of spores and organic matter ($P<0.05$).
Keywords: Mycorrhiza, spore, volcanic materials, profile

Introduction

Mycorrhizal fungi form symbiotic associations with the young fine roots of many plant species. Arbuscular mycorrhizal (AM) fungi form associations with 70% of flowering plants as well as many ferns and conifers and constitute an estimated 70% of the microbial biomass in most undisturbed soils. They can only survive in the presence of a live host. Mycorrhizae supply their hosts with mineral nutrients (notably phosphorus) in exchange for energy compounds. Mycorrhizal fungi constitute the dominant microorganisms in most undisturbed soils–estimated at about 70% of microbial biomass (St John, 2005). Mycorrhizal fungi are in general more specific to soil type than to host type. Various soil conditions and factors are effective on mycorrhizal spore numbers in soils. Soil pH is the biggest selective factor, but soil texture and organic matter may also influence the suitability of the soil for particular fungi. There are fungi that tolerate cool spring temperatures and others that remain dormant until the soil warms up (St John, 2005). AMF symbiosis is thought to play a particularly important role in the successional process on bare or disturbed lands such as volcanic deserts, where the availability of nutrients such as nitrogen and phosphorus is quite limited. According to an AMF-related basic model of primary vegetational succession on volcanic substrates, nonmycotrophic plants are the dominant colonizing species during early successional stages, followed by facultative mycotrophic species at the intermediate stages, whereas obligate mycotrophic species dominate in later seral communities (Janos, 1980; Allen, 1991). Allen and coworkers (Allen et al., 1984; Allen, 1987) reported, however, that post-eruption re-establishment of AM occurred quickly on Mount St. Helens, and that the plant invaders of successional vegetation were all mycotrophic plants. Allen (1991) suggested that mycorrhizal status and the progress of vegetative succession would vary with different environmental conditions in terms of water and nutrients. Although AM fungal colonization is thought to be an important factor in the process of vegetative succession, relatively little about the AM fungus community and its patterns in primary succession has been documented.
In the early stages of succession, such as new substrates on volcanoes, pioneer seed plant species are nonmycorrhizal due to a lack of fungal propagules (Allen, 1991). In primary successional environments on Mount St. Helens (Wash.), plant establishment was determined by microhabitats such as depressions and near-rock sites rather than the presence of arbuscular mycorrhizal propagules (Titus and del Moral, 1998).

Studies on the distribution and infection rates of mycorrhizal spores in volcanic areas around the world and also studies on determining the types of spores are gaining importance each passing day. However, there are no studies on mycorrhizae existing in volcanic areas in our country. The present study aims to conduct a spore count in five different volcanic sites in Central Anatolia and provide a general contribution regarding the mycorrhizal state of these particular areas.

Material and Methods

Site description

The study was performed on Mount Erenler in central Anatolia, about 55 km west of the city of Konya, between 37°54′56″N and 37°33′22″N and between 32°11′06″E and 31°51′16″E. The study area is situated north of the middle Toros Mountains zone. Long-term records show that the mean annual precipitation is 379.38 mm and the total evaporation is 1226.4 mm. According to the Konya meteorological station, the mean annual temperature is 11.5 °C and the mean annual soil temperature at 50 cm is 12.5°C (DMI, 1994). The research area has a semiarid Mediterranean climate with low humidity, according to the De Martonne-Bottman rainless index formula (Akman, 1990). Soil moisture and temperature regimes are xeric and mesic, respectively, according to the climate data (Soil Survey Staff, 1999). The study area comprises different stratigraphic and structural formations. The oldest formation in the area is the Kızılören formation, which consists of dolomites and dolomitic limestone from the late Triassicearly Jurassic. All of these units were overlaid unconformably by late Miocene-early Pliocene Erenler volcanic materials. The volcano was mapped as Kızılören ignimbrite, tuff, andesite, trachyandesite, and Erenkaya ignimbrite, with andesite being the most common formation in the area. The volcanic materials in the study area were derived from continental crust and products of old subduction related volcanism (Kurt et al., 2005).

Sampling and analysis

For the study, five representative soil profiles were chosen, and disturbed and undisturbed soil samples were taken from the horizons after their macro morphological identification was completed. The depth of each horizon was measured using a tape meter. Soil samples were dried, gently crushed with a wooden roller, and sieved to 2 mm. Visible roots, stubble, and coarse fragments were removed and stored in plastic bags for use. Soil pH was measured potentiometrically, both in a 1:2.5 soil-water (w/v) suspension and 0.01 N KCl with a glass electrode (USDA, 2004). Electrical conductivity (EC) was determined potentiometrically in a 1:2.5 soilto-water suspension (USDA, 2004). Particle size distribution was determined by the hydrometer method after removal of organic matter using H_2O_2 and stirring in a sodium hexametaphosphate solution (Bouyoucos, 1951). Organic matter in the soils was determined using the Walkley and Black wet digestion method (Van Lagen, 1993). The amount of carbonate in the soil was measured with a Scheibler calcimeter (USDA, 2004). Cation Exchange Capacity (CEC) and exchangeable Ca, Mg, K, and Na were extracted by ammonium acetate (1 N, at pH 7), and quantity was determined by flame photometer and atomic absorption spectrophotometer (AAS) (Schollenberger and Simon, 1954). The percent base saturation was determined by dividing the sum of the K, Mg, Ca, and Na in mEq 100 g–1 soil to CEC. Phosphate retention capacity was measured according to the methods of the *Soil Survey Laboratory Methods Manual* (USDA, 2004). Total P_2O_5 analysis of the soil and rock samples was conducted by fusion with lithium metaborate ($LiBO_2$) and dilution in a HNO_3-HF procedure (Chao and Sanzolone, 1992).

Spore extraction and quantification

After sampling, each soil sample (10 g fresh mass) in pots was sieved according to the sieving and decanting procedure of Gerdeman and Nicolson (1963). The sieving was centrifuged at 3500 rpm (10 g) for 10 min. The pellet was resuspended in 50 % sucrose and centrifuged again at 3500 rpm (10 g) for 1 min. After the centrifuging process, the supernatant was poured onto a 50-100 μm sieve, washed thoroughly with deionized water and then placed in a 9 cm petri-dish for examination under a stereomicroscope (x40).

Spores and debris were collected on 50-100 μm sieves with tap water. Some spores were tightly grouped in sporocarps and it was difficult to count the number of spores per sporocarps, so, to simplify the procedure, we referred to a sporocarp as one spore (Zhao et. al., 2003).

Statistical Analysis

The simple correlation coefficients among all analyzed characters were calculated by the MSTAT statistical program (Düzgüneş at al., 1987).

Results

Certain chemical-physical properties and distribution of mycorrhizal spores in the research soil

Certain site characteristics of the spots where the soil profiles were opened in the study area are presented in Table 1. As it can be seen in the table, of the five profiles that were opened in an area with primarily andesitic material, three profiles were in forest areas and two were in grasslands.

Table 1.Selected site characteristics of the studied profiles.

Profile	Coordinates		Parent Material	Elevation (m)	Land Position	Slope (%)	Land Use
	Latitude	Longitude					
I	37° 49'44''	32° 09'40''	Andesite	1453	Steep slope	25	Grassland
II	37° 47'44''	32° 01'19''	Andesite	1729	Steep slope	15	Forest
III	37° 48'00''	32° 01'15''	Andesite	1740	Hill	30	Forest
IV	37° 48'57''	32° 09'16''	Andesite	1608	Foot slope	15	Forest
V	37° 49'52''	32° 02'24''	Andesite	1448	Foot slope	10	Grassland

Soil samples that were taken from both different profile-horizons and different depths of the experimental area were used for analyses. The soil composition included a pH range of 5.05-7.24 (light acidic in pH), EC 18.6-416.5 µS/cm (unsalted in EC), % organic matter 0.24 to 5.95 (slightly-very high), %$CaCO_3$ 0-0.6 (slightly), pH and contained a small amount of organic matter and a high percentage of lime. The soils which were dried, then ground and sieved (2.0 mm), contained 16.80-70.90 % sand, 5.7-31.7 % silt, 21.60-69.60 % clay. Their phosphorus fixation capacity rate varied between 6.3-40.3%. Furthermore, spore numbers (including sporocarps) varied from 0 to 94 per 10 g. field soil. These figures are presented in Table 2.

As it can be seen in Table 2, pH, EC, organic matter, $CaCO_3$, rate of phosphorus retention, texture class and mycorrhizal spore numbers varied depending on one another and depth in a total of 27 horizons in five different profiles. Organic matter and $CaCO_3$ values of the horizons generally showed decreases depending on depth. EC, pH and rate of phosphorus retention also generally showed a decrease depending on depth but this decrease turned into an increase at certain depths. So, the change observed in numbers was not a regular variation but a fluctuation. On the other hand, mycorrhizal spore numbers generally increased at increasing depths of A horizons but decreased at increasing depths of the other horizons (Bw1-Bw2-Cr1-Cr2-Cr3) as sampling went down deeper from A.

The highest total mycorrhizal spore number (221 number/10 g soil) was found to be in Profile IV, which belonged to a forest area and had six different horizons (A1, A2, Bw1, Bw2, Cr1, Cr2). In this profile, the highest mycorrhizal spore number (94 number/10 g soil) was determined in A2 horizon and in contrast to other profiles, high spore rates (45 and 55 number/10 g soil respectively) were also observed in the B horizons (Bw1 and Bw2) of this profile. In profile V, where the second highest spore number was observed, a total of 58 number/10 g soil was obtained and spore numbers showed a decrease as the depth increased starting from A horizon but the existence of spores was determined even in Cr2 horizon (3 number/10 g soil), which had the highest horizon depth (+130 cm).

Regarding the spore numbers in other profiles, there were a total of four horizons in profiles I and II and a total of 26 spore number/10 g soil was observed in A1 and A2 horizons of profile I, 46 spore number/10 g soil was observed in profile II. Profile III had seven horizons and a total of 29 spore number/10 g soil was determined in profiles Ah, A and Bw2.

Table 2. Some physical, chemical and biological properties of the studied profiles.

Profile	Horizon	Depth (cm)	pH (1/2,5)	EC (µS/cm)	Org. Matter (%)	P Retention (%)	$CaCO_3$ (%)	Particle size			Texture class	Spore number
								Sand	Clay	Silt		
I	A1	0-12	6,44	43,1	2,87	6,3	0,3	60,	22,	16,6	SC	6
	A2	12–32	6,34	28,3	2,31	7,8	0,6	68,	20,	10,6	SC	20
	Cr1	21-47	6,21	30,9	0,77	9,9	0,0	65,	25,	9,6	SC	0
	Cr2	+47	6,70	22,6	0,0	9,5	0,0	70,	23,	5,7	SC	0
II	Ah	0-3	6,15	65,4	4,97	17,2	0,5	48,	24,	26,6	SC	12
	A	3–15	6,13	37,5	1,93	20,7	0,2	48,	32,	18,6	SC	27
	AC	15-20	5,99	32,2	1,43	26,1	0,3	44,	36,	18,6	SC	7
	Cr	+20	6,18	30,1	0,0	23,8	0,0	52,	27,	19,7	SC	1
III	Ah	0-10	6,13	76,5	5,95	21,2	0,3	35,	42,	21,7	C	13
	A	10–29	6,08	54,9	3,06	28,8	0,2	33,	48,	18,0	C	14
	Bw1	29-57	5,90	28,7	0,44	40,3	0,2	28,	50,	21,0	C	0
	Bw2	57-79	5,70	18,6	0,24	39,0	0,2	34,	42,	22,6	C	2
	Cr1	79-116	5,08	29,6	0,26	42,7	0,0	20,	55,	23,7	C	0
	Cr2	116-179	4,17	416,5	0,0	34,3	0,0	40,	27,	31,7	C	0
	Cr3	+179	4,65	32	0,0	34,1	0,0	24,	51,	23,6	C	0
IV	A1	0-15	5,05	39,8	3,09	25,8	0,1	47,	34,	18,3	C	25
	A2	15-37	5,16	18,7	0,80	27,0	0,2	35,	46,	17,6	C	94
	Bw1	37-52	5,40	21,3	0,84	26,4	0,2	40,	42,	16,6	C	45
	Bw2	52-79	6,30	43,25	0,0	29,8	0,1	16,	69,	13,6	C	55
	Cr1	79-94	7,05	120,1	0,0	26,4	0,0	18,	63,	18,0	C	2
	Cr2	+94	7,24	136,4	0,0	20,8	0,0	30,	63,	5,9	C	0
V	A1	0-16	6,19	68,5	1,41	11,3	0,3	65,	21,	13,3	SC	22
	A2	16-40	6,28	20,6	0,81	14,8	0,1	59,	23,	17,0	SC	24
	Bw1	40-70	6,17	20,1	0,0	16,1	0,2	68,	23,	8,0	SC	3
	Bw2	70-102	6,23	14,2	0,0	15,4	0,0	69,	22,	8,0	SC	7
	Cr1	102-130	6,35	24,1	0,0	14,2	0,0	60,	29,	10,0	SC	0
	Cr2	+130	6,07	26,0	0,0	16,3	0,0	68,	23,	7,8	SC	3

Table 3. Correlation coefficient of Mycorrhizal Spore Numbers and some other soil properties.

Soil parameters		Mycorrhiza Spore Number				
		Profile I	Profile II	Profile III	Profile IV	Profile V
Depth		-0.402	-0.331	-0.758 *	-0.510	-0.571
pH		-0.263	0.047	0.676	-0.685	0.108
EC		0.052	0.205	-0.139	-0.832 *	0.515
Organic matter		0.657	0.342	0.905 *	0.075	0.907 *
$CaCO_3$		0.978 *	0.252	0.696	0.858 *	0.559
Total P_2O_5		0.855	-0.152	0.510	0.079	0.907 *
Phosphorus retention		-0.511	-0.465	-0.834 *	0.592	0.600
Exchangeable Cations	**Ca**	-0.775	-0.937	0.792 *	-0.531	-0.487
	Mg	-0.653	-0.904	0.005	-0.542	-0.646
	Na	-0.790	-0.671	-0.565	-0.675	-0.626
	K	0.003	0.181	0.446	0.591	0.658
CEC		-0.738	-0.927	-0.324	-0.547	-0.575
Base saturation		0.317	0.383	0.801 *	-0.503	0.044
Particle Size Distribution	**Sand**	0.120	-0.227	0.344	0.163	-0.421
	Clay	-0.896	0.196	0.005	-0.272	-0.544
	Silt	0.277	-0.076	-0.570	0.385	0.888 *

*$P<0.05$

Discussion

The effect of depth on the distribution of mycorrhizal spores in the profile is significant in that it is connected with plant root region, because mycorrhizal spores can only survive by hooking into the root of another plant (Harley, 1989; Harley and Smith, 1983; Kendrick, 1985). For this reason, the gradual decrease in spore density that generally occurs through deeper horizons can be attributed to the distance from the plant root and consequently from organic matter and the decrease in air and water. In general, the organic matter stimulate spore production, and the mycorrhizal root debris can also be an important reservoirs of inoculum and the contact between colonized root debris and uninfected plant may enhanced the mycorrhizal spread with low annual rainfall (Arora et al., 1991). The correlation analysis showed a negative correlation between mycorrhizal spore number and soil depth in all the horizons of five different profiles (r= -0.402, r= -0.331, r=-0.758*, r= -0.510 and r= -0.571, respectively), but a positive correlation was observed between spore number and organic matter (r=0.657, r=0.342, r=0.905*, r=0.075, r=0.907* respectively). Of these findings, the correlation relating to the depth of profile III and the correlation values regarding the organic matter in profiles III and V were found to be statistically significant ($P<0.05$). In their study, Anderson et al., (1984) also obtained a similar correlation between mycorrhizal spore number and organic matter.

In addition, a positive correlation was observed among mycorrhizal spore number, $CaCO_3$ and K in all horizons ($CaCO_3$: r=0.978*, r=0.252, r=0.696, r=0.858*, r=0.559 and K: r=0.003, r=0.0.181, r=0.446, r=0.591, r=0.658 respectively). Similarly, in a study conducted by Siquera et al. (1990) it was shown that spore production significantly increased in soils as the result of lime applications.

However, a negative correlation was detected between spore number and some of the other properties in all horizons (such as Na: r=-0.790, r=-0.671, r=-0.565, r=-0.675, r=-0.626 and CEC: r=-0.738, r=-0.927, r=-0.324, r=-0.547, r=-0.575 respectively) (Table 3). Gildon and Tinker (1983) reported that sodium and chlorine ions had a negative effect on the formation of mycorrhizal spores. Similar results were also obtained in the present study.

On the other hand, in some horizons other chemical and physical properties of the soil had an effect on spore numbers. However, different correlations were obtained between certain soil properties possessed by all the profiles (EC, total P_2O_5, rate of phosphorus retention, amount of Ca, base saturation and rate of silt) and the number of mycorrhizal spores in the soil. That is, opposite correlations were observed between the same soil properties and the spore numbers in different profiles. When the correlation values between the mycorrhizal spore numbers of different profiles and certain soil properties are considered with respect to horizons, the correlations between spore number and rate of phosphorus retention, amount of Ca and base saturation of profile III were found as r= -0.834*, r=0.792* and r=0.801* respectively, whereas the correlation between spore number and EC value was found as r=-0.832* in profile IV and the correlation between spore number and silt ratio in profile V was found to be r=0.888*. A large number of researchers obtained similar or different results regarding the distribution of spores in the soils depending on soil properties (Dowding, 1959; Gerdeman and Nicolson, 1963; Nicolson, 1967; Gür, 1974; Hayman and Stovold, 1979; Anonymous, 2006; Gök et al., 1997; Stutz et al., 2000; Ortega, 2001; Chaurasia et al., 2005 and Sharif and Moawad, 2006; Karaarslan et al., 2006; Uyanöz et al., 2006; Karaarslan and Uyanöz, 2010).

In conclusion, in this study it was determined that mycorrhizae, which can be naturally found in the soil under all conditions and is a microbiological fertilizer, can also be found at different depths of volcanic areas but their densities could vary depending on various factors existing in that medium, particularly depth and the existence of organic matter.

Although V. A. mycorrhizae are widely distributed in nature, we have little information on the volcanic areas that affect their distribution and survival. For this reason, more work is needed on the ecology of V. A. M. fungi and their distribution in various volcanic soil conditions.

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Qualitative evaluation of land suitability for some important agricultural plants: A case study for Givi region in Iran

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Abstract
One of the most appropriate ways for using optimal water resources is to employ cropping pattern system in respect of regional soil properties. The suitability is the aptitude of a given type of land to support a defined use. The process of land suitability classification is the appraisal and grouping of specific areas of land in terms of their suitability for a defined use. The objective of this study was to determine the suitable areas in the developing irrigation project for specifying land and soil properties, land suitability for agriculture and irrigation, and to reduce the possible land limitations. For this purpose, 4780 ha from south of Ardabil province and east of Khalkhal city was investigated. In this study two categories are recognized: orders and classes. The orders indicate whether or not given types of land are suitable for the concerned land utilization type and are expressed by the symbols of suitable and not suitable. Classes of highly suitable, moderately suitable and marginally suitable reflect degrees of suitability within the order "suitable". Evaluation of climate quality for plants was done with three methods of simple, numeric and parametric limitations. Main part of studied area had high topology and due to lime in most of soil series cultivation of some agricultural plants or orchards was substantial. Also, sprinkler and drip irrigation methods and plowing perpendicular to the slope was priority.

Keywords: land suitability, classification, limitation

Introduction

According to each area have specific potential. Thus, usage of it must not destroy the soils and decrease the yield of plants.
Recognizing the Soils, production capacity information and assign them to most profitable and suitable land use must not brunt soil fertility and capability.
Main objective of land evaluation is achieving optimum usage from each land and soil with assessment physical, social and economical phases.
The objective of this study was determination and assessment the area and situation of available land to specify land characteristics and soil types, land potential for agriculture, irrigation and remove or decrease the reparable limitations.

Material and methods

The study area is located in south of Ardabil province and east of Khalkhal County and covers an area about 4780 hectares.
This area is located on 48°, 11' to 48°, 21' East longitude, and 37°, 34’ to 37°, 47’ North latitude. This area have moderate to high topography. Main slope of this area was from northeast to southwest. Its annual rain and temperature range was 325 mm and 10.7°^{c}, respectively.
The soils of studied area were classified in 3 orders of Entisols, Inceptisols and Alfisols (Soil Taxonomy, 2010). Temperature and moisture regime of studied area was Mesic and Xeric. With Assessment the water quality for agriculture with Willcox diagram, water of studied rivers classified in C_2-S_1 group and shows water is categorized as good quality.
According to different soil types on satellite images with scale of 1:20000, profiles with length, width and height of 1.5 * 1 * 2 meter and augers until 1.5 meter with distance of 500 meter and based on standard of semi detail studies with 40 studied points per 1000 hectares were excavated. Surface and subsurface diagnostic horizons characteristics such as color, depth, texture, structure, gypsum, lime and pH were assessed. Totally, in this study 72 profiles and 80 augers were excavated with using GPS and then studied until 1.5 meters for control of soils. Soils of studied area including 9 series that were on 5 physiographic units of Hills, Valley Bottom, piedmont Alluvial Plains, river terraces and one complex unit (high plains & Hills). For perform necessary

and requirement experiments, soil samples collected from different depth of standard profiles and laboratorial analysis of soil samples done based on standard and usual methods.

Result and discussion

Based on done soil studies in studied area for surface irrigation three class of II, III and IV and miscellaneous land type (MIS) were specified. Figure 1 shows the area of classified land for surface irrigation in studied area. Also, based on done soil studies in studied area for drip and sprinkler irrigation two class of (II, III) and (I, II) were specified, respectively (with MIS). Figures 2 and 3 show the area of classified land for sprinkler and drip irrigation in studied area, respectively.

Also, evaluation and classification studies of irrigation capability of lands for remove or increase agricultural limitations and determination the better use of lands with attention to different soils potential of studied area were done.

Lands of studied area divided to four degree and four sub degree for surface irrigation after improvement activities and remove or increase the limitations. Table1 shows area and percentage of degree of land capability classification for irrigation.

For infiltration experiments from total of 9 series and various conditions, 8 points near standard profile of soil series were selected and infiltration of surface soil was measured in three replications with using double ring method.

For determination the climatic suitability, variables such as minimum period of growing cycle, sunshine, temperature, rainfall or precipitation of growing cycle and specific climatic parameters such as length of day, relative humidity and other characteristics based on requirements of implant pattern plants were measured.

Study of climatic suitability in studied area done based on climatic suitability of F.A.O and with three methods of simple, parametric and number and intensity limitation, for determination the qualitative ability of implant pattern plant.

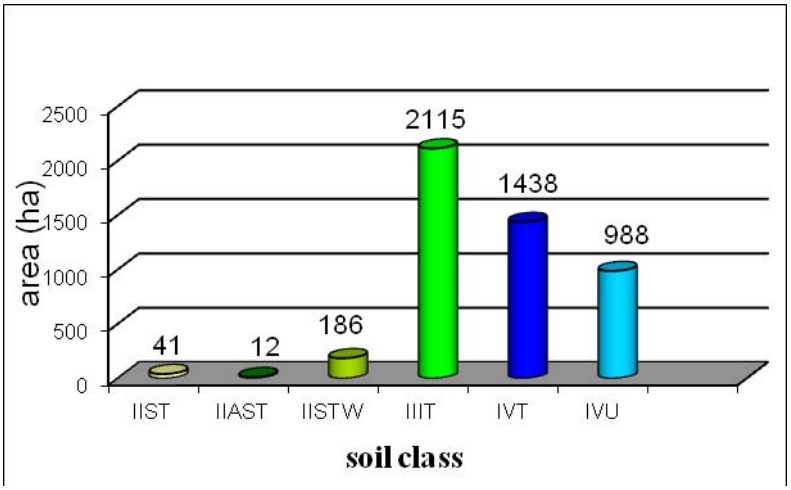


Figure 1- Area of classified land for surface irrigation

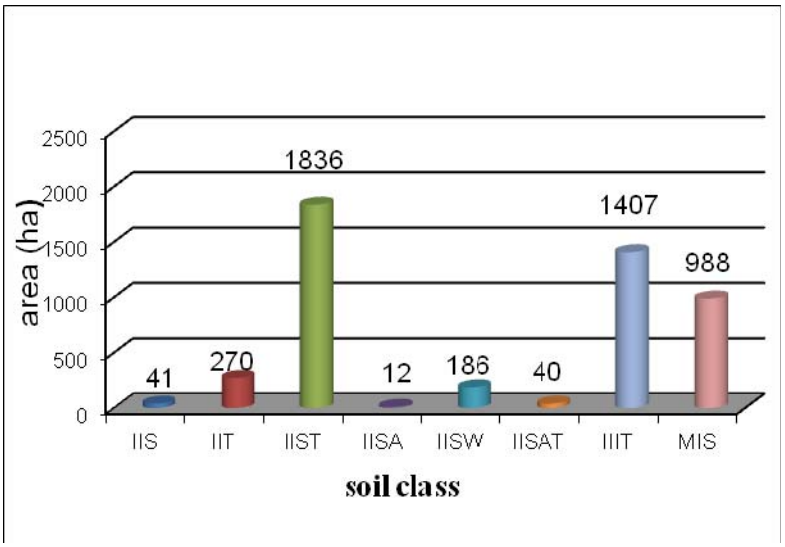


Figure 2- Area of classified land for sprinkler irrigation

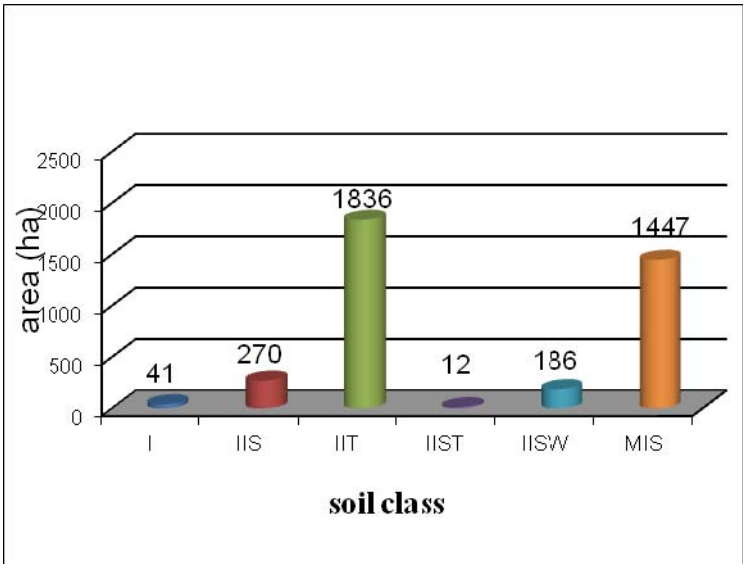


Figure 3- Area of classified land for drip irrigation

Table 1- Area and percentage of irrigation capability classification of lands

symbols		class		subclass	
degree	sub degree	Area (ha)	(%)	Area (ha)	(%)
1	-	53	1.2	53	1.2
2	2t	678	14.2	864	18.1
	2w	186	3.9		
3	3t	1493	31.2	1493	31.2
4	4t	1382	28.8	1382	28.8
MIS		988	20.7	988	20.7
SUM		4780	100.0	4780	100.0

Based on soil series characteristics, laboratorial analysis and observance standards of qualitative classification of land suitability in studied area suitable order with symbol of (S) including S1, S2

and S3 classes and unsuitable order with symbol of (N) including N2 class for these thirteen plants (wheat, barley, maize, sorghum, potato, bean, alfalfa, tomato, sunflower, grape, soya, watermelon and almond) were specified. Table 2 shows results of area comparison between suitable and unsuitable classes of land suitability for pattern plant.
Climatic suitability classes based on three methods of simple, parametric and number and intensity of limitation for the selected plants were showed in Table3. According to Table 3, Climatic suitability class for barley, potato, grape, watermelon was S1, for wheat, maize, tomato, sunflower, alfalfa and almond was S2 and for sorghum, bean, soya was S3.

Table2- Area of land suitability classes for suggested pattern plants

Pattern plants	suitability classes (ha)			
	S1	S2	S3	N2
Wheat	53	186	2869	684
Barley	53	186	2869	684
Maize	0	239	2869	684
Sorghum	53	186	2869	684
Potato	0	0	2595	1197
Bean	0	53	3055	684
Tomato	0	0	2595	1197
Sunflower	0	0	3108	684
Alfalfa	0	53	3055	684
Soya	0	0	3108	684
Grape	0	0	3279	513
Watermelon	0	2903	376	513
Almond	0	3040	239	513

Table3- Climatic suitability classes for suggested pattern plants

class / plant	number and intensity of limitation	parametric	simple
Wheat	2	62	S2
Barley	1	94.29	S1
Maize	2	73.97	S2
Sorghum	3	60.47	S3
Potato	0	100	S1
Bean	3	57.12	S3
Tomato	2	87.31	S2
Sunflower	2	87.72	S2
Alfalfa	2	69.47	S2
Soya	3	64.44	S3
Grape	1	-	S1
Watermelon	3	-	S1
Almond	2	-	S2

Whereas large areas of studied area have about 5-10 percent lime and sometimes in depths of 100 cm have lime layers or limestone, and with attention to high amount of lime disorganize absorption of some micro elements such as Iron, then it is necessary to attention planting some agricultural plants or trees.
Large areas of studied area have moderate to high topology. For be stone and gravel and lime layers or limestone in subsurface horizons, it is suggested use minimum amount of excavation and embankment.
If there aren't stone, gravel and gypsum in soil layers, drip and sprinkler irrigation and vertical plow on slop (in suitable soils) and cultivation on topographic contours are in preference.

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Soil cover diversity of the southern prebaikalia developed in paleocryogenic conditions (eastern Siberia, Russia)

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Abstract

The peculiarity of the paleogeographic situation in the south of the Baikal region led to the formation of the microrelief in the form hillocky-hollow forms that have contributed to the formation of mottling soil cover, growing in soil. The objects of study were sod forest soils, gray forest soils and chernozems of the southern Baikal region formed in a hummock-hollow topography and located in a virgin state, and mastered. Studies have shown that the most common differences between the soils developed in these circumstances are as different thickness of the humus horizon and in different humus content in the hills and hollows. In connection with the violation of the soil for various reasons (deflation, deluvial drift), even under natural conditions is not always possible unique genetic interpretation of soil. Thus, the profile of the studied soils with hummock-hollow topography is very different on the thickness of the humus horizon, which characterizes their different genesis. Since the thickness of the humus horizon of soil under study is small, then the plowing of the soil is moved from the mounds of material in the depressions, as well as erosion and loss of significant amounts of organic substances. Thus, the reserves of humus and nutrients in the plow horizon of the soil mound and depressions differ by 2-3 times, as compared to virgin soil - a factor of 3-5. Saving and restoring the fertility of arable soils in hilly-hollow topography should be directed at minimizing the procedures, the introduction of subsurface treatment, planting of perennial grasses.

Keywords: Southern Prebaikalia, paleocriogenic conditions, soils of hillocky-hollow forms of the microrelief, diversity and mottling soil cover

Introduction

Soils as integral part of environment are in dynamic balance with all biosphere components and suffer changes that negatively reflected in their properties and ecological functions. In the given context soil is regarded as a complex dynamic self-organizing and self-developing open system, which functions by exchanging information, matter and energy with other systems: atmosphere, rock, biota (Dobrovol'skii, 2005). Soil is the key element through which all streams of matter and energy in the ecosystems pass and transform.

According to physic-geographical regionalization Southern Prebaikalia applies to south of Eastern Siberia with the light-coniferous taiga pine, aspen and birch trees and lush grasses (Physical-Geographical Regionalization, 1968). In terms of geomorphology of the study area occupies piedmont plain with flat interfluves 550-650 m, 120-150 m relative height, the average slope angle 8°. Complex natural conditions in the region contributed to the development of a wide sub taiga, forest-steppe and steppe landscapes and soil. Soil formation occurs on unconsolidated sediments in deep water with low humidity and high heat in to the grass as compared with the surrounding positive morphological structures.

According to the "Soil-ecological regionalization of the Irkutsk region," V.A. Kuzmin (2002), the study area belongs to the Irkutsk-Cheremkhovo soil province of sod-podzolic soils, sod forest soils, sod-calcareous soils, gray forest soils and chernozems. The soil cover in the region is characterized by high diversity and mottling associated with the manifestations of paleocriogenesis, which increases with the anthropogenic impact.

Relict cryogenic microrelief is widely distributed in southern Baikal region. Morphologically it is constitutes the alternation of hummocks and hollows of rounded and oval shape. Their size differs and is determined in many respects by the depth and composition of loose sediments. The hummock-hollow complexes and interstitial-polygonal forms are located primarily in the lower parts of the slopes and bottoms of valleys. These hills and hollow microrelief forms are 10-20 m in diameter and 1-3 m in height.

The main reason for its formation is associated with a polygonal cracking of the soil surface as a result of rapid climate cooling that occurred in the late Pleistocene - 10.5 -11 000 years ago, approximately. In the future, under climate warming in the early Holocene, there was a thawing of permafrost and on the ground cracks formed depressions (hollows), on-site polygons – mounds

(hummocks, hills). Soils developed in these conditions have different horizons and properties (Velichko and et., 1996; Vorob'eva, 1980).



Fig 1. Forest landscapes of the Southern Prebaikalia with hillocky relief

Materials and Methods

The heterogeneity of the microrelief has a significant impact on the productivity of natural ecosystems, biodiversity and the diversity of soil. During prolonged cultivation as a result of mechanical movement and erosion of top fertile layer of soil moved from the hills to the hollows, and drifts down the slope, which leads to soil degradation and impedes agricultural land use (Vorob'eva, 1980).

The soils of hummocks and hollows alternating a short distance, creating a mottling soil cover, which is represented polychronous regular cyclic complexes (Fridland, 1972). The mottling consists of one type or combination of automorphic and semi-hydromorphic soils.

The objects of study were sod forest soils, gray forest soils and chernozems of the southern Baikal region, formed in hillocky microrelief.

Studying of chemical, physicochemical properties of soils were conducted using standard methods (Agrochemical Methods of Soil Studying, 1975).

Results and Discussion

Studies have shown that the most common differences between the soils of hummocks and hollows are in varying thickness of the humus horizon, and different content of humus. In connection with the violation of the soil for various reasons (deflation deluvial drift), even under natural conditions is not always possible genetic interpretation of the soil. Thus, the profile of soil mounds and depressions showed a sharp contrast to the thickness of the humus horizon and the humus content that characterizes their different genesis. One reason for the small thickness of the humus horizon in the soils of the hills that meet the conditions of soil formation, self-contained, is the nature of the distribution of root mass, it seems to be pressed against the surface, probably due to the peculiarity of the thermal regime of soils under study: the deep penetration of roots prevent soil in the low temperature end of melting in the spring and summer. An equally important reason for the small thickness of the humus horizon, especially the black earth on the hill is the different intensity and speed of biochemical processes in a sharply continental climate of the region. In spring, they slowed and amplified only in the middle of summer. Depression is a closed product of collapse of the walls and sides of polygons, cryogenic fracture. It can be assumed that the filling of voids in the forest zone, after the melting of permafrost in the Holocene Optimum, occurred because the walls

with low humus content. In the steppe, the cracks were filled with soil material with a high humus content, which led to the development of a strong humus-accumulative horizon. This led to the formation of buried humus horizons with bimodal distribution of humus, when the first maximum of its content falls on humus-accumulative horizon, the second – on the buried humus horizon.
Since the thickness of the humus profile of the studied soils is small, and then their plowing as a result of run-off leads to a significant loss of organic matter and soil fertility in general. Reserves of humus and nutrients to the 0-100 cm layer of arable soils on hills and hollows differ by 2-3 times, compared to virgin soil of 3-5 times.
Measures aimed at preserving and restoring the fertility of cultivated soils, located in hilly-hollow topography should be directed at minimizing the processing, the selective introduction of fertilizers, sowing of perennial grasses. However, it is best to not use automatically pick up such land as arable land, and used as hay meadows and pastures.

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Qualitative Land suitability evaluation for Alfalfa and Maize in Khoramdareh agribusiness area of Zanjan Province

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Abstract

The main purpose of this research was to evaluate land suitability for irrigated Alfalfa and Maize in Khoramdareh agribusiness area. It is worth mentioning that this study has been carried out with average input and management. So, the results could be extending to similar land in the area. In this study the physical and chemical characteristics of soils and the climatic characteristics have been surveyed. The studied area is about 910 hectares located in Zanjan province, Iran. Based on the detailed survey results, the study area evaluated in7soil family and 20soil units. Limitation methods (Simple limitation and Number and intensity of limitation) and Parametric methods (Square root and Storie) were used as land evaluation methods. The results of Square root method are more realistic than other methods. According to Square root method results, the units for Alfalfa are evaluated Highly suitable (S_1), Moderately suitable (S_2) and Marginally suitable (S_3).Suitability classes for Maize are Moderately suitable (S_2) and Marginally suitable(S_3).

Keywords: Land suitability, Parametric methods, Limitation methods, Alfalfa, maize

Introduction

In recent century, the land resource is decreasing with the growth of population. There is an urgent need to match land types and land uses in the most practicable and logical way to continue sustainable production and to meet the needs of society while conserving fragile ecosystems (FAO,1993). Land evaluation is the assessment of land performance when used for specified purposes. As such it provide a rational basis for making land use decision based on analysis of rational between land use and land ,giving estimates of required input and projected outputs(FAO,1983). Land suitability evaluation is an examination process of the degree of land suitability for a specific utilization type (Sys et al, 1991).

This approach is based on the matching of qualities of different land unit in specific area, with requirements of actual or potential land use. The results of land evaluation should be useful for rational land use planning (FAO, 1993).

Since FAO established a frame work for land evaluation (1979), different studies were carried out using it. Among these studies, a work by Sys et al is noticeable that it formed the basis of this research.

Materials and Methods

Khoramdareh agribusiness area is lying between 338700m to 342500m East latitude and 4006750m to 4012000m North longitude. The study area is about 910 ha. It is located 5 km east of Abhar, Zanjan province,Iran.

The climatic data was collected form Khoramdareh synoptic climatology station and then have been processed absolute minimum temperature (-15.6$^{\circ}c$) belonged to January and February. Absolute maximum temperature (39$^{\circ}c$) was reported on July. Annual mean temperature, annual rainfall and relative humidity were reported 12.5$^{\circ}c$, 278.7mm and 45.3%, respectively.

According to the results, temperature regime is Mesic and moisture regime is dry Xeric. Detailed Soil survey was carried out and results were used as the base information in this research.

Khoramdareh agribusiness soil was classified up to Family following USDA method (USDA,2003). Physiographic land forms of study area are plateau and piedmont alluvial plain. The soil of area was classified in two Orders: Entisols and Inceptisols. Two Families for Entisols and five Families for

Inceptisols were identified. Based on survey results the study area occupied by 7 soil Families and 20 soil units (Table 1, Fig.1).

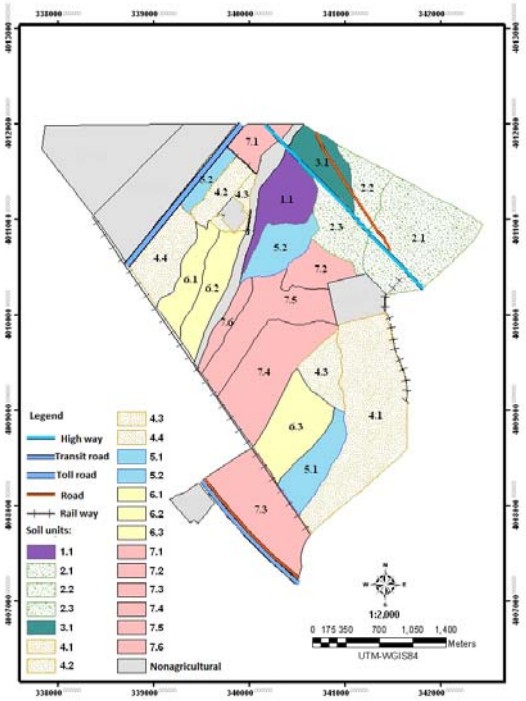


Figure1.Land units map of Khoramdare agribusiness area

Table1.Soil classification of Khoramdareh agribusiness area

		Soil classification		
Land form	Soil No.	Family	Subgroup	Order
Plateau	1	Fine loamy, mixed, mesic	Typic Haploxerepts	Inceptisols
	2	Fine loamy, mixed, mesic	Typic Calcixerepts	Inceptisols
	3	Loamy skeletal, mixed, mesic	Typic Calcixerepts	Inceptisols
Piedmont plain	4	Fine, mixed ,mesic	Typic Calcixerepts	Inceptisols
	5	Fine loamy, mixed, mesic	Typic Haploxerepts	Inceptisols
	6	Loamy skeletal, mixed, mesic	Typic Xerorthents	Entisols
	7	Sandy skeletal, mixed, mesic	Typic Xerorthents	Entisols

Land suitability classification, using the guidelines of FAO (1976) is divided into Order, Class, Sub Class, and Unit. In this system, orders are divided in to Suitable(S) and Not Suitable (N). Suitable order includes three classes of highly suitable (S_1), moderately suitable (S_2) and marginally suitable (S3).
Not Suitable order consists of two Classes of Currently not suitable (N_1) and permanently not suitable (N_2). The subclasses are a more detailed division of classes based on land quality and characteristics. Sub

classes show kind of limitation. In present study some of limitation is shown with following lower-case letters.
c: Climatic limitations ,t:Topographic limitations ,s:Soil physical properties limitations(consist of texture and structure, soil depth and coarse fragment problems) , f:Soil fertility limitations, n :Soil salinity & alkalinity limitations.
Land suitability unit is reflecting minor differences in required management within Subclasses.
Land use requirements including soil, topography and climatic characteristics were got from Sys et al (1991) and Givi (1998) and then were modified with regard to the regional conditions and the cultivars of crops.
Four methods including Limitation methods (Simple limitation & Number and intensity of limitation) and Parametric methods (Storie & Square root) were used to evaluate the land suitability for these crops.
Simple Limitation method: land use requirements compare with climatic or land characteristics and suitability classes determined for those. Lowest suitability class for characteristics is known as the final climatic or land suitability class.
Number and intensity of limitation method: Up on the number of climatic limitations, intensity of climatic limitations is determined. It is put together with land limitations and finally land suitability class is determined.
Parametric methods: Parametric methods carried out following two procedures include Storie and Square root methods. After compare between climatic and land characteristic with land use requirements, one rating between 0 and 100 is given to every climatic or land characteristic. According to the selected method (storie or square root method), at first stage with use of equation1 or equation2, Climate Index (CI) is calculated. Afterwards Climate Rating (CR) is estimated on the basis of equation 3. At second stage, with using of Climate Rating (CR) and land characteristics rating, Land Index (LI) is calculated for selected method (equation1 or equation2).

- Storie method: Eq.1

$$I = A \times \frac{B}{100} \times \frac{C}{100} \times \ldots$$

I : Land Index (LI) or Climate Index (CI)
$A, B, C, \ldots$: Rating of characteristic

- Square root method: Eq.2

$$I = R_{\min} \times \sqrt{\frac{A \times B \times C \times \ldots}{100}}$$

I : Land Index (LI) or Climate Index (CI)
$R_{\min}$: Minimum rating
$A, B, C, \ldots$: Rating of other characteristic

If CI< 25 ⇒ CR= I6.67 + 0.9 CI Eq.3
If 25< CI< 92.5 ⇒ CR= 1.6 CI

On the basis of amount of LI, land suitability class is determined. For parametric methods, suitability classes are defined according to table 2.

Table 2.Suitability class in parametric methods

suitability classes	Land Index (LI)
Highly suitable(S_1)	75-100
Moderately suitable(S_2)	50-75
Marginally suitable(S_3)	25-50
Not suitable (N)	0-25

Result and discussion

The results of regional climatic data and estimations indicated a growing period of 154 days from November 15 to April 17. Since there is no intersection between growing cycles of Maize and Alfalfa and the regional growing period, these crops cultivate in irrigated form.

Suitability classes for Maize and Alfalfa was carried out by four methods of Simple limitation, Number and intensity limitation, Square root, and Storie.

All these methods showed the climatic suitability classes of S_2 and S_1 for Maize and Alfalfa, respectively. Main limitation in suitability class for Maize is relative humidity of developing stage.

Land suitability for these crops was evaluated by the mentioned methods (Table3).In most of units, the results obtained from these methods are not completely the same for one crop. With respect to the real condition of study area, out puts during the last years, experiences of local farmers and some result of academic thesis, it seems that the results of Square root method is more realistic than other methods. Therefore, the results of the Square root method became the base for interpretation.

In 1.1, 4.4, 5.2 and 7.4 land units existence of gravelly limiting layer is the most limiting factor for cultivation. 1.1, 2.1, 2.2, 2.3 and 3.1 land units are located in plateau land form and have topographic limitations.

In study area, there are Climatic limitations for maize cultivation. 4.1, 4.3, 5.1 and 5.2 evaluated inS_{2c}.Due to high gravel percentage, sub class for 4.1, 6.1, 6.2, 6.3, 7.1 and 7.2 soil unit is S_{2cs}. Because of slope limitation, land suitability subclass for 2.1 and 2.2 is S_{2ct}.7.3, 7.4, 7.5 and 7.6 soil units have high gravel percentage limitation and evaluated in $S_{3s,c}$ subclass. 1.1 and 4.4 soil units evaluated in S_{3c} subclass. 2.3 and 3.1 soil unit have $S_{3t,c}$ subclass(Fig.2).

For Alfalfa 4.1, 6.1, 6.2 and 6.3 land units evaluated in S_1 class. These units have not significant limitation. 4.2, 4.4, 5.1, 5.2, 7.1, 7.2 and 7.3 land units evaluated in S_{2s} subclass. Limiting factors are soil physical properties .In mentioned soil units ,high gravel percentage is the main limiting factor and 4.4 and 5.2 soil units have limiting layer in the depth of 80cm.slope limitation cause 2.1, 2.2, 2.3 and 4.3 land units evaluated in S_{2t} subclass. Existence of gravelly limiting layer and slop limitation cause 1.1 land unit evaluated in S_{2ts}. 7.4, 7.5 and 7.6 soil units have very high gravel percentage and 7.4 unit has gravelly limiting layer in the depth of 50cm.these limitation causes mentioned units evaluate in S_{3s} subclass. Because of slope and gravel limitation, 3.1 soil unit evaluated in $S_{3t,s}$ subclass (Fig.3).

Table 3. Land suitability subclasses for 20 soil unit of study area for Alfalfa and Maiz

Soil Unit	Alfalfa				Maiz			
	SL	NIL	Storie	Square root	SL	NIL	Storie	Square root
1.1	S_{2ts}	S_{2ts}	S_{3t}	S_{2ts}	S_{2cts}	S_{2cts}	S_{3c}	S_{3c}
2.1,2.2	S_{2t}	S_{2t}	S_{2t}	S_{2t}	S_{2ct}	S_{2ct}	S_{3c}	S_{2ct}
2.3	S_{3t}	S_{3t}	S_{3t}	S_{2t}	$S_{3t,c}$	$S_{3t,c}$	$S_{3t,c}$	$S_{3t,c}$
3.1	$S_{3t,s}$	$S_{3t,s}$	$S_{3t,s}$	$S_{3t,s}$	$S_{3t,s}$	$S_{3t,s}$	$N_{2t,c}$	$S_{3t,c}$
4.1	S_1	S_{2s}	S_{2s}	S_1	S_{2c}	S_{2c}	S_{3c}	S_{2c}
4.2	S_{2s}	S_{2s}	S_{2s}	S_{2s}	S_{2cs}	S_{2cs}	S_{3c}	S_{2cs}
4.3	S_{2s}	S_{2s}	S_{2t}	S_{2t}	S_{2cs}	S_{2cs}	S_{3c}	S_{2c}
4.4	S_{2s}	S_{2s}	S_{3s}	S_{2s}	S_{2cs}	S_{2cs}	S_{3c}	S_{3c}
5.1	S_{2s}	S_{2s}	S_{2s}	S_{2s}	S_{2cs}	S_{2cs}	S_{3c}	S_{2c}
5.2	S_1	S_1	S_{2s}	S_{2s}	S_{2c}	S_{2c}	S_{3c}	S_{2c}
6.1,6.2,6.3	S_{2s}	S_{2s}	S_{2s}	S_1	S_{2cs}	S_{2cs}	S_{3c}	S_{2cs}
7.1,7.2	S_{2s}	S_{2s}	S_{2s}	S_{2s}	S_{2cs}	S_{2cs}	S_{3c}	S_{2cs}
7.3	S_{3s}	S_{3s}	S_{3s}	S_{2s}	$S_{3s,c}$	$S_{3s,c}$	$S_{3s,c}$	$S_{3s,c}$
7.4	S_{3s}	S_{3s}	S_{3s}	S_{3s}	$S_{3s,c}$	$S_{3s,c}$	$N_{2s,c}$	$S_{3s,c}$
7.5	S_{3s}	S_{3s}	S_{3s}	S_{3s}	$S_{3s,c}$	$S_{3s,c}$	$N_{2s,c}$	$S_{3s,c}$
7.6	S_{3s}	S_{3s}	S_{3s}	S_{3s}	$S_{3s,c}$	$S_{3s,c}$	$N_{2s,c}$	$S_{3s,c}$

SL: Simple Limitation NIL: Number& Intensity Limitation

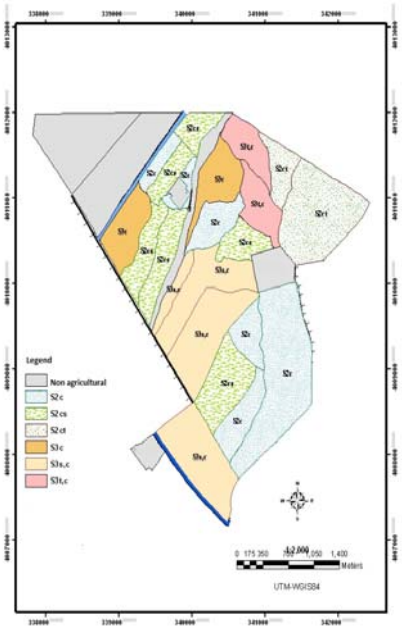


Figure2.Land suitability map for Maiz in Khhoramdareh agribusiness area

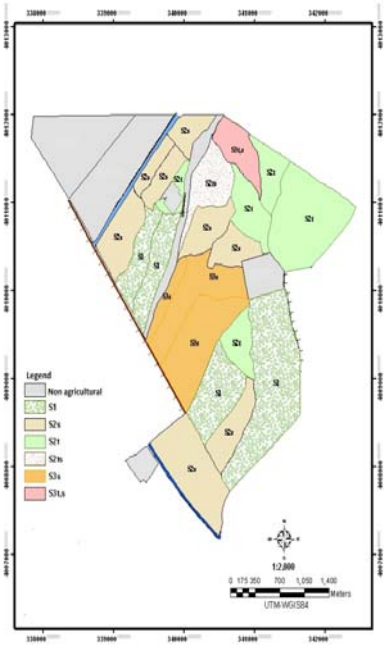


Figure3.Land suitability map for Alfalfa in Khoramdareh agribusiness area

Acknowledgments
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The Morphology, Mineralogy, Geochemistry and Physical Implications of Foid bearing Syenite and Syenite-Carbonate Rocks Contact Zone Soils: Kırşehir-Akpınar-Buzlukdağ, Turkey

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Abstract
The study area is located to the central part of Central Anatolian Crystalline Complex (CACC). The area mainly composed of Kırşehir metamorphic rocks as the basement units and intruded by syenite, foid syenite and foid diorite. The metamorphic rocks mainly represented by mica schist, chlorite schist, vollastonite marble and marble units. Calcsilicatic minerals and hornfels rocks are observed at the contact of intrusive and metamorphic basement in some parts of the study area. In order to determine morphology, mineralogy, geochemistry and physical properties of the soils two profiles were digged in the area. One of them is located in the foid bearing syenite and the other one is located in the syenite with carbonate rocks contact zone. The petrographical studies reveal that the foid bearing syenite characterised by the presence of nepheline, K-feldspar, plagioclases, Na-amphibole, pyroxene with rare amount of garnet (melanite), titanite and opaque minerals. The marble is mainly composed of calcite and rare amount of wollastonite and opaque minerals.
Contact of foid bearing syenite profile is lythic xerorthent, and the other one is described as a typical haploxeroll. They contain important morphological, mineralogical, geochemical and physical differences. It was found that these differences belong to the composition of the host rock of the region.
Keywords: Argillisation, Central Anatolia, Foid syenite, Haploxeroll, Lythic xerorthent

Introduction

Central Anatolia Crystalline Complex (CACC), bounded by the İzmir-Ankara-Erzincan Suture Zone in the North, the Tuz Gölü Fault in the west and the Ecemiş Fault Zone in the South, are roughly triangular in shape and located in between the Ankara-Sivas-Niğde cities (Göncüoğlu et al., 1991; Akıman et al., 1993). Central Anatolia Crystalline Complex consist of metamorphic rocks as a basement units, ophiolitic units which are mainly crops at northern edge of CACC, magmatic units and cover units. Magmatic units are represented by felsic and mafic plutons. These felsic and mafic plutons are intruded into the metamorphic and ophiolitic units. Felsic plutons are composed mainly of granitoids, monzonites, and syenitoids, whereas mafic plutons comprise gabbros. The felsic intrusive rocks are calcalkaline, shoshonitic and alkaline in nature and divided into three groups as a granite, monzonite, and syenite. Granitic plutons are more abundant than syenitic rocks and mainly occur along the western edge of the complex, whereas syenitic plutons form in the inner part. The alkaline rocks are divided into two main groups as silica saturated and unsaturated units. The silica saturated alkaline rocks, which display gradational contacts with the monzonitic and granitic rocks, in the compositions of quartz syenite and syenite. Unsaturated silica rocks are foid syenite, foid monzosyenite, foid diorite and foid gabbro in composition. Gabbros are spatially associated and coeval with the felsic plutons. (Kadıoğlu et al., 2006).
Buzlukdağ syenitic rocks belong to the CACC's silica-undersaturated alkaline intrusive rocks. The rocks are located to the northwestern (NW) of the CACC, approximately 40 km west of Kırşehir. These syenitic rocks intruded into the Kırşehir metamorphic rocks which belong to the basement of the CACC. Kırşehir metamorphic rocks mainly represented by mica schist, chlorite schist, wollastonite marble and marble units. Calcsilicatic bearing minerals and hornfels rocks are observed at the contact of the intrusive and metamorphic basement in some parts of the study area. The dominant felsic lithologies are foid bearing syenites. Alkali feldspar foid bearing syenite, foid diorite porphry and foid gabbros are also can be observed in the study area (Deniz, 2010).
The Buzlukdağ pluton consists mainly of foid bearing syenite with minor lithology of foid bearing alkali-feldspar syenite, foid bearing diorite porphry and foid bearing gabbros. Foid bearing rocks have holocrystalline hipidiomorph granular texture in thin section. They are mainly composed of

nepheline, K-feldspar, plagioclase, Na-pyroxene, biotite, phlogopite, Na-amphibole with rare amount of garnet, cancrinite, titanite and opaque minerals under the microscope (Fig. 1). Migmatite, hornfels and marble rock units are observed at the outer zone of syenites as a product of contact metamorphism (Fig. 1).

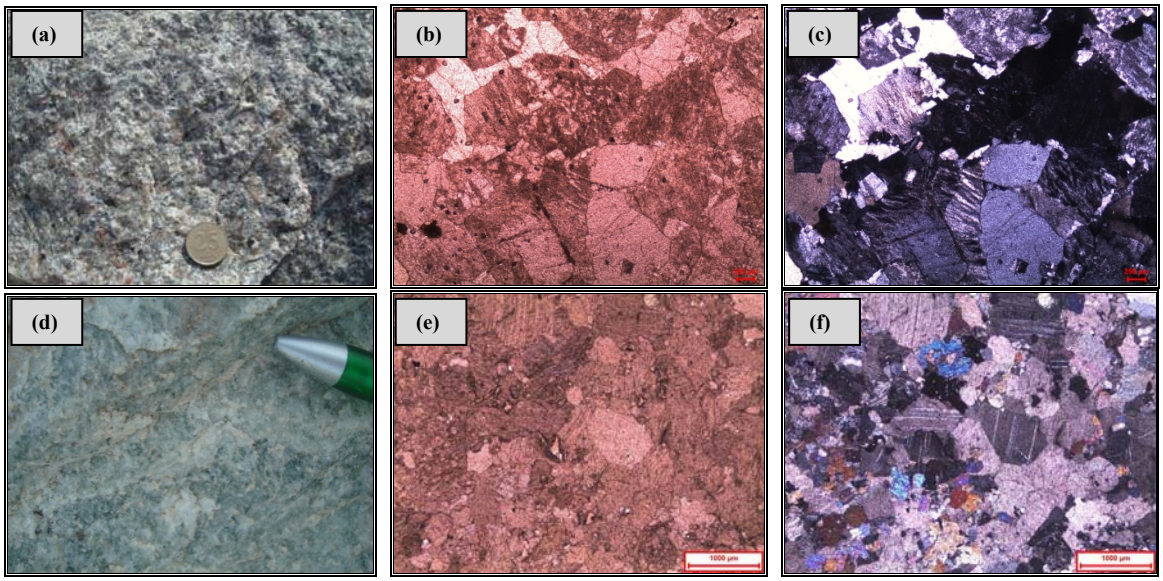


Figure 1. Photographs and photomicrographs from the foid bearing syenites and wollastonite marbles. (a) Photograph of foid bearing syenite, (b-c) photomicrographs of foid bearing syenite (parallel and cross nicol), (d) Photograph of wollastonite marble, (e-f) photomicrographs of wollastonite marble (parallel and cross nicol).

Detrital sedimatary rocks can be revealed the contact metamorphic products of the migmatites in the area. The migmatites have migmatitic texture under the microscope and they are composed of have quartz, feldspar and mica minerals. Quartz and feldspar minerals formed light colour levels which are named as a leucosom whereas biotites formed dark colour levels named as melanosom of the unit. Leucosoms have scalar granoblastik texture whereas melanosoms have slightly oriented texture. Quartz, plagioclase, scapolite, biotite, hydrobiotite and chlorite are forming the main mineral assemblages of the rock unit. Hornfels are found at the contacts of the syenites. Hornfels have granoblastic texture with smaller grains. Quartz, plagioclase, scapolite and pyroxene minerals are forming the main mineral composition. Marbles typically have granoblastic texture and they are composed of calcite, quartz and opaque minerals under the microscope. Wollastonite is also can be observed within some parts of the marble level in the form of wollastonite (Deniz, 2010).

Materials and Methods

Representative samples have been selected from each studied rocks and then prepared thin sections of these rock samples. After preparing thin sections, petrographic investigations are carried out in the polarizing microscope. Selected samples were crushed, ground and sieved, then pressed into thick pellets for XRF analysis in the laboratories of the Department of Geological Engineering and Earth Science Application and Research Center of Ankara University (YEBİM-Ankara, Turkey).

After taking soil samples, they were air dried, crushed and sieved using a 2 mm sieve. Particle size distribution was determined by the hydrometer method (Bouyoucos 1951), Organic matter in air-dried samples was determined by the Walkley-Black wet digestion method (Nelson and Sommers 1982). pH and EC-electrical conductivity were determined according to the methodology of the Soil Survey Laboratory (1992). Lime content was determined by Scheibler calsimeter (Soil Survey Staff, 1993). Exchangeable cations were measured by using the 1 N NH_4OAC (pH 7) method (Soil Survey Laboratory, 1992). In addition, morphological properties of the four profiles were determined by sampling genetic horizons in the field, and soils were classified according to the methodologies of the Soil Survey Staff (1993 and 1999) and FAO/ISRIC (2006).

Results

Buzlukdağ foid bearing syenitic rocks intruded into the mica schist, chlorite schist, wollastonite marble and marble metamorphic units. Migmatite, hornfels and marble which are the contact metamorphic rocks are observed at the contact of the intrusive and metamorphic basement in some parts of the study area (Fig. 2) (Deniz, 2010).

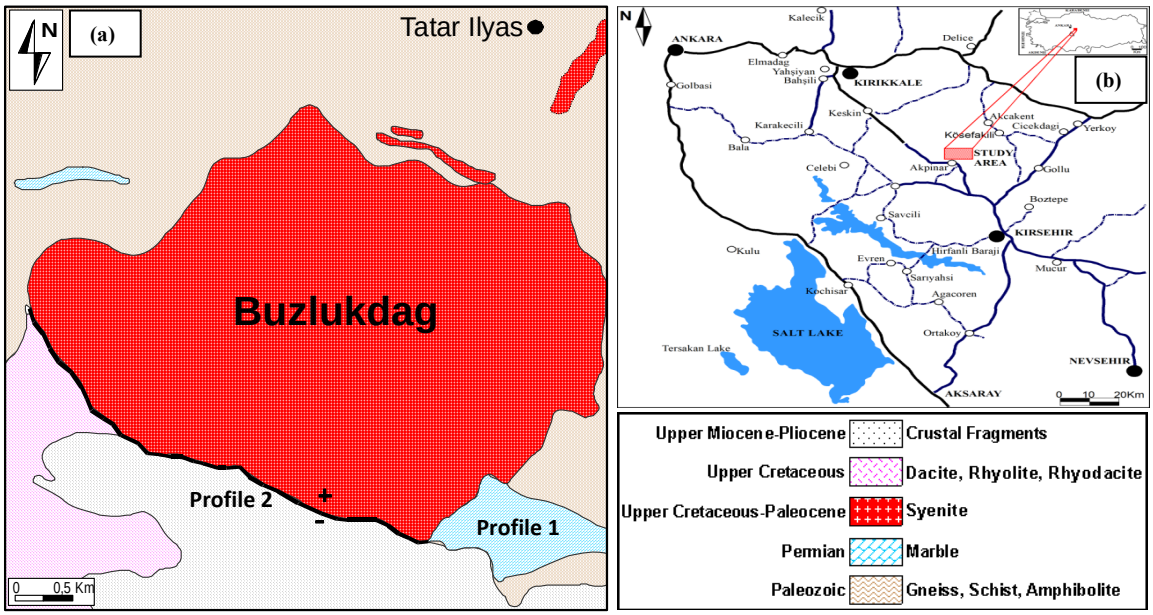


Figure 2. (a) The geological map and (b) location map of the study area.

According to Jenny (1980) natural soil bodies are the result of climate and living organisms acting on parent material with topography and with time required for soil forming processes. These soil forming factors determine soil properties by governing the type and intensity of the pedological processes involved. Because the variable of climate, parent material, relief and time also govern geomorphic processes, landscape evaluation is intimately related to soil development (McFadden and Knuepfer, 1990).

According to the meteorological data and soil water balance analysis it was found that the study area has Xeric soil moisture regime and Mesic temperature regime. Through Profile I formed on syenite, foid syenite and foid diorite parent material has light colour (7.5 YR 5/3), low organic matter and lower than 20 cm depth, it has only ochric epipedon. The horizon orders of the profile in the study area were defined to be A-C form and located on between high slope and slightly high slope. This means this soils has no diagnostic subsurface horizons and low pedogenetic development. It has only ochric epipedon overlying C or R horizon. Therefore, this soil can be defined as young soils. These pedons were classified as Lithic Xerorthent according to soil taxonomy (1999). Besides, it was classified as Lithic Leptosol FAO/ISRIC (2006).

The morphology of Profile II formed on foid siyenit and hornfels parent material and located on flat plateau was differently found from Profile I (Fig. 2). The horizon orders of this pedon are defined to be A/Bw/BC/C. Soil colour is 7.5 YR 3/4 in the Ap horizon, due to high organic matter. This soil has mollic epipedon on surface layer due to low value colour, high bas saturation, slightly hard structure. Main soil formation process in the differentiation of soil profile were structural formation, iron oxidation, clay formation and sericitization while, main subsurface diagnostic horizon is cambic horizon developed as a result of structural formation in this profile. Especially, structural development was observed after 20 cm depth. According to soil taxonomy (1999) and FAO/ISRIC (2006) this pedon was classified as Typic Haploxeroll and as Haplic Kastonozem (Table 1.).

Table 1. Morphological properties of profiles

Horizon	Depth (cm)	Colors	Structure	Consistence (Dry and Wet)	Boundary	Special features
			Profile I: Lithic Xerorthent / Lithic Leptosol			
A	0-10	7.5 YR 5/3	2mgr	sh fr ss ps	cw	
C1	10-22	7.5 YR 4/3	1fgr	sh vfr ss ps	cw	
C2k	22-33	7.5 YR 4/3	-	so vfr ss ps	-	CO_3 nodules
			Profile II: Typic Haploxeroll / Haplic Kastanozem			
A	0-10	7.5 YR 3/4	2mgr	h fr ss ps	cw	
Bw	10-20	7.5 YR 4/3	2msbk	h fr ss ps	cw	struc. dev.
BC	20-40	7.5 YR 3/2	1fsbk	sh fi ss ps	gw	
C	40-60	7.5 YR 3/2	-	h fi ss pt	-	

Boundary: a = abrupt; c = clear; g = gradual; d = diffuse; s = smooth; w = wavy; i = irregular
Structure: 1 = weak; 2 = moderate; 3= strong; vf = very fine; f = fine; m =medium; c = coarse; gr = granular; pr = prismatic; abk = angular blocky; sbk = subangular blocky; sg = single grain; m = massive;
Consistance: Dry : lo = loose; so = soft; sh = slightly hard; h = hard; Moist: lo = loose; vfr = very friable; fr = friable; fi = firm; et : so = nonsticky; ss = slightly sticky; st= sticky; po = nonplastic; ps = slightly plastic; pt= plastic; struc. dev. = structural development

Significant differences in soil chemical, physical and morphological properties in a small area are known to be related to landscape position and parent material (Ruhe, 1956, Dengiz et al., 2006). It was apparent, however, that while the regional controls of climate and vegetation were important at continental scales, “local” soil variability within smaller areas could often be attributed to changes in relief and topography and to local parent materials (Dahlgeren et al., 1997; Lark, 1999). The major physical and chemical properties of the soils are presented in Table 2. Soil texture is not significantly changing in top soil of all pedons defiened as silty clay loam. Typic Haploxeroll has the highest clay content while, Lithic Xerorthent has the highest silt content. The pH of the soils was moderately alkaline and there are no significant differences in the values of pH 7.1-8.1. In addition, both pedons have slightly soluble salt content. Calcium carbonate content of the pedons was found to be low. The calcium carbonate content was even much higher in the horizons with carbonate accumulation (i.e. calcic horizons). The low amount of $CaCO_3$ in Profile II can be explained by leaching of $CaCO_3$ in the profile. Exchangeable Ca and Mg cations were accounted for over 95% of the exchangeable complex as a result of dissolution of carbonates whereas, exchangeable K and Na levels were found rather low. In general expectation, lower landscape positions usually have higher organic matter contents than those upslope due to higher water content on low slope potions yields more biomass and more incorporation of organic matter into soil (Dengiz and Başkan, 2010). For all soils, the organic mater is highest in the surface horizon and decreases sharply to its lowest level in the subsoil. In the study area, the reasons of the low level organic matter are attributable to rapid decomposition and mineralization of organic matter. Soil organic matter ranged from 1.19 to 2.2% in Lithic Xerorthent, while Typic Haploxeroll has organic matter between 1.2-4.6% in h upper horizons of both profiles (Fig. 2).

Table 2. Some physical and chemical properties of soils

Horizon	Depth (cm)	pH	EC ($dS.m^{1}$)	$CaCO_3$ (%)	O.M (%)	Exchangeable cations (cmol kg^{-1})				Texture (%)			
						Na^+	K^+	Ca^{++}	Mg^{++}	Clay	Silt	Sand	Class
Profil I: Lithic Xerorthent / Lithic Leptosol													
A	0-10	7,9	0,3	2,3	2,2	0,08	0,8	21,5	8,0	26	24	50	SCL
C1	10-22	7,8	0,3	3,7	1,9	0,07	0,4	26,4	11,1	34	21	45	SCL
C2k	22-33	8,1	0,3	16,7	1,9	0,12	0,2	30,5	5,3	25	21	54	SCL
R	33+												
Profil II: Typic Haploxeroll / Haplic Kastanozem													
A	0-10	7,3	0,4	2,0	4,6	0,03	1,4	12,1	5,7	24	21	55	SCL
Bw	10-20	7,1	0,3	1,9	2,9	0,03	1,3	12,9	4,8	31	12	57	SCL
BC	20-40	7,3	0,4	1,7	1,6	0,06	1,5	17,5	10,2	37	13	50	SCL
C	40-60	7,3	0,5	1,9	1,2	0,09	1,5	20,3	8,5	42	11	47	SC
R	60+												

O.M. = organic matter; EC = Electrical conductivity; SCL = Silt Clay Loam; SC = Silt Clay

Discussion

Soil properties data of these both profiles indicated significantly differences each other in terms of pedogenic processes which have been shaped by landscape position and parent material. Another way to view this concept that these factors are keys on soil forming processes especially at the local region. In the study area, the main negative impact of soil forming factor on profile development in high slope positions is soil erosion. Graham and Boul (1990) indicated that in mountainous terrain, soil erosion and mass movement or landslides are important geomorphic processes. While soil development proceeds on all parts of the regolith-covered landscape, it can be interrupted at any stage by mass movement event. This interruption is relatively common on high slope degree, so Entisol often predominant there. Therefore, these soils can be defined as young soils. Soils in lower slope position (Profile II) showed marked differences in terms of more development sub surface profile due to no interruption events. Main subsurface diagnostic horizons of this soil is mollic epipedon and cambic horizon. On the other hand, In the Profile I, detected $CaCO_3$ and pH values were rised up to 16,7% and 8,1, respectively in wollastonite marble rocks. According to our observations, it was concluded that these values must have resulted from of this rocks' (wollastonite) mineralogic and geochemical composition's; but, they were found at very low level in the Profile I. However, due to placed in an alluvial fan, Profile II has thicker (60 cm) than the another one (33 cm). As a result that, morphologic, genetic and chemical differencies which have seen between the Profiles I and II are resulted mainly from the main rock and topographical conditions.

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SOIL GENESIS AND CLASSIFICATION

POSTER PRESENTATIONS

Variation of Pedological and Geochemical Properties of Selected Soil Pedons at Northern Iraq

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Abstract
Interested in the current study the composition and evolution of soils under the factors of geochemical and processes pedogenic different weather conditions dry and semi-dry and in different areas of the provinces of Nineveh and Dohuk / northern Iraq. Were selected twentieth samples of soil profiles in Makhmour and Bashiqa and Qand and Smeal and Zaweta Areas. And subjected these models with ten models of the rock formation Anjana (upper Miocene) to the analysis of volumetric (Clay, Silt & Sand) and chemical (distribution of calcium carbonate and Gypsum and iron oxides in the prospects) as well as all the physical tests (color, texture, and bulk density) with the relationship.
Although the rocks of the original is one and is configured Anjana formation (with some posts of other formations), but it notes there are differences felt in the nature of texture and mineral composition and chemical when moving from soil profile of Makhmour less developed and the direction of soil profiles Bashiqa and Qand and Smeal until the soil Zaweta the most developed. Soils of the study appeared generally with texture clay soil except for section corner that appeared with texture sandy clay loamy as well as enrichment horizons beneath the surface and bottom sizes in the mud.
Key words: pedogenic, geochemical, northern Iraq.

Introduction

Field work included a plan to study the current selection of five sections represent selected areas of northern Iraq as stretching from the Makhmour (60 km south east of Mosul). 35 km south when the line length (43°-50-00) and latitude (35°-37-30) to the Zaweta (35 km northeast of the city of Dohuk) in the north at longitude (44°- 33-45) and latitude (37°-55-25) and includes the Bashiqa (30 km east of Mosul) and the Qand (40 km north-east of Mosul) and the Smeal (20 km northwest of the city of Dohuk), as it was collected (30) samples (20 specimen soil and 10 samples of rocks) spread over five regions and each region provider soil (Pedon) one representative of four models of soil (representing four depths) as well as for samples were selected from outcrops rock nearby and of the composition of Anjana (Upper Miocene).

1: Pedological Processes:

It means all the Pedological Processes responsible for the emergence and evolution of soils include the impact of these Pedological Processes five factors of the materials constituting the starting material (Parent Material) of the soils. It could be argued here that these Pedological factors will be limited to the surface horizons (horizon A) and sub-surface horizons (horizon B), and include these factors as follows:

An Addition:

It is intended to add material from external sources to the soil come from outside the body of the soil, as an addendum to water and the magnitude of the material dissolved, whether in the form of falling rain or sources of irrigation as well as for organic materials or living organisms or the addition of the outstanding from the water or air or both.

The Losses:

This process is intended loss of salts and weathering products from the body of the soil as a result of washing, or water loss through evaporation - transpiration and exit of gases of different kinds of events as a result of the living. It is noted by the results of loss and acquisition transactions and weathering and washing agent that areas characterized by high amounts of receipt falling rain where the worker washing high relatively.

Movement and Translocation of salts:

include the operations of transmission of the salts unstable up effect of capillarity or down, down from one point to another within the body of soil moisture by succession of seasons, and drying.

We may find in this case that the elements that are linked within the freak salt such as sodium, potassium, calcium and magnesium are concentrated in the prospects of Central ratios greater than the prospects of surface and prospects of deep and this is due to the vulnerability of these salts characteristic of poetry (the rise of salts from the bottom up) as well as transfer of salts from the top to the bottom as a result affected by the washing operations.

Transformation:

a process of transformation of metals and compounds of the image to another as well as the stages of transformation of organic matter and spoke such a phenomenon is very limited in some models of soils study has been lacking at times in the others, was due to the low amounts of rain falling (as it plays the water role important in the process of transition metals, as in the case of turning clay minerals and metals of gypsum) and the fact that most of the study areas are located within the dry conditions and semi-arid and this in turn makes it difficult for the phenomenon of transition metals (Transformation) in such soils.

The heart of the soil and mixing it.

Pedoturbation:

occur the heart of the soil and mixing operations of a natural phenomenon (Churning) that you get as a result of cracks that occur in the dry season and this leads to the descent of soil surface to the bottom and push the soil from below the surface to the surface, leading to confusion and the heart of the soil on an ongoing basis. It is known that this phenomenon occurs in conditions such as study areas (climatic conditions dry and semi-arid).

2: Business field:

Sites have been identified soil profiles and rock samples on the map and described in. Was selected models of soil and rocks based on the idea of installing geologic formation of rock material origin (Parent Material) which is configured Anjana with partial participation of configurations other, as well as the installation of Field observations of soil and circumstances of its composition (Operations geochemical and Pedological) with the relative change in climatic conditions (incident rainfall and temperature) as well as on the impact of other factors. Featuring all areas of study that it is under the climatic conditions dry and semi-arid, but to different rates of falling rain annual of the few to medium, ranging between (200- 300 mm / yr.) in the drunk, the lowest amount of rain in the study area either rates of amounts of rain falling in areas of study (Bashiqa and Qand) are almost comparable, ranging from (300- 400 mm / yr.) while up rates of falling rain in the Smeal up (500-600 mm /yr.). Finally, in area Zaweta rain falling rates of up to about (850 mm / yr.).

3- Morphological Description of Soil Profiles:

Has been installed and the morphological characteristics of appropriation field "on the bases set forth in the Guide to the soil survey ((Soil Survey Staff, 1994, as shown in the following:

Pedon No. : 1 (Makhmour Profile) plate (1):

Location: the province of Nineveh - Makhmour a distance of about (1.5 km) to the west of qara chok-fold.

Order: Inceptisols

Date of Description: (30 - 03 - 2008).

Parent Material: sandy and calcareous rocks and clays.

Topography: flat.

Drainage: Good.

Land Uses: cultivation of cereals (wheat and barley) + fruit orchards.

Slope: flat.

4: Classifications of Studied Soil:

Soils of the study were classified based on the foundations of Soil Classification (Soil Taxonomy) and depending on the physico-chemical and morphological study that has been presented by the table (1).

Table 1. Classification of soils study sites

No.	location	order	Sub order	Great groub
	Makhmour section (Nineveh)	Inceptisols	Ochrepts	Xerochrepts
2-	Bashiqa section (Nineveh)	Entisols	Fluvents	Torrifluvents
3-	Qand section (Nineveh)	Aridisols	Orthids	Calciorthids
4-	Smeal section (Dohuk)	Vertisols	Xererts	Chromoxererts
5-	Zaweta section(Dohuk)	Mollisols	Xerolls	Argixerolls

5: Grain Size Analysis:

Characterized most of Pedons study areas as being of good content mud high, and attributed the cause of the increasing clay content macro in outlook lower for all Pedons to the movement of minute soft horizons of surface horizons under the surface by the operations of washing slow or transportation mechanic, thus increasing the proportion of coarse-grained in the prospects of surface and decline with depth. It may be by a process of self-mixing of the soil (Churning) as in the soils vertisols came last observation consistent with what the (1998 Isbell,) in his study of the characteristics of soils and varieties vertisols in Australia.

In general, the longer working topographic factor climate are important factors in influencing the distribution ratios sizes granular soils, and this seems obvious, in most of the prospects of sections of study and in spite of the low rates of falling rain, the more components of clay with depth as a result of this rain that work on the movement of these minutes small towards the bottom.

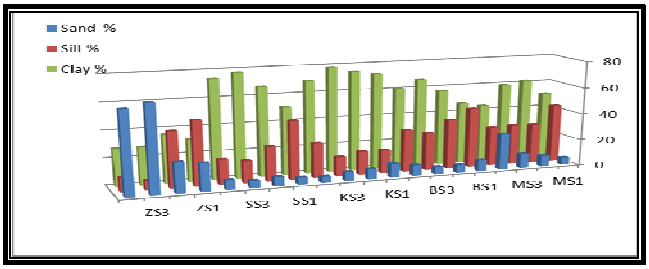


Figure 2. The distribution of volumetric ratios in models of sections of the study (soil samples)

6: Parent Material Uniformity:

In order to identify the extent of homogeneity of material originally formed from the soil has been relying on the accounts of the proportion of fine sand (125 - 50 µm) to the proportion of sand aggregate (2mm-50 µm) and all sections of study and because sand of this size is a low traffic and are affected little operations of soil formation (Barshad, 1964) and (Beshay & Sallam, 1995 in Sheikh Bzena, 2003). and found to compare the content horizons upper fine sand and coarse to the sections of the study with some of them that there are homogeneous, plumb in the proportion of fine sand / sand aggregate As shown in Figure (3).

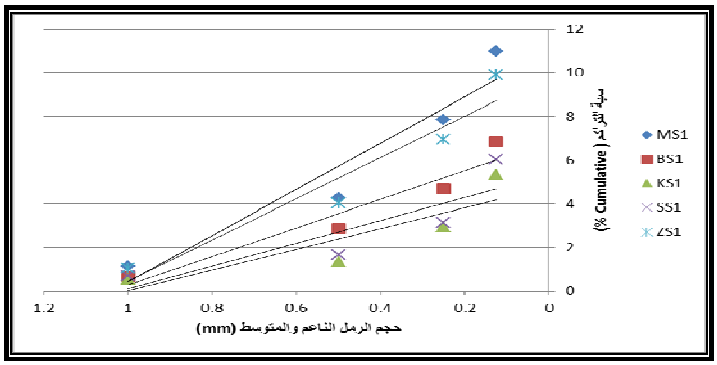


Figure 3. Determine the homogeneity of the study areas soils

The homogeneity in the vertical distribution of sand between the horizons Supreme clips study indicates the presence of heterogeneity in the original materials of the soils studied, dating back mostly to the residue and materials out of one and the composition of Anjana was also reference to it previously.

It should be noted that these ratios may vary among some sections of the study and this in turn reflects the contrasting events Pedological significantly as well, the geological conditions in those areas studied and factors of soil formation, since each process geological, or a factor of soil formation effect certain in the distribution of particularly with regard to the movement and deposition of components as well as geological for the difference in the intensity of weathering processes between soils (Brewer, 1976).

7 - Physical and chemical characteristics of soils:

Study was conducted physical and chemical characteristics of soils present study to reflect the importance of the statement in the characteristics and merits of each type of these soils. And these qualities will be discussed, as follows:

7-1 Total Calcium Carbonates:

The results in Table (2) to the content of the horizons of soils studied calcium carbonate overall increase with depth in all sections, and between (11.80 - 38.34%), which clearly reflects the operations of washing constant with time for the calcium carbonate of the prospects of surface and accumulation in the prospects under the surface as well as "for soils affected by this feature capillary tubes that allow the movement of calcium carbonate dissolved from the deep subsurface horizons to horizons above it.

The reason for the disparity in the amount of calcium carbonate and the nature of distribution in soil profiles of the study areas is attributable mainly to the nature of the material origin of rocks, (Carbonate Rich Sandstone) as well as on the rocks of limestone and to the climatic conditions of the soils study, which is similar to the Mediterranean climate which indicates that the increase Carbonate in the surface layer is the result of the nature of the materials originally consisting of rocks of limestone and rich Calcium Carbonate as well as the succession of courses wetting and drying in these regions. It is worth mentioning here is that the soil area drunk and Bashiqa is located within the semi-arid region where high-temperature and lack of rain These results are consistent with the findings of the (Paquet and Clauer, 1997; Saleh, 1979; Siderius, 1973). The reason for the increase in the amount of calcium carbonate with depth was due to that most carbonates concentrated in the separated clay in horizons bottom of the section that happen to a significant accumulation of carbonate due to increasing clay content in the lower horizons of the section.

Table 2. The physical characteristics and chemical models of the current study Submitted site

Location and order	Depth	$CaCO_3$ (%)	CEC سنتيمول.	EC $dS.m^{-1}$	pH	Organic Matter (%)	Bulk Density (ρ_b) gm/cm^3
Makhmour (M) Inceptisols	MS1 surface	33.87	39.54	1.53	7.95	1.74	1.36
	MS3 sub surface	38.34	38.51	1.92	8.05	0.85	1.67
	Av.	36.01	39.03	1.72	8.0	1.3	1.52
Bashiqa (B) Entisols	BS1 surface	26.77	34.23	0.48	7.76	2.15	1.45
	BS3 sub surface	31.65	32.55	0.32	7.79	0.98	1.76
	Av.	29.21	33.39	0.40	7.78	1.56	1.60
Qand (K) Aridisols	KS1 surface	23.86	38.36	0.45	7.68	1.84	1.33
	KS3 sub surface	26.10	34.65	0.34	7.85	1.05	1.70
	Av.	24.98	36.50	0.40	7.76	1.44	1.52
Semeal (S) Vertisols	SS1 surface	15.65	37.94	0.40	7.77	2.32	1.56
	SS3 sub surface	19.75	33.55	0.33	7.78	1.23	1.78
	Av.	17.70	35.74	0.37	7.78	1.77	1.67
Zaweta (Z) Mollisols	ZS1 surface	11.80	40.51	0.39	7.42	4.45	1.60
	ZS3 sub surface	18.85	30.85	0.30	7.55	1.47	1.81
	Av.	15.32	35.68	0.35	7.49	2.96	1.71

7-2: Cation Exchange Capacity (CEC):

Reflect the cation exchange capacity (CEC) of the Group of cations exchanged (such as calcium, magnesium, sodium and potassium) and on the sites exchange of clay minerals, and values ranging between (30.85 - 40.51 Sntimol. Kg) and attributed the cause of increased values (CEC) in horizons surface to increase the content of the article membership and that are involved in surface adsorption and thus increase the values of exchange capacity of the positive ions, on the other hand appeared Clear differences in the values of cation exchange capacity with different depth layers as begun to fall these values in the prospects under the surface and these findings are consistent with what he found (Obeidi and Mohamed, 1998) The reason for the difference in mineral composition and the percentage of clay and calcium carbonate, as it was observed a relationship between cation exchange capacity and the pattern of distribution of clay in the horizons of soils studied.

7-3: Electrical Conductivity (dS.m-1 EC):

Soils characterized by areas of study in general and except as drunk providers and the extent of low salinity ranged between (0.30 - 1.92 $dS.m^{-1}$) As can be seen from the table (2), and the low content of salts in the soils study reflects the effectiveness of the washing process, including salts, as well as case good natural drainage and low water level the ground. The low values of (EC) to the lack of salinity in some sections of the study such as the section corner to the lack of rocks out of the container and salts to lower the water level as the ground water used for irrigation, low salinity (Saleh, 1979). Also, the low values of electrical conductivity (EC) of soils study may be due as well, to be affected the presence of calcium carbonate secondary as the conditions basal helped to provide new construction of these soils making it easier to configure a system of spaces as it helps to wash salts in Pedons study and therefore the absence of any indicators for the occurrence of the process of salinization (Alsnjara, 2007). The reason for the relative increase in the values of electrical conductivity (EC) models for soils drunk might point to the climatic conditions prevailing in that region (high temperature and rainfall low) as well as all irrigation water used for irrigating the land.

7-4: pH:

Indicate the values of pH (pH) in models of soils of the study (7.42 -8.05) and shown in the table (2) to that all the soils studied were neutral and slightly bent of the base (especially in Makhmour section) with a note that there is rising a little in the values of (pH) with depth and all sections of the study, was largely due to increased content of soils of calcium carbonate with depth and to the high rate of saturation rules ground (Loeppert et al., 1994 Saleh, 1979 ;), as well as the factors of soil formation that run on increase the content of these soils from carbonates, as characterized by the ability of regulatory carbonates good, making it resistant to the changes in the degree of interaction was confirmed by the soil (Pacharne et al., 1996).

7-5: Organic Matter:

The table (2) that the content of organic matter models of soils study and the exception of soil Zaweta was low and the extent of between (4.45 - 0.85%) due to the climatic conditions prevailing where high temperatures and moisture content low in summer, which increases the operations of oxidation of organic matter as well as the lack of cover Plant The reason for the relatively high content of organic matter in a section corner (1.47-4.55%) has reflected the climatic conditions prevailing in that region (incident rainfall and higher moisture content higher) and the nature of the vegetation prevalent and harm consists mostly of pine trees (Saleh, 1979 Kleiss, 1970 ;).

7-6: Bulk Density (gm / cm^3):

Values of bulk density samples soils study Ranged between (1.33-1.81gm/cm^3) The results shown in (Table 2) generally to increase their values with depth and attributed the cause of the increase in bulk density with depth for all horizons to increase the amount of clay as the increase in rainfall has caused the reduction and disability natural drainage as it works to increase the rate of weathering and the composition of the mud and increasing stratification and lack of formation groupings and this was confirmed (Parfit et al., 1984). due variation in the values of bulk density between the study areas to the nature of the climatic conditions prevailing in those areas and the content of the soil of calcium carbonate, which reflected in the rates of gatherings.

7-7: Soluble Ions :

The ion magnesium dissolved ($Mg^{+ +}$) ranged quantities between (1.41-0.30$ml.Liter^{-1}$) Table (4) may be a reason for the increase of this ion is the weathering of minerals bearing magnesium such

as dolomite and clay minerals (chlorite and smectite) as well as on the operations of added of magnesium through irrigation groundwater (and especially the Makhmour section), which carries with it the ion magnesium dissolved, may be attributed cause of the low concentrations of ion magnesium dissolved in excerpts of his corner and Smeal to the operations of washing of the addition to the fact that the soil in those sections of tissue clay loam and at least the content of the separated clay, as the magnesium dissolved concentrated presence in the separated clay, especially in the process of clay minerals (eg. chlorite and vermiculite, palegorskite) most common in soils, such as Makhmour and Bashiqa section. The findings are consistent with what was noted by him (Alsnjara, 2007)

Table 4. Chemical characteristics (dissolved ions) samples of soils of the current study

Soil Order	Depth	(Cations) meq.lt^{-1} (				(Anions)meq.lt^{-1}(		
		Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	$C1^{-}$	SO_4^{2-}
Makhmour (M) Inceptisols	MS1 surface	2.65	1.23	1.22	0.29	2.36	1.45	1.67
	MS3 sub surface	1.97	1.25	1.20	0.22	2.03	1.06	1.73
Bashiqa (B) Entisols	BS1 surface	2.45	1.15	0.99	0.28	2.15	0.94	1.70
	BS3 sub surface	1.87	1.41	0.98	0.24	2.12	0.88	1.55
Qand (K) Aridisols	KS1 surface	2.14	1.20	1.02	0.19	1.86	1.32	1.39
	KS3 sub surface	1.85	0.86	0.95	0.13	1.44	0.98	1.32
Semel (S) Vertisols	SS1 surface	2.35	0.61	0.81	0.27	1.50	0.97	1.55
	SS3 sub surface	1.90	0.44	0.65	0.23	0.81	0.87	1.42
Zaweta (Z) Mollisols	ZS1 surface	2.06	0.57	0.72	0.11	1.36	1.27	0.90
	ZS3 sub surface	2.23	0.31	0.77	0.10	1.86	1.28	0.18

The ion sodium dissolved (Na^{+}) appeared to concentrations higher than the concentrations of potassium (K^{+}) and for all soils studied (and in particular soils drunk) may be due to the use of well water for irrigation and the container on the proportion of dissolved salts, which lead to increased concentrations of sodium. The reason for the low ion of sodium in the clips Smeal and the angle not to use well water for irrigation as well as "the nature of the process of washing in those areas because of the abundance of the amount of falling rain and on the contrary, in a section drunk that with increasing concentrations of sodium ion dissolved due to poor washing process because of the climatic conditions prevailing in that region as well as on the operations of the perfusion territory of the water wells and carry the water of dissolved and suspended materials, in particular sodium ion dissolved.

The ion potassium dissolved (K^{+}) were characterized by soils study, down content in all sections of the study, and less with depth for all horizons of the study and noted that the change in the values of potassium dissolved with depth are minor changes and perhaps due to the homogeneity of distribution of metal for metal-bearing potassium, such as vermiculite and illite with Depth to horizons clips study that they were the proportions are close together in the prospects of surface and subsurface as the changes in the content mud is not large with depth, as that there is a correlation of potassium in the soil with the separated clay and in the presence of clay minerals-bearing potassium (such as illite) in the separated clay .

8:Conclusions:

- The rates of distribution volumetric samples in soils study shows that the texture of these soils ranged from clay in most soils sections of study and between sandy clay loam in samples of soil Zaweta which enriched horizons under the surface and bottom sizes clay, indicating high rates of movement due to exposure to mud and washing, suggesting a high degree of development of this soil compared with the rest of the soils of the study.
- Results of the analysis showed the vertical in the proportion of fine sand / total sand and the presence of heterogeneity in the original materials (Genesis Anjana with some other formation) for all soils profile of the study.

- Despite the similarity of the geological conditions and pedogenic, but he could feel the relative differences in the analytical data and calculations to study soils clips, which range between two representatives of sections of Zaweta and Makhmour soils.
-The degree of development of soils ranged from Makhmour section, which is the least sophisticated and Qand, Bashiqa , Smeal access to the Zaweta, which is the most sophisticated.

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Comparison of Soil Type in Similar Land Forms Units as an Indicator to Present Principle Levels of Environment Management

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Abstract
In Iran, types of soil describe overall physical attributes of a section of the land surface, such as land type (based on physiographic and lithology) and land form (based on geomorphology and physiographic).presented approach to study of soil types is based on land forms units and project aim is compression of types of soil in the similar land forms. Land forms are units that form according to erosional processes (water and wind).Based upon physiographic condition, land forms divide into subclasses. The studied area (Abshirvan basin) is fund in the west of Iran with covering an area of 23000 Ha. The land forms are classified according to erosional behavior of different lithologic units. In the second-level the homogeneous units are formed. These are characterized by homogeneous, geomorphology, slope, geographic aspect and hypsometry. According to these studies, 10 similar homogeneous units obtained. The soil profile has been dug in each similar homogeneous unit. The soil profiles were described in the filed. Routine laboratory analyses included soil texture, PH, Ec, organic matter, cations and anions. Soil taxonomy were determined based upon tree methods; U.S, F.A.O and French classifications. The studied have shown that soil properties are often the result of land forms morphology. Classification of soils in the similar homogeneous units have shown that; in soil taxonomy (U.S. method), the soils species are similar to category of the sub great group, in soil taxonomy (French classification) the soils species are similar to category of the sous class and but in soil taxonomy (FAO), the soil species to category of the sub group are similar.The similar homogeneous units (land forms) enable users to decision make on using one of the soil taxonomy methods.
Keywords: land form, erosional processes, Abshirvan basin, land type, homogeneous units

Introduction
There are different methods to study of soil, i.e. land system, land form, land type, land care, landscape, in this project is used from landforms units for soil evaluation. Realistic understanding and evaluation of land forms can be achieved through an integrated approach to the terrestrial environmental.

Materials and Methods
General description of the study area
The studied area is located on the east of Ilam town in the west of Iran and its boundary is approximately in coordinates 46°, 35′ to 46°, 50′ eastern longitudes and 33°, 29′, to 33°, 26′, northern latitudes (Figure 1). The area is 200000 ha, its altitudes is varied from 700 to 2545 m above the sea level, consequently the average elevation is 1622 m from sea level; the climate is semi-humid with the average rainfall 674mm. a major part(approximately 50%) of the study area are covered with topographic slope more than 20%.

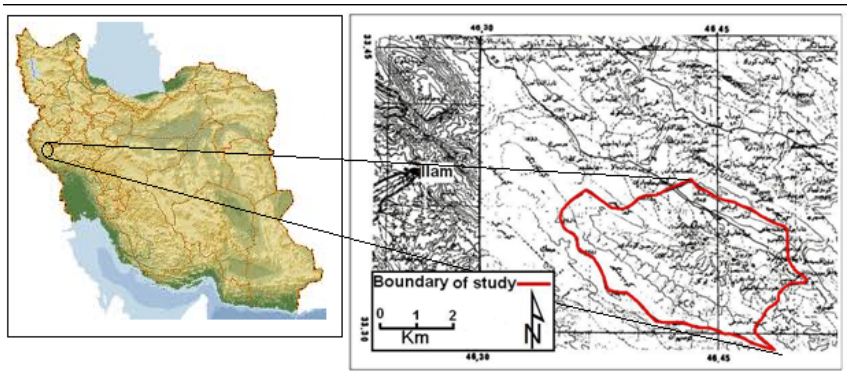


Fig.1.Situation of studied area in Iran

Material

This study was done based on following documents:

1. Topography maps (scales 1:50000, 1:250000), in order to prepare region base map and determination of physiographical characteristics including slope, geographic aspect and hypsometric.
2. Geologic map (scales 1:100000). This map done to study lithology and tectonic characteristics and relations of these in shaping studied region.
3. Aerial photos with scale 1:50000 and 1:20000, for interpretation geomorphologic (land forms) characteristics of the studied region.
4. Preparing geomorphologic map based on aerial photo interpretation, topography maps and geology map.
5. Field observation for complementing geomorphology studies and also profile digging in order to soil sampling.

Methods

Using of mentioned documents, the following method was carried out:

1. Interpretation of aerial.
2. Preparing Land forms map based on aerial photo interpretation.
4. Field observation for complementing land forms studies.
5- Preparing slope map.
6- Preparing hypsometric map.
7- Preparing geographic aspects map.
8- Incorporation of maps of slope, hypsometry and geographic aspects.
9- Establishing map of homogeneous units.
10- Establishing map of similar homogeneous units.
11- Studying and classification of soil species.

Results

Land forms (Fig.2).

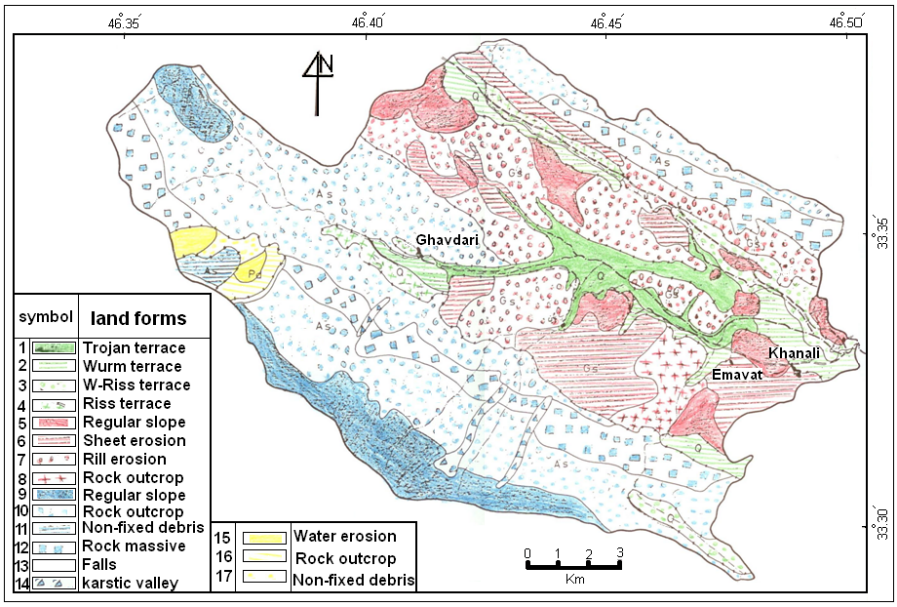


Fig.2.Land forms map

Slope (Fig.3).

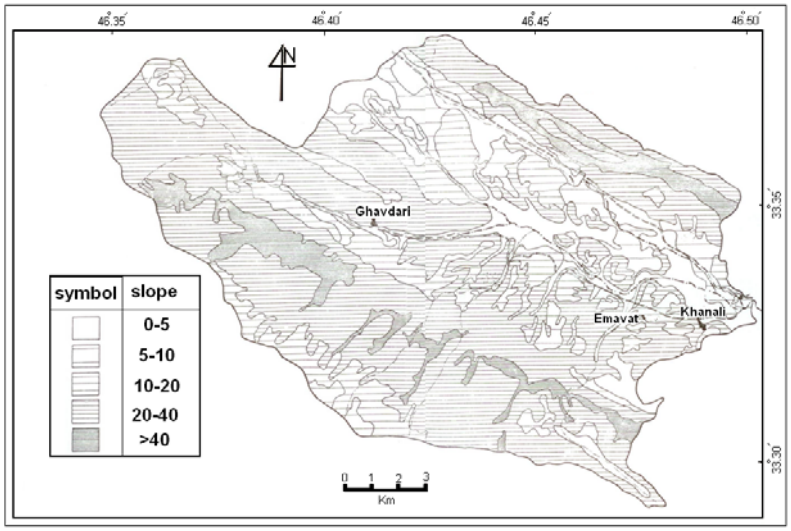


Fig.3.Slope map

Hypsometry (Fig.4).

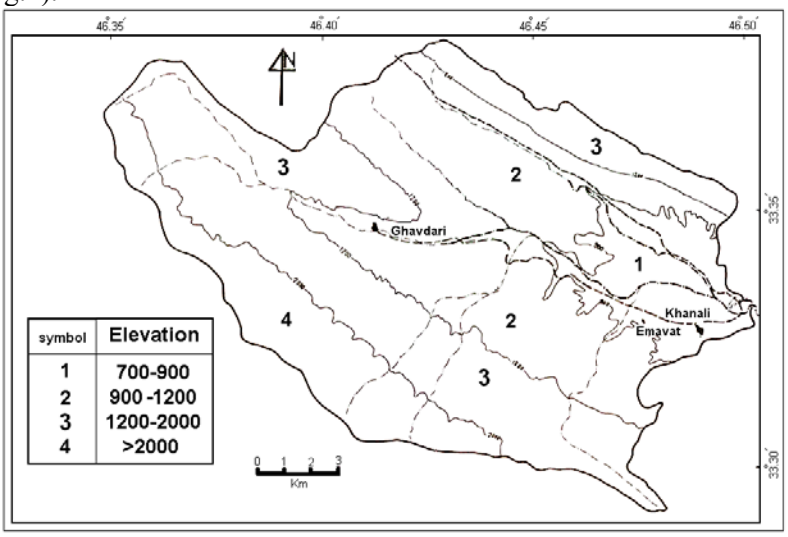


Fig.4.Hypsometric map

Geographic aspects (Fig.5).

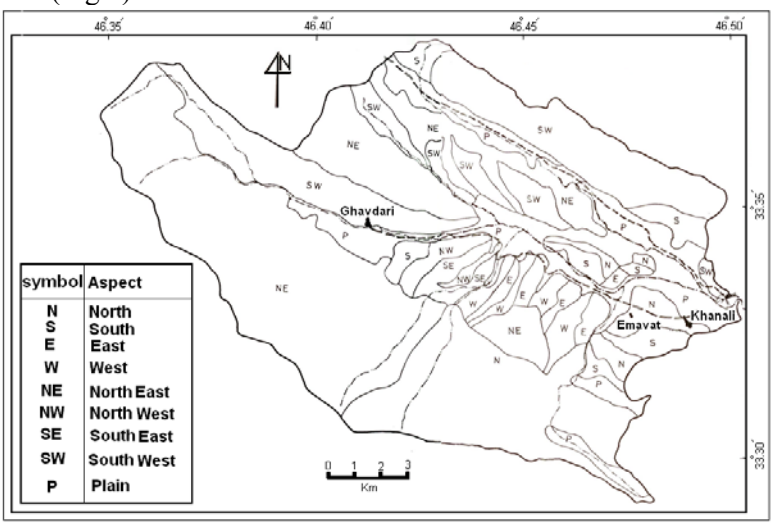


Fig.5. Geographic aspects map

Similar homogeneous units (Fig.6).

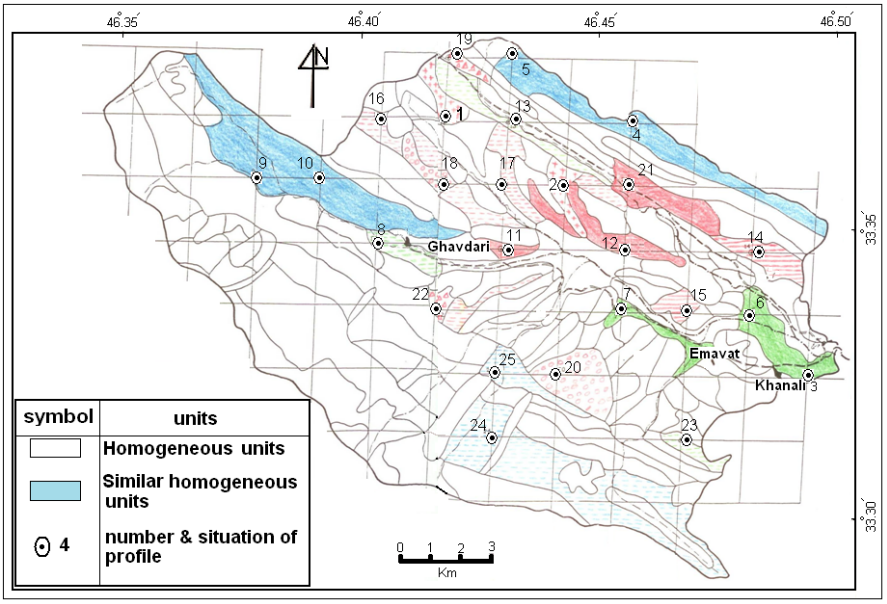


Fig.6. similar homogeneous units map

Geology (Fig.7).

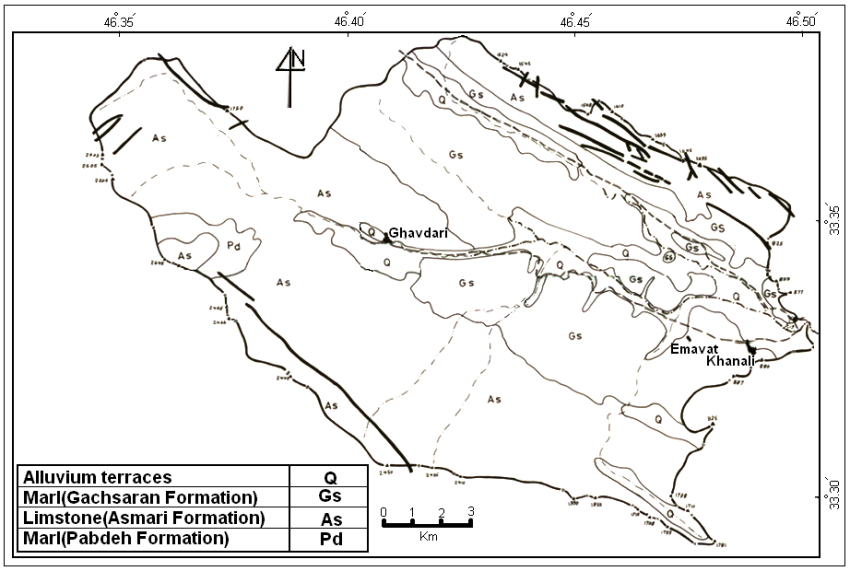


Fig.7. Geology map

Pedology

These studies carried out on land forms. Soil taxonomy is showed in table 2

Table2: Soil taxonomy in similar homogeneous units

Code of similar homogeneous units	No. profile	U.S.D.A.Soil Taxonomy					F.A.O	French Taxonomy
		Soil family	Subgroup	Great group	Sub order	order	Subgroup	Sous classe
1	1	Fine,mixed(calcareous),mesic	Typic Xerorthents	Xerorthents	Orthents	Entisols	Calcaric Regosols	Xerorankers
	2	Fine,mixed(calcareous),mesic	Typic Xerorthents	Xerorthents	Orthents	Entisols	Calcaric Regosols	Xerorankers
2	3	Fine,mixed,Thermic	Typic Xerochrepts	Xerochrepts	ochrepts	Inceptisols	Calcaric Cambisols	Sols brune calcaire
	6	Fine,Carbonatic,Thermic	Typic Xerochrepts	Xerochrepts	ochrepts	Inceptisols	Calcaric Cambisols	Sols brune calcaire
	7	Fine,mixed,Thermic	Typic Xerochrepts	Xerochrepts	ochrepts	Inceptisols	Calcaric Cambisols	Sols brune calcaire
3	4	Loamy,Skeletal,mixed(calcareous),mesic	Lithic Xerorthents	Xerorthents	Orthents	Entisols	Eurtic leptosols	Lithosols des deserts chauds
	5	Loamy,Skeletal,mixed(calcareous),mesic	Lithic Xerorthents	Xerorthents	Orthents	Entisols	Eurtic leptosols	Lithosols des deserts chauds
	9	Loamy,Skeletal,mixed(calcareous),mesic	Lithic Xerorthents	Xerorthents	Orthents	Entisols	Eurtic leptosols	Lithosols des deserts chauds
	10	Loamy,Skeletal,mixed(calcareous),mesic	Lithic Xerorthents	Xerorthents	Orthents	Entisols	Eurtic leptosols	Lithosols des deserts chauds
4	8	Fine,mixed,mesic	Typic Xerochrepts	Xerochrepts	ochrepts	Inceptisols	Calcaric Cambisols	Sols brune calcaire
	23	Fine,mixed,mesic	Typic Xerochrepts	Xerochrepts	ochrepts	Inceptisols	Calcaric Cambisols	Sols brune calcaire
	13	Fine,mixed,mesic	Typic Xerochrepts	Xerochrepts	ochrepts	Inceptisols	Calcaric Cambisols	Sols brune calcaire
5	11	Fine,mixed(calcareous),mesic	Lithic Xerorthents	Xerorthents	Orthents	Entisols	Calcaric Regosols	Xerorankers
	12	Fine,mixed(calcareous),mesic	Lithic Xerorthents	Xerorthents	Orthents	Entisols	Calcaric Regosols	Xerorankers
	21	Fine,mixed(calcareous),mesic	Lithic Xerorthents	Xerorthents	Orthents	Entisols	Calcaric Regosols	Xerorankers
6	14	Loamy,Skeletal,mixed(calcareous),Thermic	Typic Xerorthents	Xerorthents	Orthents	Entisols	Calcaric Regosols	Xerorankers
	15	Loamy,Skeletal,mixed(calcareous),Thermic	Typic Xerorthents	Xerorthents	Orthents	Entisols	Calcaric Regosols	Xerorankers
7	16	Fine,mixed(calcareous),mesic	Typic Xerorthents	Xerorthents	Orthents	Entisols	Calcaric Regosols	Xerorankers
	17	CoarsLoamye,mixed(calcareous),mesic	Typic Xerorthents	Xerorthents	Orthents	Entisols	Calcaric Regosols	Xerorankers
8	18	Fine,mixed(calcareous),mesic	Typic Xerorthents	Xerorthents	Orthents	Entisols	Calcaric Regosols	Xerorankers
	20	Fine,mixed(calcareous),mesic	Typic Xerorthents	Xerorthents	Orthents	Entisols	Calcaric Regosols	Xerorankers
9	19	Fine,mixed(calcareous),mesic	Typic Xerorthents	Xerorthents	Orthents	Entisols	Calcaric Regosols	Xerorankers
	22	Fine,mixed(calcareous),mesic	Typic Xerorthents	Xerorthents	Orthents	Entisols	Calcaric Regosols	Xerorankers
10	24	Fine,mixed(calcareous),mesic	Typic Xerorthents	Xerorthents	Orthents	Entisols	Calcaric Regosols	Xerorankers
	25	Loamy,Skeletal,mixed(calcareous),mesic	Lithic Xerorthents	Xerorthents	Orthents	Entisols	Calcaric Regosols	Lithosols des deserts chauds

Discussion

In this method, because of using erosional behavior of bed rock, the land forms play an important role in the soil properties. Our approach to soil classification is based on a combination of land form and physical attributes criteria .The philosophy to which we adhere is that this method considers the integration of all factors, which determines a real differentiation into a certain level of soil type. This method not only will it become more easily measurable and with greater precision, but also it will reflect total changes. For example, change in land form will certainly lead to great changes in soil conditions.

It is evident that incorporation of land forms units with physical attributes can provide units which have common character. These units called homogeneous units.

The studied have shown that soil properties are often the result of land forms morphology. Classification of soils in the similar homogeneous units have shown that; in soil taxonomy (U.S. method), the soils species are similar to category of the sub great group, in soil taxonomy (French classification) the soils species are similar to category of the sous class and but in soil taxonomy

(FAO), the soil species to category of the sub group are similar. The similar homogeneous units (land forms) enable users to decision make on using one of the soil taxonomy methods.

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Soil Survey and Mapping of Soils Formed on Two Different Physiographic Units and Their Classification

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Abstract

The study area has two major physiographic units. One of them is river alluvial plain that is common in study area and second unit is hilly topography. Especially, alluvial land, formed on accumulated sediment depositions by time, show large variety in their properties at short distances. The objective of this research was to determine and classify different soils formed on alluvial plain and hilly land. This study was carried out in Çetinkaya district located on near the Bafra Plain. The study area covers about 1762.4 ha. Average annual temperature and precipitation are 13.6 ºC and 764.3 mm, respectively. After examination of topographic, land use, geologic and geomorphologic maps and land observation, 11 profile places were excavated in study area. Detailed land observations were done with grid method and auger examinations. The soil samples were taken from each profile and their analyses were done in the laboratory. By assessing the results of analyses and field studies, 10 different soil series were determined and described. Five of them were classified as Entisol due to their young age and three are as Inceptisol and two are as Mollisol. Whereas Kızılırmak series has the largest area (17.9 %), Çiftlik series has the smallest area in the study area (4.0 %).
Keywords: Physiographic units, soil survey and mapping, soil classification

Introduction

Soil survey provides an accurate and scientific inventory of different soils, their kind and nature, and extent of distribution so that one can make prediction about their characters and potentialities (Manchanda et al., 2002). It also provides adequate information in terms of land form, terraces, vegetation as well as characteristics of soils (texture, depth, structure, stoniness, drainage, acidity, salinity and so on) which can be utilized for the planning and development. Jenny's (1980) well-known soil forming factor equation identifies the five factors of soil formation. Soil is characterized as a function of parent material, climate, organisms, and relief and time. The equation implies that, by looking for changes in one or more of these factors as the landscape are traversed, one can accurately locate boundaries between different bodies of soil. Soil survey map units are based on a variety of landscape properties such as soil morphology, substratum type, slope, landform and flooding frequency. These properties have been chosen because they affect the land's capabilities and its response to management. Dengiz and Baskan (2010) indicated that soil formations were highly associated with topographic positions which influence on morphological and physico-chemical characteristics of the soils in local region. In their study, they found that young soils due to minimum soil formation and classified as Entisol / Leptosol while, Inceptisols / Cambisol and Calcisol on plateau position had the greatest degree of pedogenesis that have cambic and calcic main subsurface diagnostic horizons. In addition, Dengiz et al. (2008) investigated physical, chemical and morphological properties, classification and mapping of soils of hazelnut cultivation in Ünye-Tekkiraz district of The Eastern Black Sea Region. After examination of topographic, land use, geologic and geomorphologic maps and land observation, 15 soil profiles were investigated in the study area. According to their results, 11 different soil series were classified and described. Two them were classified as Entisol due to their young age and five are Inceptisol, three are Alfisol, and one is Vertisol. Whereas Hatipler series has the largest area (14.7 %), Yenicuma Dere soil series has the smallest area in the study area (3.2 %).

Technological advances during the last few decades have created a tremendous potential for improvement in the way that soil maps are produced (McKenzie et al., 2000, Bolca et al. 2011). Such as geographic information system (GIS) and remote sensing (RS) contribute to the generation of topographic data in form of digital elevation models (DEM) to study terrain attributes that theoretically influence pedogenesis (Dengiz and Akgül, 2005; Graham, 2006). It is also very easy to update or modify data involved in GIS database in the future. In this study, the main objectives of this research were; i-) to investigate physical, chemical, morphological properties and classification of soils, ii-) to get land slope, aspect, hill shade, drainage network, creation of a three

dimensional network structure of earth surface among application of DEM, iii-) to make soil database and mapping of soils series formed on physiographic units that are river alluvial plain and hilly topography using GIS.

Material and Method

Field Description

This study was carried out in Samsun-Bafra delta plain and near district. The Bafra Plain found in the Kızılırmak Delta and located in the central Black Sea region of Turkey (Figure 1).

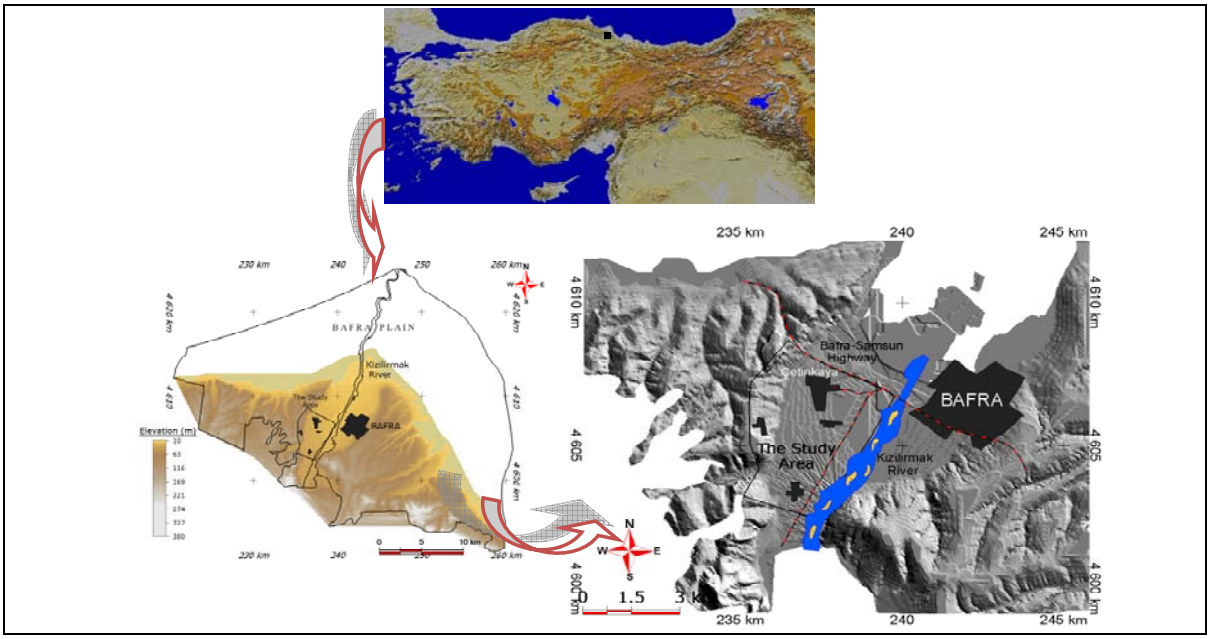


Figure 1. Location map of the study area

The study area is far 30 km from west of the Samsun province (4602-4609km N- 234-242km E UTM). It covers 1762.4 ha and its lies at an elevation from sea level 0-150 m (Figure 2).

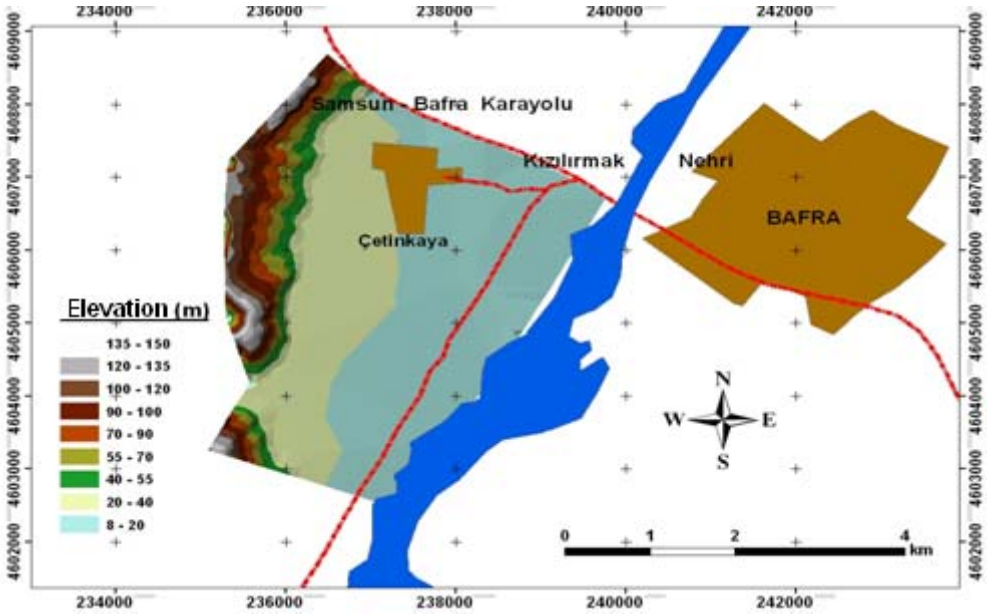


Figure 2. Elevation map of the study area

The current climate in the region is semi-humid. The summers are warmer than winters (the average temperature in July is 22.2 and in January is 6.9 ^{o}C). The mean annual temperature, rainfall and evaporation are 13.6 ºC, 764.3 mm and 726.7 mm respectively. According to Soil Taxonomy (1999), the study site has mesic soil temperature regime and ustic moisture regime. The study area has two major physiographic units. Particularly river alluvial plain is common and it has slightly sloped (0.0-2.0%) and second unit is hilly and moderately to severe sloped (%3-20). The majority of research area's soils were classified as Vertisol, Inceptisol and Entisol in Soil Taxonomy (1999). Flat land of the study area has been under intensive agricultural activities. Rice, wheat, maize, pepper, watermelon, cucumber and tomato with sprinkler and furrow irrigations in the summer, and cabbage and leek in the winter have been produced in the study area. The main water resource to this area is Kızılırmak River. The study area has been commonly used for irrigated agriculture. Presently, the irrigation systems used by farmlands are furrow, drip and sprinkler irrigation systems

Method

Soil surveyors consider the topographic, parent material, vegetation and climate variations as a base for depicting the soil variability. In addition, soil mapping needs identification of a number of elements. These elements which are of major importance for soil survey are land type, vegetation, land use, aspect, drainage pattern, geological material, slope, relief and so on. Soils are surveyed and mapped, following three tier approaches, comprising interpretation of all data, field survey (including laboratory analysis of soil samples) and cartography (Sehgal et al. 1989; Soil Survey Staff, 1993). However, computer aided digital image processing and GIS techniques have also been used for mapping soil and advocated to be a potential tool (Dengiz et al., 2008). Descriptions of soils in the study area were accomplished according to soil survey manual (1993). Soil samples collected from all horizons were analyzed for total soluble salts, CEC (Cation Exchange Capacity) and pH (Soil Survey Staff, 1992), texture (Bouyoucos, 1951), organic matter (Nelson and Sommers, 1982), $CaCO_3$ (Soil Survey Staff, 1993) and bulk density (Blacke and Hartge, 1986). Soil classification was accomplished using Soil Taxonomy (1999).

Results and Discussion

Topographic, land use-land cover, geological maps and meteorological data were used to detect different soil profile places, to prepare soil map and to form soil data-base of the study region. First of all, Digital Elevation Model (DEM) was generated by digitizing from topographic sheets to determine elevation, slope percentage, aspect and physiographic variations (Figure 3). All these data were analysed using of TNT Mips 6.4v MicroImage GIS and RS programme.

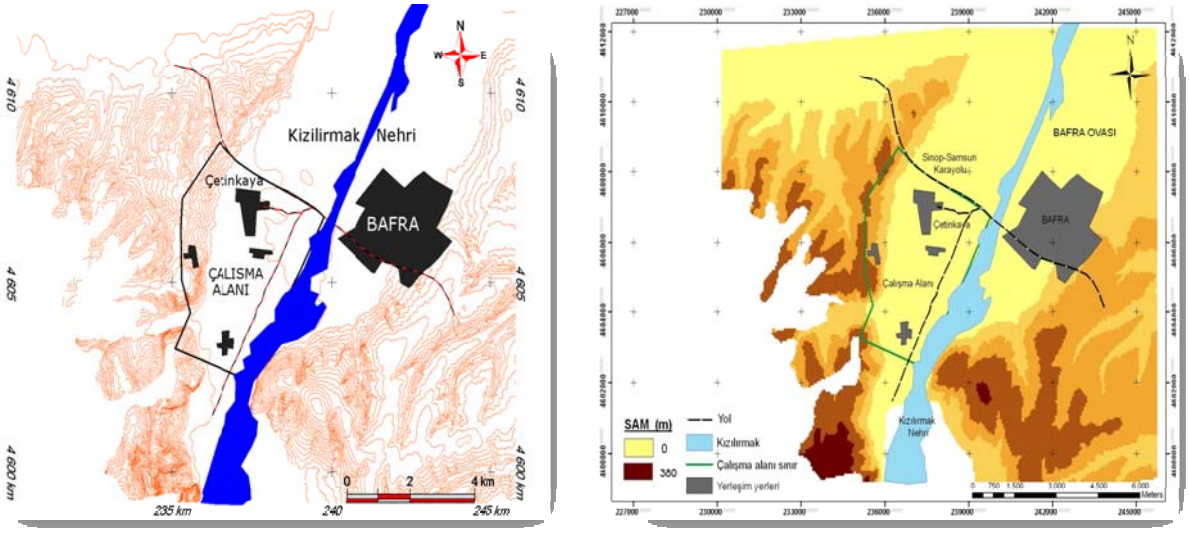


Figure 3. Topographic and DEM maps of the study area

The physiographic units were recognized and delineated by analyzing the landscape generated from DEM, elevation maps and field survey. According to slope distributions derived from DEM are more than half of the study area (1693.1 ha) has less than 10% slope and 3.9% has more than 10% slope varying from steep to very steep land

Physico-chemical and morphological properties of soils

The soil is an unconsolidated three-dimensional natural body that mantles the landscape. The characteristics and properties of soils are the result of a complex interaction of physical, chemical and biological reactions (soil forming reactions) (Edwards, 1989). The study area has two major physiographic units. Particularly river alluvial plain is common and it has slightly sloped (0.0-2.0%) and second unit is hilly and moderately to severe sloped (%3-20). Soil is a three dimensional natural body and is characterized by surface and subsurface diagnostic horizon characteristics. Total ten soil series were identified and their horizon orders of the profiles in the study area. Results of physical and chemical analyses of all soil series were given in Table 1. Whereas Kızılırmak series has the largest area (17.9 %), Çiftlik series has the smallest area in the study area (4.0 %) (Figure 4).

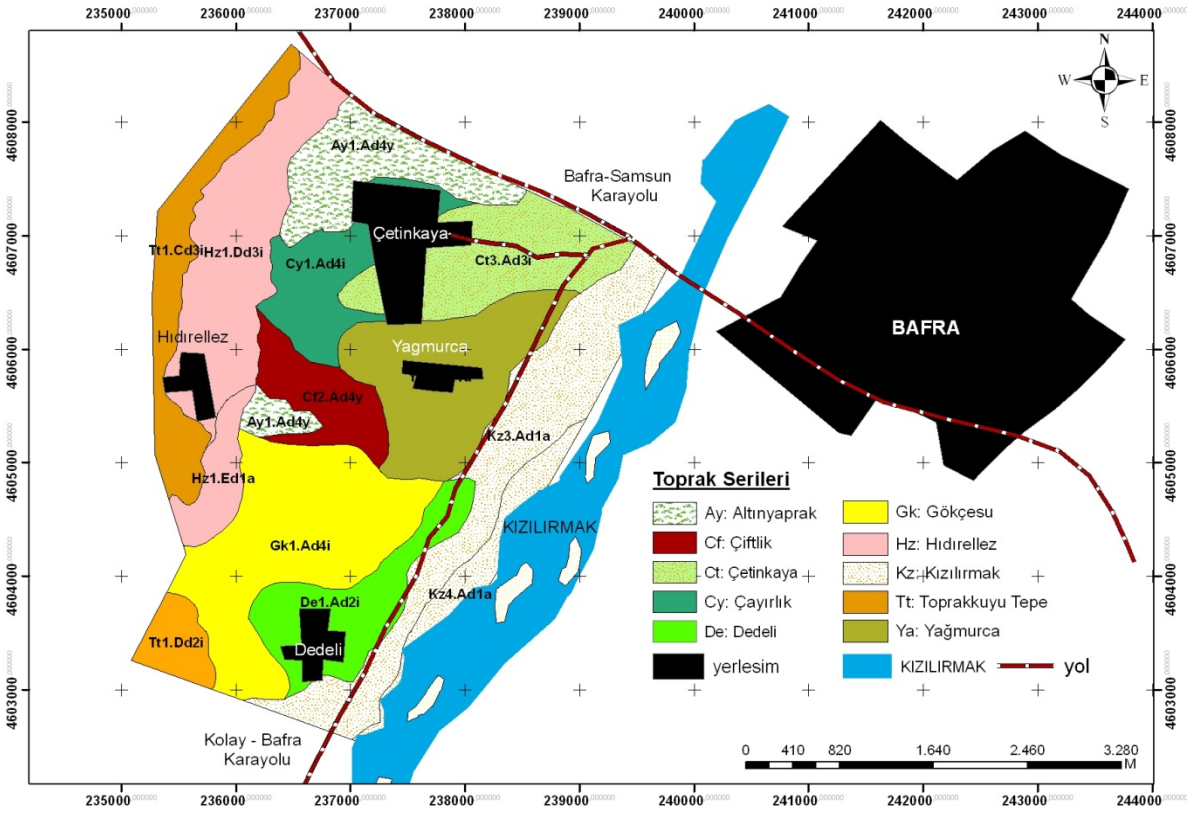


Figure 4. Soil map of the study area

Highland soils

The highlands of the investigated area are represented by marl and lime stone parent materials, hilly and mountainous land. Topraktepe and Hıdırellez soil series were identified and their horizon orders of the profiles were defined to be A-C and A-B-C, respectively. Topraktepe soil series has no diagnostic surface and subsurface horizons except for carbonate accumulation in 59-100 cm depth and low pedogenetic development. Therefore, these soils can be defined as young soils. This case is the obvious effect of eroding forces. Because, this soil series locates on steep and very steep slopes. Therefore, surface soils were carried and accumulated from uplands to low lands leading to restrict for pedogenetic process. On the other hand, Hıdırellez soil series has cambic horizon developed as a result of structural formation and calcic horizon formed from accumulation of calcium carbonate. Especially, structural development was observed after 19 cm depth while,

calcium carbonate accumulation was detected between 48-78 cm depth. Exchangeable Ca and Mg cations accounted for over 95% of the exchangeable complex as a result of the dissolution of carbonates, whereas exchangeable K and Na levels were rather low. Therefore, both soil series have very high base saturation and pH value varies 8.0-8.4. In addition, these series have high clay content so; clay is dominant texture in both soil profiles.

River alluvial plain soils

Alluvial lands formed on accumulated sediment depositions carried by Kızılırmak River. Alluvial soils are the result of processes of erosion and deposition, and therefore exhibit various characteristics reflecting the composition and properties of the material transported (Weber and Gobat, 2006). Eight soil series were identified in this physiographic unit. These are Çetinkaya, Yağmurca, Kızılırmak, Dedeli, Gökçesu, Çayırlık Çiftlik, and Altınyaprak soil series. Çetinkaya, Yağmurca, Kızılırmak and Dedeli soil series formed on alluvium parent material. Ogg and Baker (1999) concluded that development of soils in the alluvial areas was not highly affected by climate and time. This means this pedon has no diagnostic subsurface horizons and low pedogenetic development so their horizon order is A-C. On the other hand, Gökçesu, Çayırlık Çiftlik, and Altınyaprak soil series are older than that soil series and their soil horizon order are A-Bw-C and A-Bss-C. Their main pedogenic formation is development of cambic horizon and slickenside process. Maximum structural formations (strong prismatic and blocky structures) were observed in Gökçesu, Çayırlık, Altınyaprak and Çiftlik soil series whereas, structure has not developed in Çetinkaya, Yagmurca, Kızılırmak and Dedeli soil series. There are common pebbles and cobbles within profiles of Kızılırmak and Dedeli soil series. However, Kızılırmak soil series formed on young terrace (floodplain) soils where the water table is closer to the surface have redoximorphic features (yellowish-brown and yellowish-red mottles) less than 1 m depth. Soil texture varied from loam through clay loam to clay across the surface soils of all profiles. Altınyaprak and Çiftlik soil series had the highest clay content, while Kızılırmak series had the highest sand content. Soil CEC varied between 9.0 and 55.9 cmol kg^{-1}. The soil with the highest CEC was the Altınyaprak series which had the highest clay content, while Kızılırmak series had the lowest clay content. On the other hand, Kızılırmak, Çetinkaya, Dedeli, and Yağmurca soil series had a higher bulk density than other profiles due to its high sand content. The calcium carbonate content of profiles was high in Dedeli, Altınyaprak, Gökçesu and Kızılırmak series, although the Yağmurca, Çetinkaya and Çiftlik series had lower calcium carbonate contents due to carbonate leaching. For all soils, the organic matter level was highest in the surface horizon and decreased sharply to its lowest level in the subsoil. Soil organic matter content ranged from 1.1% to 3.6% in upper horizons. These low organic matter levels are attributable to rapid decomposition and mineralization of organic matter due to cultivation practices.

Soil Classification

Four soil orders, five suborders, seven great groups and eleven subgroups were identified in the study area. The soils were classified according to the criteria proposed by the Soil Taxonomy (1999) and FAO/ISRIC (2006) based on morphological, physical and chemical characteristics. According to the meteorological data, the study area has ustic soil moisture regime and mesic temperature regime. Soils of the study area were classified as Entisols (53.5%), Inceptisol (35.0%), and Vertisols (11.6 %), according to Soil Taxonomy (1999) (Table 2).

Table 2. Classifications of the study area soils a according to Soil Taxonomy (1999)

Soil Series	**Soil Taxonomy (1999)**				**FAO/ISRIC (2006)**
	Orders	Suborders	Great groups	Subgroups	
Çetinkaya	Entisol	Psamment	Ustipsamment	Typic Ustipsamment	Eutric Regosol
Yağmurca					
Kızılırmak		Fluvent	Ustifluvent	Typic Ustifluvent	Skeletic Fluvisol
Dedeli				Vertic Ustifluvent	Clayic Fluvisol
Topraktepe		Orthent	Ustorhent	Vertic Ustorhent	Vertic Leptosol
Çayırlık	Inceptisol	Ustept	Haplustept	Fluventic Haplustept	Fluvic Cambisol
Gökçesu				Vertic Haplustept	Vertic Cambisol
Hıdırellez			Calciustept	Vertic Calciustept	Calcaric Cambisol
Altınyaprak	Vertisol	Ustert	Haplustert	Calci Haplustert	Calcaric Vertisol
Çiftlik				Chromic Haplustert	Chromic Vertisol

Conclusion

This research demonstrated a clear difference in the spatial distribution of individual soil properties, which is mainly determined by in suit pedogenesis processes. Soil properties data formed on two different physiographic units soils indicated significantly differences each other in terms of pedogenic processes which have been shaped by landscape position and parent material. Another way to view this concept that these factors are keys on soil forming processes especially at the local region. In addition, the relationships between physical and chemical properties of the soils and landscape positions determined by this research affect plant growth. Study of the variations in soil properties is not only important for soil mapping and classification but also in soil management that require detailed information on spatial distribution of soil properties.

The major problem faced in conventional soil survey and soil cartography is the accurate delineation of boundary. Field observations based on conventional soil survey are tedious and time consuming. DEM, aspect, slope data in conjunction with other digital ancillary data using GIS provide the best alternative, with a better delineation of soil mapping units. However, there is a need to check with field observation for accurate soil boundary delineation (Dengiz et al, 2008).

Table 1. Results of physical and chemical analyses of soils of the study area

Soil Seris	Horizon	Depth (cm)	pH	Total salt (%)	CEC (cmol kg^{-1})	$CaCO_3$ (%)	OM (%)	B.D (gr cm^{-3})	Texture (%)			
									C	Si	S	Class
Dedeli	Ap	0-13	8.4	0.2	32.6	13.4	2.1	1.33	43	39.5	17.5	C
	A_1	13-40	8.5	0.4	37.0	14.2	1.1	1.37	40	42	18	SiC
	C_1	40-87	8.5	0.3	9.1	14.8	-	1.63	9	36	55	SL
	C_2	87+	-	-	-	-	-	-	-	-	-	-
Gökçesu	Ap	0-18	8.3	0.3	55.0	19.9	2.8	1.22	64	24	12	C
	A_1	18-44	8.4	0.3	50.6	22.8	1.1	1.19	69	24	7	C
	Bw	44-80	8.3	0.3	51.9	16.4	1.1	1.20	68	24	8	C
	C_1	80-110	8.4	0.4	43.0	17.5	0.4	1.27	50	43	7	SC
	C_2	110+	8.4	0.4	46.3	12.8	0.5	1.23	57	32	11	C
Hıdırellez	Ap	0-19	8.0	0.4	44.1	1.6	2.0	1.31	52	26	22	C
	Bw	19-48	8.2	0.4	45.8	3.3	0.5	1.26	57	26	17	C
	Bk	48-78	8.2	0.5	46.9	3.4	0.3	1.24	60	24	16	C
	Ck	78+	8.3	0.5	44.1	4.9	0.1	1.24	55	29	16	C
Yağmurca	Ap	0-20	8.1	0.2	23.1	7.9	1.6	1.51	19	33	48	L
	C	20+	8.3	0.2	11.5	17.1	0.1	1.64	11	45	44	L
Kızılırmak	Ap	0-24	8.2	0.3	23.8	13.9	1.1	1.49	25	44	31	L
	C_1	24-57	8.4	0.1	11.2	14.2	-	1.65	9	43	48	L
	C_2	57-88	8.4	0.2	9.8	14.3	-	1.64	8	31	61	SL
	C_3g	88+	8.4	0.2	9.2	13.4	-	1.65	8	26	66	SL
Çayırlık	Ap	0-20	8.1	0.5	42.9	12,6	3.6	1.27	47	36	17	C
	Bw	20-39	8.1	0.5	43.7	12,1	1.8	1.37	42	33	25	C
	Bk	39-90	8.4	0.4	46.2	18,8	0.6	1.46	36	35	29	CL
	C	90+	8.5	0.5	47.0	12,3	1.0	1.34	50	28	22	C
Çetinkaya	Ap	0-17	8.1	0.2	34.3	6,5	3.1	1.40	23	35	42	L
	A2	17-48	8.0	0.2	30.8	7,0	1.4	1.51	21	37	42	L
	C	48+	8.3	0.2	10.0	14.9	0	1.64	9	32	59	SL
Toprak tepe	Ap	0-20	8.1	0.3	48.2	2.4	2.7	1.29	47	36	17	C
	A_2	20-59	8.3	0.3	38.6	27.0	0.5	1.52	42	33	25	C
	C_1k	59-100	8.4	0.2	33.1	42.9	0	1.58	36	35	29	CL
	C_2k	100+	8.4	0.3	47.2	16.3	0	1.45	50	28	22	C
Altın yaprak	Ap	0-19	8.2	0.3	52.0	6.3	2.3	1.39	49	34	17	C
	A_2	19-44	8.2	0.3	50.7	7.4	1.5	1.40	49	36	15	C
	Bss_1	44-69	8.2	0.4	55.9	11.4	1,6	1.29	61	30	9	C
	$Bkss_2$	69-111	8.4	0.4	43.6	18.7	0.6	1.30	56	38	6	C
	C	111+	8.8	0.4	54.0	8.5	0.7	1.27	72	21	7	C
Çiftlik	Ap	0-19	8.0	0.5	38.9	1.8	2.2	1.49	38	33	29	CL
	A_2	19-50	8.0	0.8	40.0	1.6	0.9	1.53	39	37	24	CL
	Bss1	50-79	8.0	0.6	37.2	7.8	0.5	1.49	44	33	23	C
	Bss2	79-100	8.2	0.3	36.3	8.3	0.3	1.54	44	33	33	C
	C_1	100+	8.2	0.4	43.0	2.8	0.5	1.50	45	29	26	C

C: Clay, Si: Silty, S: Sand, L: Loam, CEC: Cation Exchange Capacity, OM: Organic Matter, BD: Bulk Density

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Iron Oxide Forms and Clay Mineral Identification in Various Physiogeraphic Units of Dasht_E_Tabriz Soils, Northwest Iran

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Abstract

Various iron forms and clay minerals in three physiographic units of hill, piedmont and river alluvial plain in one transect of Dasht_e_Tabriz were studied to assess the effects of pedogenic processes. The moisture and temperature regimes are xeric and mesic, respectively. Seven pedons were selected, sampled and analyzed for soil physiochemical properties, clay minerals and different forms of iron (Fe); Fe_d, citrate-bicarbonate-dithionate extractable Fe; Fe_o, acid oxalate extractable and Fe_p, Na-pyrophosphate extractable Fe. The soils were classified as a Typic Argixerolls, Fluventic Haploxerepts, Typic Haploxerepts, Fluventic Haplocambids, Typic Anthracambids and Typic haplocambids. According to obtained results, there is some variation of iron oxides concentration which might be related to the rate of weathering, moisture content and pedogenic accumulations. A wide relative variation in mean value of Fe_d, Fe_o and Fe_p was observed among physiographic units. Piedmont plain with aridic moisture regime had lowest amount of Fe_d and highest Fe_o/ Fe_d ratio. The Fe_d values are higher than Fe_o values in all soils, indicating that a considerable fraction is present in crystalline form. Fe_d accumulates in B horizons and it is higher in mollisols than other soil orders but Fe_o has reducing pattern in pedons and it is high in pedons with limited in drainage. Based on liner coefficient of correlation, Fe_p has significant positive correlation with OC. The XRD results indicated that, illite, kaolinite, smectite and chlorite are the major clay minerals of soils.

Keywords: clay minerals, iron oxides, physiographic units.

Introduction

Distribution and forms of iron oxides are good tools to distinguish pedogenic processes and the amount of soil development. Percent of free iron have been used as distinguishing soil types and differentiating soil horizons (McKeague & Day, 1966; McKeague et al., 1971). Iron oxides of soils are found as a component of several iron-bearing minerals that releases and reprecipitate irons in soils in the form of poorly crystalline and crystalline iron oxides or hydroxides. Comparisons of free iron percentage have been used as in determining relative ages of soils (Alexander, 1974). Poorly crystalline Fe oxides (often called poorly ordered, short range ordered, non-crystalline and active or amorphous iron oxides) can be measured by acid oxalate extraction (Fe_o), Free or pedogenic Fe compounds may be estimated by citrate-bicarbonate-dithionate (CBD) extraction (Fe_d) and Na-pyrophosphate extraction is utilized for determination of organically bound Fe (Fe_p). The oxalate extraction is presumed to remove the poorly crystalline iron oxides. The dithionate extraction is presumed to remove finely crystalline iron oxides in addition to the oxalate-soluble fractions (McKeague & Day, 1966; McKeague et al., 1971). Therefore, the amount of iron released by the dithionate method (Fe_d) should be equal to or greater than the amount of iron released by the oxalate method (Fe_o). The difference between the values obtained by two methods represents the amount of iron presents in definite crystalline forms. The Fe_o/Fe_d ratio, as an active Fe ratio, quantifies the proportion of the more and less active fractions (Kampf et al., 1999). The objective of this study is (i) To present data on the status and distribution of iron oxides in Dashte-tabriz soils; and (ii) to interpret the relationships between iron oxides and physiographic units in a selected transect and (iii) to identify types of clay minerals in soil pedons.

Materials and methods

*Description of study area***:** This study was conducted on Dasht-e-Tabriz located in Azarbaijane - sharghi province, from 46° 28′ to 46° 14′ E longitude and 37° 56′ to 38° 17′ N latitude. We selected one transect in Dasht-e-Tabriz, about 35 Km in length which is a part of Zagros orogenic zone ranging in elevation of 1400-2500 m from sea level. The irregular distribution of rainfall in transect led to different soil types. The upper part of transect consists of conglomerate, moderate consolidated with intercalation of sandstone and fresh water limestone, the mean annual rainfall is 380mm and the mean annual temperature is 11°C, soil moisture and temperature regimes are xeric

and mesic, respectively. The lower part of transect is located in young terraces with limestone and marl, the mean annual rainfall is 290mm and the mean temperature is 13°c, soil moisture and temperature regimes are weak aridic and mesic, respectively. Based on reconnaissance survey, transect with seven pedons was delineated to represent the variation of parent material and precipitation. Pedon 1 on the hillslope, pedons 2, 3 6 and 7 on the piedmont plain and pedons 4 ,5 on the river alluvial plain. Pedons 1, 2 and 3 have xeric moisture regime but pedons 4, 5, 6 and 7 have aridic moisture regime. River alluvial plain is typically influenced by the cycles of illuvial sediments, hillslope which is less indicative of deposition of sediments and episodes of erosion, reflects approximately stable geomorphic conditions whereas piedmont plane is impacted periodic depositions. The soils were sampled using standard techniques and classified according to Soil Taxonomy (Keys to Soil Taxonomy, 2010). Soil samples were air dried, crushed and passed over a 2-mm sieve to remove coarse fragments.

*Physiochemical analysis***:** Particle size distribution was determined by sieving and sedimentation, using pipet method (Day, 1965). Organic carbon (OC) was determined using the wet digestion method (Nelson, 1982) and pH and Electrical Conductivity were estimated in saturated paste and saturation extract, respectively (Salinity Laboratory Staff, 1954). Alkaline-earth carbonates were measured by acid neutralization and back titration (Nelson, 1982). Cation exchange capacity was obtained by saturation with 1 molar NH_4OAC at pH 8.2 (Chapman, 1965). Acid ammonium oxalate extraction, during 4-h shaking at pH=3 in darkness, was used to analysis poorly crystalline and organically bound iron oxides (Fe_o) (Makeague & Day, 1966). The Fe extracted by the citrate-bicarbonate-dithionate (CBD) was attributed to crystalline, poorly crystalline and organically bound Fe (Fe_d), (Mehra & Jackson, 1960). In addition, Fe was extracted by 0.1 M Na-pyrophosphate at pH=10 for determination of organically bound Fe (Fe_p), (Loveland & Digby, 1984). The differences between CBD - Fe and ammonium oxalate - Fe and pyrophosphate - Fe were considered as an estimation of crystalline secondary oxides and non-crystalline oxides, respectively (Birkland, 1999). Statistical analysis was carried out using MATLAB software.

*Mineralogy analysis***:** The clay fraction was separated after destruction of chemical cementing agents according to Mehra and Jackson (1960) and Kunze (1965). Clay minerals were analyzed on glass slides by X-ray diffraction using Shimadzu XRD 6000 and CuKα radiation source. The (001) reflections were obtained following Mg-saturation, glycerol salvation, K-saturation and K-saturation plus heating at 550 °C. Clay minerals were estimated semi-quantitatively with Biscaye method (1965).

Results and discussion

*Distribution of clay minerals***:** The XRD results indicated that the minerals were almost uniform in the type but semi-quantitative estimates revealed that the abundance of clay minerals is different as a result of physiographic units (Figure 1). *Illite and chlorite:* The occurance of micaceous minerals/illite (10A°) as predominant clay mineral and chlorite (14A°), is largely due to their inheritance from parent material (Khormali & Abtahi, 2003). The illite content of piedmont plain with aridic moisture regim decreases with depth. Several processes may account for this decrease, such as enhanced physical weathering of biotite grains in the near-surface horizons due to large daily and seasonal fluctuations in temperature and moisture and to limited lessivage in the aridic climates. In another physiographic units, simple transformation of illite to other clay minerals (mainly smectite) may play a major role in the decrease in illite content with depth, in these units the soil available moisture increase and provides a relative leaching environment for the release of K^+ from micaceous minerals and mainly illite. Illite constituets the main part of all studied soils, both illite and chlorite are inherited in this soils; chlorite does not show any regular pattern with increasing depth. In some horizons, shoulders from 14 to 10 indicate mixed layered phases.

*Kaolinit***e:** precipitation of kaolinite from solution requires acid conditions with moderate silica activity and small amounts of basic cations. This clay minerals forms mainly from feldspars and mica alteration, in conditions of low K^+ activity and high H^+ activity (Dixon, 1989). These conditions occur in warm and humid tropical and subtropical climates. As our studied area located in arid and semi-arid region, so presence of kaolinite is due to its inheritance from surrounding parent material. In most pedons kaolinite decreases with depth, that confirms its inheritance origin, just in river alluvial plain, the amount of kaolinite at surface is more than subsurface, it can be

because of sedimentation cycles in this area. *Smectite:* This mineral that is reflected by basal d-spacing of 18 A° in the glycerol treated samples typically was greater in hillslope followed by river alluvial plain, piedmont plain units in abundance. Transformation of micaceous minerals (illite) mainly in surface horizons and in situ synthesis particular mainly in Bt and Bw horizons, seems to be the main pathway for the formation of smectite (Khormali & Abtahi, 2003), but presence of large amounts of this mineral in poorly drained pedons in river alluvial plain suggests a neoformation origin of this mineral under favorable soil solution conditions.

*Distribution of iron compounds***:** The concentration of iron oxides and their vertical distribution indicate some differences between studied soils (Table1) that might be related to precipitation, moisture content and degree of weathering, seasonal flocculation of water table, pedogenic accumulation and organic matter. The values of Fe_d in soils are higher than Fe_o values, indicating that a considerable fraction exists in crystalline form. Fe_d values in these soils were commonly low, ranged from 3.3 to 10.9 g $Kg^{-1}$and values obtained for P6 and P7 are lower than another pedons, reflecting low weathering of primary Fe bearing minerals and formation of Fe oxides. The vertical distribution of Fe_d indicate an increasing trend towards the lower B horizons and the largest amount of Fe_d can be related to argilic and cambic horizons. This pattern may be explained in two ways: The first interpretation is related to the high rate of *in situ* weathering, as a result of wetting-drying cycle and activity of roots, and the great presence of micaceous minerals at B horizons. The occurance of high rates of mica (illite) along with parallel increase of Fe_d in Bw horizons suggests that large amount of Fe_d are released from micaceous minerals by weathering. The presence of partial swelling of chlorite after glycerolation (figure 1) suggests that the release of some Fe from chlorite could also be possible. According to the second interpretation, the accumulation of Fe_d in subsurface horizons can be because of migration of iron oxide – coated clay from upper to lower horizons. The accumulation of Fe_d in some of subsurface horizons can be attributed to migration of iron oxide-coated clay from upper to lower horizons. The determination of association of Fe_d with translocation of clay fraction was calculated by Fe_d/clay ratio (Blume & Shwertmann, 1969). In P1, this ratio decreased from soil surface to lower part and the maximum Fe_d occurred at B horizons, following the same pattern as clay. The co migration of clay and iron oxides is confirmed by the significant correlation of Fe_d and clay($r=0.62$; $p< 0.01$) (Table 2). The comigration of clay with iron oxides is reported by various workers (Juo & Maduakor, 1974). The Fe_d /clay ratio in P1 decreases with depth, in such cases horizon formation is well expressed and established. In P2 and P3 this ratio increased from soil surface to lower part and high proportion of Fe_d is independent from clay fraction. Therefore most of its content is a product of in situ pedogenic processes. In P4 and P5 there is no distinct trend in Fe_d/clay ratio, maybe it is because of sedimentation cycles, high amount of Fe_d in these pedons can be related to weathering before sedimentation. In P6 and P7 the Fe_d amounts are lower than other pedons that can be related to low precipitation. In these pedons Fe_d /clay ratio remains approximately constant, that indicates the weak horizonation of soils, due to low precipitation that limits the intensity of weathering of the parent material. Decreasing the Fe_d in the lower part of the solum can be attributed to a decrease in extractability of iron by dithionate cause by the carbonate content of the parent materials. Fe oxides in the crystalline form (Fe cryst.) in the Bt and Bw horizons had higher amounts as well as Fe_d , these results suggest the degree of more development of those soils in comparison with other soils; because Fe_d provides an estimate of the total pedogenic Fe (Blume & Schwertmann, 1969). The verticle distribution pattern of oxalate extractable Fe (Fe_o) and part of Fe oxides in organic-complex form as Fe_p indicate a decreasing trend with depth. Within the pedons of P3, P4 and P5 where the anaerobic conditions were more prevalent than other soils, the amount of Fe_o was greater and ranges from 2.1-5.7 g Kg^{-1}. This is probably attributed to a great extent by the change of oxidation-reduction conditions in these zones (Schwertmann & Taylor, 1989). The presence of considerable amount of organic matter in the topsoil and some declines in content of Fe_p with depth revealed that the proportion of Fe_p forms complexes with organic matter, especially in Ap horizons, this was confirmed by the high significant relationship of Fe_p and organic carbon content ($r=0.86$, $p<0.01$) (Table 2). The Fe_o/Fe_d ratio, as active ratio, almost varied in all soils. Several workers indicated that the amount of pedogenic iron oxides and their crystallinity were increased with increasing weathering rate and soil age leading to a decline in the pattern of Fe_o/Fe_d ratio, higher active ratio associated with a lower amount ofsecondary Fe oxides in the crystalline form (Singer, 1977; Schwertmann & Taylor,

1989). The Feo/Fed ratio mostly was high for A horizons than B horizons. The active Fe ratio is low in P1, P2 and P3 in comparison with other pedons Decreasing this ratio beneath the B horizon in P1, P2, P3 and approximately constant in P5 indicates a high proportion of iron oxides exists in poorly crystalline forms rather than in purely crystalline forms.

Table1. Some physiochemical properties of studied pedons

Horizon	Depth cm	Clay %	Texture Class	pH	OC %	CCE %	CEC $cmol_c\ Kg^{-1}$	EC $dS\ m^{-1}$	Fe_d	Fe_o	Fe_p
									$g\ Kg^{-1}$		
P1- Typic Argixerolls (hillslope)											
Ap	0-25	30	cl	6.6	1.55	4	17.5	0.5	9.8	4.8	2.4
Bt	25-44	41	c	6.3	1.5	4.1	18.2	0.9	10.9	4.4	2.3
Bw	44-66	42	c	6.6	1.4	3.6	18.1	0.99	10.7	3.6	2.2
BC	66-130	27	sc	6.8	0.3	3.53	14.29	0.40	6	3.1	0
2- Fluventic Haploxerepts (piedmont plain)											
Ap	0-20	28	scl	7.02	0.8	5	21.7	0.6	8.2	4.8	1.2
Bw1	20-62	33	cl	7.28	0.7	5.1	18.3	0.46	9.9	3.7	1
Bw2	62-114	25	scl	7.01	0.3	5.27	17.9	0.24	10.2	3.2	0
BC	114-125	24	l	7.63	0.25	4.2	19.9	0.12	8	2.7	0
P3- Typic Haploxerepts (piedmont plain)											
Ap	0-15	25	l	7.47	0.73	3.3	18.9	1.33	7.8	4.5	1
Bw1	15-32	29	scl	7.29	0.6	5.9	15.6	5.6	8.7	4.3	0.4
Bw2	32-50	19	sl	7.32	0.5	6.12	15.2	2.7	9	4.2	0.2
Bw3	50-60	25	scl	7.3	0.3	4.5	12.4	9.1	8.3	3.8	0
BC	60-130	24	scl	7.26	0.1	2.5	16	2	6.7	2.1	0
P4- Fluventic Haplocambids (river alluvial plain)											
Ap	0-16	33	cll	7.46	0.55	10	15.72	2.09	7.9	4.7	2
Bw1	16-48	43	sic	7.35	0.48	8	23.62	3.21	9.2	4.2	1.8
Bw2	48-74	50	sic	7.45	0.46	4	18.5	2.85	9.1	4.1	1
Bw3	74-89	29	cl	7.53	0.2	6	15.7	1.6	6.4	3.2	0
C	89-140	33	cl	7.89	0.05	14	19.5	6	6.3	3	0
P5- Typic Anthracambids (river alluvial plain)											
Ap	0-18	29	scl	7.85	0.5	15.5	15.61	8.51	8.5	5.7	1.2
Bw1	18-34	27	scl	7.98	0.66	15.7	14.73	4.31	8.2	5.5	1.1
2Bw1	34-69	45	c	7.69	0.62	17.1	16.52	10.55	8.1	5.3	1.1
2Bw2	69-120	50	c	7.8	0.45	18.4	21.9	8.1	8.4	5	0
P6- Typic Haplocambids (piedmont plain)											
Ap	0-17	12	l	7.76	0.24	24	8.86	1.02	3.3	3.2	0.8
Bw1	17-38	26	scl	7.82	0.18	25	7.46	1.17	6.4	3	0.1
Bw2	38-75	30	cl	8.53	0.1	24	8.08	1.49	6.9	3.2	0
C	75-130	20	l	8.9	0.01	20	7.62	1.76	5	2.2	0
P7- Typic Haplocambids (piedmont plain)											
Ap	0-26	18	sl	7.73	0.26	20	9.93	1.32	4.4	2.4	0.5
Bw1	26-62	20	sl	7.87	0.08	19	7.24	0.58	5	2.1	0.1
Bw2	62-93	20	sl	7.75	0.06	19	7.8	1.39	5.2	2.6	0
C	93-140	25	scl	7.65	0.01	16	9.15	1	4.9	2.3	0

OC, Organic Carbon; CCE,Calcium Carbonate Equivalent; CEC, Cation Exchange Capacity; EC. Electrical Conductivity; Fe_d, citrate-bicarbonate-dithionate extractable Fe; Fe_o, acid oxalate extractable Fe; Fe_p, Na-pyrophosphate-extraction of Fe.

The active ratio has been used to determine the degree of soil development. Soils with high ratio are younger soils, whereas low active ratio is related to older soils (Alexander, 1974). In this study P1 has lower active ratio, P2 and P3 have also low active ratio in comparison with other pedons, suggest that P4, P5, P6 and P7 are relatively younger than another pedons. Correlation coefficient (r) among iron forms, clay and organic carbon are given in table 2. The Fe_o was highly correlated with Fe_d ($r = 0.61$, $p<0.01$), indicating that both are functions of the same pedological factors, and more importantly both extractants remove essentially the same form of iron (Ogunsola et al., 1989). There was also positive significant correlation between Fe_d and Fe_o forms and clay content. This

implies the fact that the release and synthesis rate of Fe_o and Fe_d are associated with clay synthesis. Fe_d showed positive correlation with $Fe_{cryst.}$ and negative correlation with Fe_o/ Fe_d ratios, which is consistent with the findings of other workers (Blume & Schwertmann, 1969; Kampf et al., 1999) . *Iron oxide forms and physiographic units:*The studied soils divided into four groups with regard to the relationships between physiographic units and moisture regimes. Hillslope and piedmont plain with xeric moisture regime, piedmont plain and river alluvial plain with aridic moisture regime. Differences in all fractions (table 3) were present in greater amount in piedmont plain with aridic moisture regime in comparison with other physiographic units. These differences may be due to the diversity of soil development or weathering rate by low precipitation. Due to great amount of clay content in sediments the clay content in river alluvial plain was more than other units. Dominance of Fe_d over Fe_o may have been due to age of soils or the age of sediments in which soils formed (Igwe et al., 2005). There were no Significant differences among hillslope; piedmont plain with xeric moisture regime and river alluvial plain with respect to all fractions of table and Fe_p fraction is function of OC.

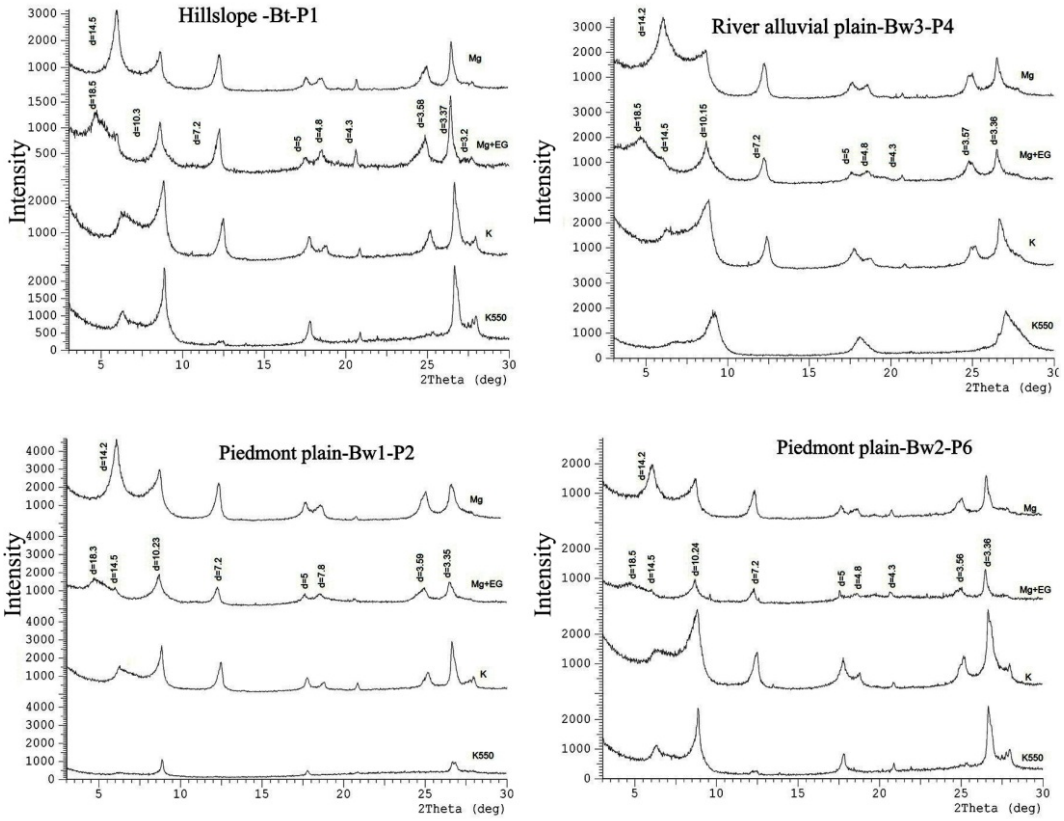


Figure2-XRD patterns of clay from different horizons in various physiogerphic units.

Table 2. Correlation coefficients for liner relationships between iron oxides forms, clay content and organic carbon.

	Fe_o	Fe_d	Fe_p	$Fe_{cryst.}$	Fe_o/Fe_d	Clay
Fe_o						
Fe_d	0.61**					
Fe_p	0.59**	0.57**				
$Fe_{cryst.}$	0.1	0.85**	0.32			
Fe_o/Fe_d	0.42*	-0.39*	0.13	-0.77		
Clay	0.5**	0.62**	0.43*	0.44*	-0.16	
OC	0.6**	0.23	0.86**	-0.05	-0.05	0.43*

* and **, significant at the 0.05 and 0.01 levels, respectively.

Table 3. Grouping of studied soils in physiogeraphic units according to different forms of iron oxides, clay content and OC.

	H	P.P*	P.P**	R.A.P
Fe_o g Kg^{-1}	3.97^a	3.7^a	2.62^b	4.52^a
Fe_d g Kg^{-1}	9.35^a	8.53^a	5.13^b	8^a
Fe_p g Kg^{-1}	1.725^a	0.42^a	0.18^b	0.91^a
Clay (%)	35^a	25.77^b	21.37^b	36.55^a
OC (%)	0.925^a	0.47^a	0.11^b	0.44^a

H= hillslope; P.P *= piedmont plain with xeric moisture regime; P.P** = piedmont plain with aridic moisture regime; R.A.P = river alluvial plain; Fe_d = citrate-bicarbonate-dithionate extractable Fe; Fe_o= acid oxalate extractable Fe and Fe_p= Na-pyrophosphate extractable Fe; OC= organic carbon; Mean followed by the small of capital letter in each row are not significantly different by Duncan s test($p \leq 0.05$).

Conclusion

Variation in weathering of primary Fe-bearing minerals, pedogenic processes (as a result of diversity in physiographic conditions and moisture regime) and geomorphologic conditions resulted from a difference in contents, distribution and forms of Fe oxides. This study demonstrated that Fe_d values are higher than Fe_o values in all soils, indicating that a considerable fraction of Fe is present in crystalline form. The Fe_d values are low and highly correlated with Fe_o indicating that both are function of the same pedological factors. Organic matter and clay fraction had a strong bearing on the distribution of form of Fe. The active ratio values have been used to estimate the degree of soil development in these soils, this ratio was lower in mollisols and inceptisols than in aridisols. In mollisols there is comigration of free iron oxides with clay which is also appears in the pedon distribution of Fe_d/clay ratio. There are significant differences between piedmont plain with aridic moisture regime with other physiographic units. The presence of kaolinite in our studied area is due to its inheritance from the surrounding kaolinite-bearing Cretaceous rocks. Illite and chlorite are also inherited from parent rocks. Simple transformation of illite to other clay minerals (mainly smectite) may play a role in its relative decrease with depth. The amount of smectite in mollisols of hillslope and Aridisols of river alluvial plain is more than other soils. Transformation of illite and neoformation is responsible for this distribution.

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SOIL CLASSIFICATION AND CLAY MINERAL IDENTIFICATION IN DASHT – E- TABRIZ, IRAN

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Abstract

Soil properties and clay minerals of northwest Iran, were characterized and related to landscape position and parent material. We examined the physical, chemical and mineralogical properties of 10 pedons in different physiogeraphic units. Data for 6 pedons representative of the region are presented here. The parent material in upper part is calcareous and lower part is sedimentary. The moisture and temperature regimes are aridic and mesic, respectively. The soils were classified as a Typic Haplocambids, Typic Haplargids, Xeric Haplocambids, Typic Anthracambids, Sodic Xeric Haplocambids and Typic Haplosalids. The clay fractions were studied by X-ray diffraction and scanning electron microscopy (SEM). Kaolinite, illite, chlorite, smectite, palygorskite and rare amount of vermiculite are present in this region. The occurrence of kaolinite is due to its inheritance from the surrounding kaolinite-bearing Cretaceous rocks. The kaolinite amount was not showing significantly difference between physiographic units. Illite and chlorite abundance in soils is also largely related to their presence in parent rock. Illite amount was highest in hill slop, followed by piedmont plain, river alluvial plain and low land. Because of vermiculite's slow stability under high pH, low Al activity and large amount of Mg and Si, amount of this clay mineral is very low. Smectite is detected in trace amounts of well_ drained pedons, but it increases in poorly drained pedons, this suggests neoformational origin of this mineral under favorable soil solution conditions. As palygorskite present in all pedons, inheritance from parent rock and neoformation are acceptable origin for this mineral.

Keywords: soil classification, clay mineral, palygorskite, smectite

Introduction

The classification of soils according to internationally accepted systems is helpful for soil conservation because it supports communication between users and scientists of different disciplines and countries. It also supports a better transfer of technologies and facilitates land use planning. Consideration of the characteristics of minerals found in soils, and their transformatino from one form to another is essential for understanding the nature of soil properties. Dasht-e-Tabriz in East Azarbaijan province is one of the important regions which need for vast and precise studies. This region with extent of about 200000 hectares contains various physiographic units. Therefore study of soil genesis and their developments should be based on accurate knowledge about affecting factors. This research work was carried out for soil classification and recognition of the clay mineral source and formation manner and their relationship with soil properties.

Materials and Methods

*Description of study area***:** This study was conducted on Dasht-e-Tabriz located in Azarbaijane - sharghi province, from 46° 28′ to 46° 14′ E longitude and 37° 56′ to 38° 17′ N latitude (Figure 1). This study area located in young terraces with limestone and marl, the mean annual rainfall is 290mm and the mean temperature is 13°c, soil moisture and temperature regimes are weak aridic and mesic, respectively. Based on reconnaissance survey, ten pedons was delineated to represent the variation of physiogeraphic units. Data for 6 pedons representative of the region are presented here.



Figure 1- Location of study area

Pedon 1 on the hillslope, pedons 2 and 3 on the piedmont plain, pedons 4 on the river alluvial plain and pedns 5 and 6 in low lands. River alluvial plain is typically influenced by the cycles of illuvial sediments, hillslope which is less indicative of deposition of sediments and episodes of erosion, reflects approximately stable geomorphic conditions whereas piedmont plane is impacted periodic depositions. The soils were sampled using standard techniques and classified according to Soil Taxonomy (Keys to Soil Taxonomy, 2010). Soil samples were air dried, crushed and passed over a 2-mm sieve to remove coarse fragments.

*Physiochemical analysis***:** Particle size distribution was determined by sieving and sedimentation, using pipet method (Day, 1965). Organic carbon (OC) was determined using the wet digestion method (Nelson, 1982) and pH and Electrical Conductivity were estimated in saturated paste and saturation extract, respectively (Salinity Laboratory Staff, 1954). Alkaline-earth carbonates were measured by acid neutralization and back titration (Nelson, 1982). Cation exchange capacity was obtained by saturation with 1 molar NH_4OAC at pH 8.2 (Chapman, 1965).

*Mineralogy analysis***:** The clay fraction was separated after destruction of chemical cementing agents according to Mehra and Jackson (1960) and Kunze (1965). Clay minerals were analyzed on glass slides by X-ray diffraction using Shimadzu XRD 6000 and CuKα radiation source. The (001) reflections were obtained following Mg-saturation, glycerol salvation, K-saturation and K-saturation plus heating at 550 °C. Clay minerals were estimated semi-quantitatively with Biscaye method (1965). For electron microscopy studies, dried small soil aggregates (~ 1 cm^3) were mounded on Al stubs using double-sided tape and carbon paste, then coated with Au and examined using LEO SEM.

Results and discussion

Physiochemical properties of studied soils: results for physiochemical studies has shown in table 1. The parent material of northwest Iran is mainly limestone, and most of the soils are calcareous thought. The electrical conductivity (EC) of well drained soils are low, but in imperfectly drained soils which are mostly saline, it reaches a maximum of 640 ds/m (pedon 6). The amounts of organic carbon is low in most of pedons and it mainly decreases with depth exept pedon 4 in river alluvial plain. The pH ranges in studied pedons is 7-8.24. The CEC of the soils which is dependent on the amount and type of clay minerals ranges between 7.8 -29.4 cmol (+) kg^{-1}. The soils were classified as a Typic Haplocambids, Typic Haplargids, Xeric Haplocambids, Typic Anthracambids, Sodic Xeric Haplocambids and Typic Haplosalids.

Table1. Some physiochemical properties of studied pedons.

Horizon	Depth cm	Clay %	Textural Class	pH	OC %	CCE %	CEC $cmol_c Kg^{-1}$	EC dS m^{-1}	Na+	Ca^{2+}	Mg^{2+}
									meq lit^{-1}		
P1- Typic Haplocambids (hillslope)											
A	0-9	13	sl	7.9	0.49	6.14	8.3	1	1.25	8	7
Bw_1	9-48	19	sl	7	0.48	7.59	20.9	0.77	0.92	6	9
Bw_2	48-60	10	sl	7.1	0.05	3.97	17.5	1.4	9.96	7	3
C	60-140	10	sl	7	0.02	5.71	12	0.93	4.74	5	5
P2- Typic Haplargids (piedmont plain)											
Ap	0-23	45	c	7.47	0.9	27	28	2.11	7.17	12	9
Bt	23-51	59	c	7.63	0.39	25	29.4	2.09	6.1	6	5
Bw_1	51-116	41	sicl	7.96	0.03	26	19.42	3.67	29.5	3	6
Bw_2	>116	65	c	7.86	0.01	26	21.9	6.6	49.8	8	17
P3- Xeric Haplocambids (piedmont plain)											
A	0-26	18	sl	7.73	0.6	20.6	9.93	1.32	5.2	8	2
Bw_1	26-62	20	scl	7.87	0.14	19.7	7.24	1.58	1.56	6	1
Bw_2	62-93	22	scl	7.75	0.1	19.4	7.8	1.39	3.87	5	4
C	93-140	25	scl	7.65	0.01	16.2	9.1	4.8	4.14	8	8
P4- Typic Anthracambids (river alluvial plain)											
Ap	0-21	48	c	7.08	0.93	37	19	2.09	2.65	17	3
Bw_1	21-48	47	c	7.34	0.52	38	19	3.21	2.2	2	8
Bw_2	48-93	45	c	7.3	0.31	39	18	2.85	2.1	4.1	5
C	>93	44	c	7.58	0.38	38	18.1	6	2.3	6	8
P5- Sodic Xeric Haplocambids (low land)											
A	0-18	25	scl	7.86	0.28	29.7	11.2	8.51	12	5	2
Bw1	18-45	18	sl	8.4	0.12	22.2	9.7	12.31	29	5.5	9
Bw2	45-84	28	l	8.22	0.11	22.8	16. 2	10.55	59	5.3	13
Bw3	84-120	30	scl	8.1	0.11	20.6	14.1	8.11	71	5	11
BC	120-150	18	sl	8.24	0.08	21	9.1	9.9	13	3	6
P6- Typic Haplosalids (low land)											
A	0-7	73	c	7.81	0.54	21	21.6	35	242	45	31
Bz_1	7-33	31	scl	7. 2	0.51	21.3	13.9	42	344	74	63
Bz_2	33-50	78	c	7.1	0.6	19.9	23.7	60	601	86	71
Bz_{3g}	50-77	80	c	7.35	0.53	19	24.4	60	592	64	54
Cz_g	77-110	28	si	7.25	0.11	20	11.8	66	640	90	84

OC, Organic Carbon; CCE,Calcium Carbonate Equivalent; CEC, Cation Exchange Capacity; EC. Electrical Conductivity

Clay mineralogy of soils: The XRD results indicated that the minerals were almost uniform in the type but semi-quantitative estimates revealed that the abundance of clay minerals is different as a result of physiographic units (Figure 2). Chlorite, illite, smectite, palygorskite and kaolinite are the major clay minerals of soils. The occurrence of micaceous minerals/illite (10A°) as predominant clay mineral and chlorite (14A°), is largely due to their inheritance from parent material (Khormali & Abtahi, 2003). The illite content of piedmont plain decreases with depth. Several processes may account for this decrease, such as enhanced physical weathering of biotite grains in the near-surface horizons due to large daily and seasonal fluctuations in temperature and moisture and to limited lessivage in the aridic climates (Boettinger & Southard, 1995). In another physiographic units, simple transformation of illite to other clay minerals (mainly smectite) may play a major role in the decrease in illite content with depth, in these units the soil available moisture increase and provides a relative leaching environment for the release of K^+ from micaceous minerals and mainly illite. Illite constituets the main part of all studied soils, both illite and chlorite are inherited in this soils, chlorite does not show any regular pattern with increasing depth. In some horizons, shoulders from 14 to 10 indicates mixed layered phases. Precipitation of kaolinite from solution requires acid conditions with moderate silica activity and small amounts of base cations. This clay minerals

forms mainly from feldspars and mica alteration, in conditions of low K^+ activity and high H^+ activity (Dixon, 1989).

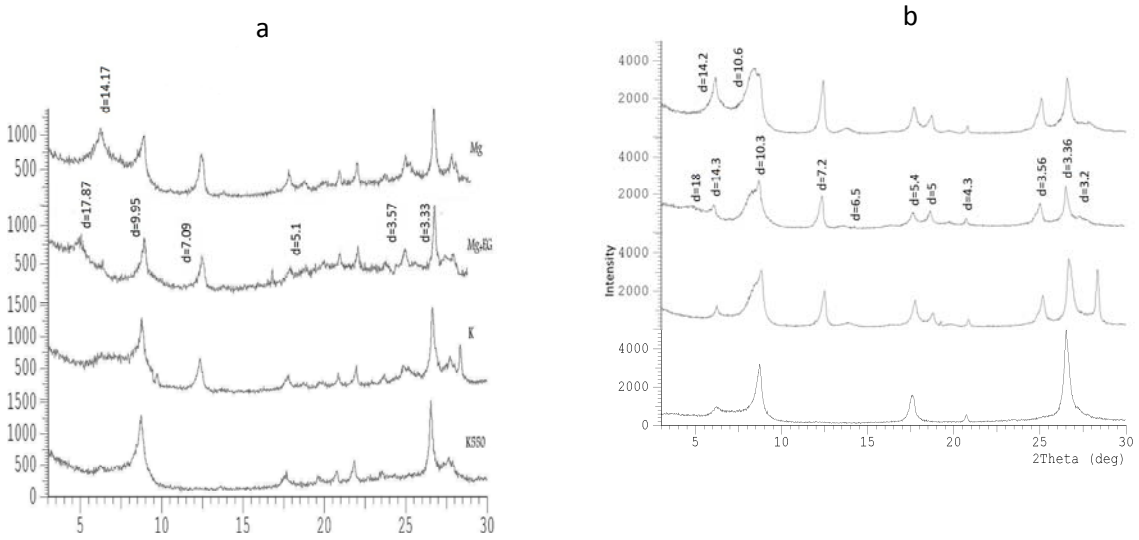


Figure 2- XRD patterns of clay from different horizons in various physiogerphic units. a, Bz, pedon6, b,Bw_1, pedon1.

These conditions occur in warm and humid tropical and subtropical climates. As our studied area located in arid and semi-arid region, so presence of kaolinite is due to its inheritance from surrounding parent material. In most pedons kaolinite decreases with depth, that confirms its inheritance origin, just in river alluvial plain, the amount of kaolinite at surface is more than subsurface; it can be because of sedimentation cycles in this area. Smectite that is eflected by basal d-spacing of 18 A° in the glycerol treated samples typically was greater in lowlands. Presence of large amounts of this mineral in poorly drained pedons in river alluvial plain suggests a neoformation origin of this mineral under favorable soil solution conditions. Neoformation of smectite was also reported by Givi and Abtahi (1985) and Gharaee and Mahjoory (1984) under saline and alkaline conditions with high concentration of Si, Mg, and Al in southern Iran.This mineral is detected in trace amount in arid conditions of piedmont plain. However, the existence of smectite in arid and semi-arid conditions like Iran, could be because of inheritance origin, that highlited by Khormali and Abtahi (2003). Palygorskite is other possible precursor mineral for smectite in arid and semi-arid environments. Study with SEM indicated the presense of palygoreskite in all of pedons (Figure 3).

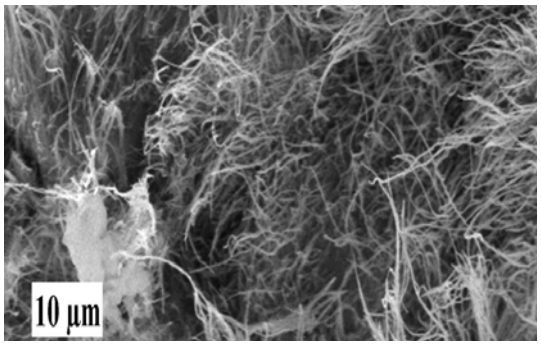


Figure 3- The SEM image for Bw1, pedon1

Conclusions

The results showed that Dasht -e-Tabriz soils, are formed with materials resulted in erosion of high land areas, which contain salty and calcareous sediments of Aji chai and also residues from Urmya lake. Geological evaluation indicates that Permian limes have wide and considerable distribution in north and northeast of studied region. All studied soils were classified as Aridisols. Chlorite, illite, smectite, palygorskite and kaolinite are the major clay minerals of soils.

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Investigation of the Fe and Mn Pedofeatures of Gypsiferous Soils in Different Moisture Regime

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Abstract
High amounts of gypsum in the soil profile are frequently found in soils of arid and semi-arid environments. Based on the soil survey there are seven major soil series in the study area, out of which only four are gypsiferous. Thirty five pedons were initially studied and then reduced to 27 pedons for detailed studies. Micromorphological observations including hypocoating, coating, loose continuous, dense complete and dense incomplete infilling of gypsum in voids and channels walls. Lenticular, prismatic, interlocked plates, psedue haexagonal and allabasrtin of gypsum crystals observed in thin section. Mn and Fe oxides in all of sample occur as coating, hypocoating and nodules forms. Nodules observed to forms of typic geodic, septaric, aggregate and digitate rarly. For produce this pedofeatures in soils have anaerobic condition. In two pdeon with xeric moisture are these conditions; however this pedofeature occur as good. In one pedon since slickenside, fracture of Fe typic nodule observed. Typical nodule of Mn oxide with digitate morphology occurs as in another pedon. Coating and hypocoating of Fe oxide in along channels observed. Typic and geodic nodules of calcite in By horizon that impregnated with Fe oxide. We observed that in the high moisture, in all pedons, Fe and Mn pedofeature increased. The lowest of these pedofeature observed in the aridic moisture regmies.
Keywords: Gypsiferous soils, Fe and Mn pedofeature, Soil moisture regime

Introduction
Gypsum can form in any type of soil parent material. The dominant soil processes responsible for gypsum formation are primarily related to availability of SO_4^{2-} ions and lack of sufficient water to remove the soluble gypsum (Buck and Van Hoesen, 2002).
Redoximorphic features are common in most soils where water saturation occurs and their presence is used extensively in making land use decisions. Although redoximorphic features are visible in the field with both the naked eye and a hand lens, micromorphological analysis can further enhance our understanding of how these features form and how to interpret them correctly. These interpretations are best made when supportive information such as water table and climatic data are available (Bouma et al., 1990; Vepraskas, 2004), but they can to a large extent be based on extensive micromorphological data correlating redoximorphic pedofeatures to environmental conditions.
Redoximorphic features form from the reduction, translocation and oxidation of Fe and Mn. An understanding of Fe and Mn chemistry is essential in the interpretation of redoximorphic features. In viewing a soil with the naked eye or a hand lens, the colours that are seen are due to oxide coatings (or lack of coatings) on mineral grains and/or impregnation of the groundmass. This is evident when the soil is viewed in thin section. In general, red, brown, and yellow colours are due to Fe oxide coatings, dark purplish black colours are due to Mn oxides and dull black colours are due to organic matter. More specifically in PPL, goethite and lepidocrocite are yellow, hematite is red and Mn-oxides are black. If soil particles are uncoated they will often appear gray, white, or the colour of the uncoated mineral grain. Fe and Mn oxides are removed from particles if they are chemically reduced in the soil. This occurs under certain specific conditions: (i) saturation with stagnant, oxygen-depleted (anaerobic) water; (ii) presence of sufficient organic matter and microorganisms; (iii) temperatures above biological zero (5^oC) to allow biological activity (Vepraskas and Faulkner, 2000; Vepraskas, 2004).
Impregnative redox pedofeatures are zones where oxidized Fe and/or Mn have accumulated in the matrix as nodules or as Fe/Mn oxide hypo- or quasicoatings along voids or coarse mineral grains (Stoops, 2003) due to changes in the oxidation state of the element.
Nodules have been described in the literature using a number of terms including concretions, masses, glaebules, and mottles (Brewer, 1976; Vepraskas 2004). These pedofeatures are orthic, disorthic or anorthic and can be further described based on their internal fabric, external

morphology and boundaries (Stoops, 2003). Any coatings related to the nodule should be described for correct interpretation of these features. Depletion redox pedofeatures are zones where Fe/Mn oxides and/or clay have been removed, due to the reduction of Fe/Mn and subsequent mobilization of these elements, alone (Fe oxide depletions or Mn oxide depletions) or associated with clay (clay depletions)(Vepraskas, 2004). All are identified in part by a grey colouration having a low chroma (less than 2, with a value of 4 or more).In this study, we have investigation these pedofeatures in soils with different moisture regimes that affected on its formation.

Material and Methods

The study sites are located in an area of about 132,000 km^2 in Fars province, southern Iran (Fig. 1). According to Banaei (1998), the area has different soil moisture and temperature regimes including xeric, ustic and aridic soil moisture regimes and mesic, thermic and hyperthermic soil temperature regimes. Precipitation ranges from 200 mm in the arid areas in the north, the south, and the southeast to 800 mm in the mountainous region of the northwestern area. However, a large part of the study area receives 200-300 mm, of rainfall. Evaporation ranges from 1100 mm in the east (Sarvestan plain) with mesic temperature regime to 1900 mm in the arid area with hyperthermic temperature regime.



Figure 1: Soil moisture and temperature regimes in the area studied.



Figure 2. Location of the studied pedons in Fars province.

Fars province as part of the Zagros area has been the site of more or less continuous sedimentation from Triassic to Pleistocene era. Regional disconformities occur at the top of Aptian, the Cenomanian-Turonian, the Cretaceous and the Eocene (James and Wynd, 1965).
The study area is a part of the post-Tethyan sea environment where sediments are rich in soluble salts and gypsum in most of the southern and southeastern parts (Zahedi, 1976). The results of the sulfur isotope geochemistry of gypsiferous aridisols of central Iran strongly support the hypothesis that such areas were cut off from the Tethys Seaway at the end of Mesozoic era and, as a result, the lower Cretaceous sulfate has controlled the sulfur geochemistry of the younger sediments (Khademi, 1997). In the north and northeastern parts, aridic moisture regime is dominant. The temperature regime varies from mesic and thermic in north and northeast, hyperthermic in the southern and the ustic and ustic-aridic prevail in the western and south-central parts. Xeric moisture regimes prevail in northwest and temperature regimes varies from mesic in the higher elevations to thermic toward the center of province (Fig. 1). Most gypsum-enriched soils in Fars province occur in alluvial plains, flood plain and piedmont plains and rarely found in younger lowlands. Based on the soil survey and remote sensing reports (Hashemi et al., 2007) there are seven major soil series in the study area, out of which only four are gypsiferous. Thirty five pedons were initially studied and then reduced to 12 pedons for detailed studies. Most pedons are located in flood plains and piedmont plains, in which different soil horizons were sampled for macro- and micromorphological studies. Pedons were described and classified according to the Soil Survey Manual (Soil Survey Staff, 1999) and Keys to Soil Taxonomy (Soil Survey Staff, 2010). The locations of the 12 pedons studied are shown in Fig. 2.
Thin sections of about 70 and 70 cm^2 with 3 mm thickness were prepared from air-dried, undisturbed and oriented colds using standard techniques described by Murphy (1986). Micromorphological descriptions were made according to Bullock et al. (1985) and Stoops (2003).

Results and Discussion

All soils are highly gypsiferous throughout the profile and in most of the pedons $CaSO_4 . 2H_2O$ increases with depth. According to keys to soil taxonomy (soil survey staff, 2010) all soils have gypsic horizon. The overall microstructure of the soils studied ranges from weakly to well separate subangular blocky (Table 1). In some case no angular blocky microstructure observed (such as the C horizon, pedon 21). The most of the B horizon have a well separated subangular blocky. But in the C horizons no angular blocky microstructure was present.
The *c/f* related distribution is predominantly close–open porphyric. The coarse materials consist mainly of quartz grain and fragments of limestone. The fine materials consist of thin crystals of gypsum, ferrous, manganese and a little calcite. The b-fabric is mostly crystallitic gypsum and a little speckled. In the rare cases porostriated b-fabric was observed. Soil matrix color in two situations observed, consist of reddish brown and yellowish brown. In the selected two pedons (3 & 20) that have hydromorphic condition, the soil color is toward grayish brown. Calcite nodules in the micrite size (<5m) observed that have typic and geodic fabric and impregnated predominantly with Fe oxides.
Mn and Fe oxides in all of sample occur as coating, hypocoating and nodules forms. Nodules observed to forms of typic geodic, septaric, aggregate and digitate rarly. Nodules have been described in the literature using a number of terms including concretions, masses, glaebules, and mottles (Brewer, 1976; Vepraskas 2004). These pedofeatures are orthic, disorthic or anorthic and can be further described based on their internal fabric, external morphology and boundaries (Stoops, 2003). Any coatings related to the nodule should be described for correct interpretation of these features.
To produce Fe and Mn oxides pedofeatures, the soil should have anaerobic condition. In pdeon 3 and 20 conditions, however, for this pedofeature are good. In pedon 3 typic Fe nodule were observed on slickenside surfaces (Fig 3. a). In this pedon soil moisture regime is xeric, therefore moist condition suitable for introduce Fe and Mn oxides pedofeature.

Coating and hypocoating of Fe oxide along the channels are observed (Fig 3. b). In this pedon water table has near to surface. Short duration of water saturation or rapid fluctuation of water tables results in intrapedal Fe/Mn oxide nodules and hypocoatings (Arshad & Arnaud, 1980). A

Table 1. Thin section description of the studied pedons.

Pedon, horizon Depth (cm)	Microstructure	*c/f* ratio 10μm	Micromass, color	pedofeature
3. Aquic Haploxeret				
Byss1, 15-35	Moderately subangular blocky, porosity (45-50%) Vesicle, vughs	4/6	Crystallitic, Yellowish brown	Irregular gypsym crystals (Micro spar), hypoidiotopic fabric (25%) in matrix,
Byss2, 35-85	Moderately subangular and angular blocky, porosity (30%) Vesicle, interpedal channels	2/8	Crystallitic, Reddish brown	Lenticular gypsum (30-50 μm), infilling with loose incomplete form in voids, Fe and Mn typic nodules (2%, black and brown color)
7. Gypsic Haploxerept				
By2, 34-77	Moderately subangular, porosity (35%), Vesicle, vughs	6/4	Crystallitic, Yellowish brown	Lenticular gypsum (100-1600 μm) frequency (90%),geodic and typic nodules of calcite impregnated with Fe oxide, nucleic and typic Fe oxide
9. Typic Calcixerepts				
By, 51-86	Moderately subangular, porosity (50%), Vesicle, chambers, channels	3/7	Crystallitic, Yellowish brown	Lenticular and granular gypsum in matrix with hypoidiotopic fabric and loose incomplete infilling, Coating and dense incomplete infilling of Fe oxide (black and brown)
18. Choromic Gypsitorrert				
Ap, 0-20	Crystallitic, Yellowish brown	2/8	sub angular blocky, porosity(20%), vesicle	Pseudo hexagonal gypsum crystals (10%), Fe and Mn typic nodules.
Byss, 20-75	Crystallitic, and speckled Yellowish brown	3/7	sub angular blocky, porosity(40%), channels, chamber, vughs	Coating of gypsum along channels, dense complete infilling (30%), clay coating (30 μm) along channels
20. Gypsic Aquisalid				
Azg, 0-15	Moderately developed sub angular and angular blocky, interpedal channels and vesicles (20%)	Crystallitic, brown	6/4	Irregular and hexagonal gypsum crystals (100-1000 μm) in matrix and loose incomplete infilling along channels (40%). Fe nodule (1%) and very few Mn nodules.
Byzg1, 15-55	As above	Crystallitic, and speckled, Reddish brown	2/8	Lenticular gypsum crystals (1300 μm) and irregular with hypoidiotopic fabric and dense complete infilling along channels, Fe and Mn nodules.
21. Gypsic Haploustept				
By1, 20-50	Crystallitic, and speckled, Yellowish brown	1/9	sub angular blocky, interpedal channels, vughs and vesicles (50%)	Granular gypsum crystals in matrix (15%), and dense complete infilling, typic nodule of Fe and Mn oxides (2%) to reddish, brown and dark color
C, >80	Crystallitic, Yellowish brown	3/7	Weak developed angular blocky, Channels, vughs and vesicles (20%)	Gypsum crystals(idiotopic and hypoidiotopic) along voids nad matrix, calcite nodule (orthic) impregnated with Fe oxide, Fe and Mn noudules with color as above

Fe-rich mineral grain affected by weathering may be surrounded by a Fe oxide hypocoating (Fig. 3b) but this would not be interpreted as an Fe redox pedofeature as key processes for their formation were not involved (reduction-oxidization related to water saturation and reduction). The formation of concentric nodules occurs over multiple wet/dry cycles or fluctuations in the water table (D'Amore et al., 2004). As the duration of water saturation increases from a few days to a

few weeks, the type and pattern of redox pedofeature changes from only impregnative to both impregnative and depletion-related pedofeatures (He et al., 2003). The increased duration of water saturation results in longer periods of reduction in areas adjacent to a source of organic carbon. In these zones, redox depletion hypocoatings are formed. The reduced Fe and Mn may diffuse into the ped where they oxidize to form Fe/Mn redox quasicoatings.
Typic and geodic nodules of calcite in the By horizon of pedon 9 are impregnated with Fe oxide (Fig 3. c, down). Impregnative redox pedofeatures are zones where oxidized Fe and/or Mn have accumulated in the matrix as nodules or as Fe/Mn oxide hypo- or quasicoatings along voids or coarse mineral grains (Stoops, 2003) due to changes in the oxidation state of the element.
Typical nodule of Mn oxide with digitate morphology occurs as in pedon 9 (Fig 3. c). Nodules are also more common as the depth to the saturated/unsaturated soil interface increases and where the water saturation has the greatest fluctuations (Hseu and Chen, 2001; Kyuma, 2004).
We observed that in the high moisture, in all pedons, Fe and Mn pedofeature increased. The lowest of these pedofeature observed in the aridic moisture regmies.

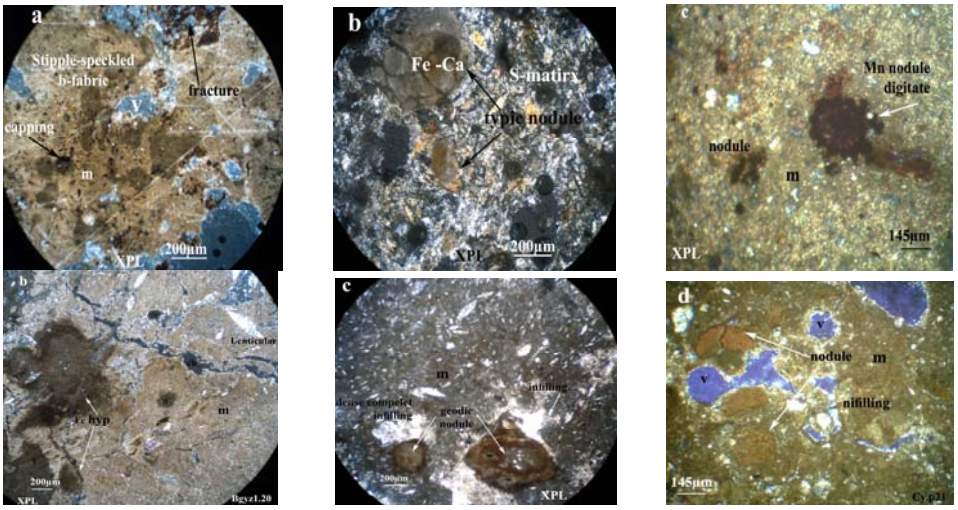


Figure 3. (a) Fracture of typic Fe nodule in vertisols, Byss1, pedon 3; (b) Typic and septaric nodules of calcite impregnated with Fe oxide in By1, pedon 7; (c) Typic nodule of Mn with digitate morphology in By, pedon 9; (b, down) Hypocoating of Fe oxide along channels in Byzg1, pedon 20; (c, down) Typic and geodic nodules of calcite in By, pedon 9 that impregnated with Fe oxide. (d) Calcite orthic nodule impregnated with Fe oxide in matrix C, pedon 21 with ustic moisture regime.

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Changes in Soil Properties Formed on Different Physiographical Land Groups

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Abstract
Soil formation is a long process and a complex phenomenon. Changes in soil forming factors result in a formation of a different type of soil. Similarities in morphological and morpho-genetic characteristics of soils are only possible in where fundamental soil forming factors and processes are also similar. One of the most important soil forming factors is topography. Under the same climatic conditions and on the same parent material, different types of soils might form because of differences in physiographical positions. The objectives of this study were to evaluate morphological characteristics and to compare changes in general properties of soils formed on different physiographic land groups under similar climatic conditions. The results clearly indicated that morphological characteristics and general properties of soils are greatly affected by physiographic positions. The greatest changes occurred in soil formed on lower terrace position. Morphological characteristics of this soil indicated that it formed on lime-rich marn under saturated conditions has a mollic epipedon and a calcic horizon. Soil formed on lower-terraces are deeper, has higher amount of organic matter content, but lower permeability than soils formed on middle and upper terraces.
Keywords: soil profile, soil classification, soil profile, terrace

Introduction

Soil, on the lives of all things, human and animal nutrition products necessary to grow a living entity and source of life. Like other natural sources limited to a value that are important for human life. According to researches on soil formation, in a long and complex process occurs as a result of interactions of the factor. Physiographic in the soil forming factors are considered as a fundamental factor in the structure .Climate, parent material and geologic time, soil formation factors degree of the effect directly related to physiographic structure. The formation of soils formed in place and pedological processes saving profile properties of moved from the storage form of materials and potentiating of the physical properties of many, in which their formation depends on the physiographic forms.
Soil taxonomic units, with its relations with the physiographic features of this research to determine the boundaries of the district of Erzurum province Aziziye plots were located within the limits Sinirbaşı Basin.
Soil types and differences between these, occurrence of soils factors the general concept of the genetics of the soils, the relationship between soil and environmental conditions alone are not sufficient to describe the mechanisms of soil formation. Because soil formation and properties of an emergence profile that play an active role in the physical, chemical and biological events depends on degree of influence of different additives.(Dinç ve ark., 1987)

Material and Methods

Soil samples were taken at different depths of three soil profiles characterized at the upper, middle and bottom position of the Söğütlü Mountain in Sinirbaşı Basin. The region created Paleozoic-Mesozoic Akdağ older metamorphic and upper cretaceous ophiolites of the orderly Şahvelet.
For the region, average temperature 6.3°C, annual precipitation is 397,8 mm, annual evaporation 1060 mm, annual average relative humidity %64, the average annual number of days that the snow – covered 94 days, the annual number of rainy days average 124 days.
Disturbed and undisturbed soil samples taken from the field in accordance with producers, samples were air-dried and passed through 2 mm sieve and analyzed for general soil physical and chemical characteristics. Soil texture was determined by the hydrometer method, bulk density by the cylinder method (Blake and Hartge 1986). Soil reaction was determined potentiometrically using a glass electrode pH meter (Mc Lean 1982), lime content with Scheibler calcimeters(Nelson 1982), organic matter content by Smith-Weldon method(Nelson and Sommers 1982) and salt content

using the conductivity bridge(Demiralay 1993).Cation exchange capacity was determined using the Na-acetate methods by atomic absorption spectrophotometry (Rhoades 1982), and exchange cations was determined by sodium bicarbonate ($Na_2(HCO_3)$) (pH 8,5 adjusted to) method volumetrically and reading by spectrophotometebelirlenmiştir (Aydın ve Sezen 1995).

Soils Formed On the Upper Terrace

The upper soil was found to have higher organic matter content, cation exchange capacity and clay content. Soils with these characteristics are medium deep and have good permeability and high water-holding capacities. There was no sign to water erosion and climate conditions due to the lack of bathing arise these features (Fig. 1).



Figure 1: Soils Formed On the Upper Terrace

Soils Formed On the Middle Terrace

The study area soils, topographical position as factor in middle terrace areas, the upper soil was found to have high organic matter content (%9,97) lime content (%13, 68), cation exchange capacity and clay content. Soils with these characteristics are medium deep, good permeability, contain level of salt interfere with plant production, water-holding capacity is high and has a good soil structural development (Fig. 2).

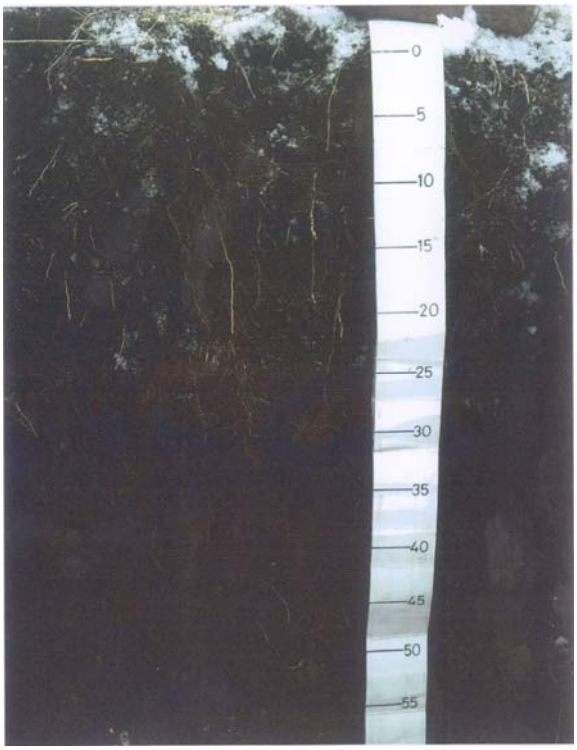


Figure 2. Soils Formed On the Middle Terrace

Soils Formed on the Lower Terrace

The study area soils, topographical position as factors in specific areas, at the lower terrace towards organic matter content decreases (%8, 54) soil organic content is high upper soil (%9, 97), lime content (%13, 68) were found to be higher and the climate conditions are not effectively connected to bathing. Soils with these characteristics are deep with low permeability and poor development (Fig. 3).



Figure 3: Soils Formed on the Lower Terrace

The results of this study indicated that formation and properties of the soils accruing on the land as factor which appears to be important effects of topography and land positions. Especially, with in the territory of the basin described as soil properties change profile, reflecting the outcome of the formation factors. Formed on the material of the soil especially on the lower terrace line content and other properties of material examined, that are formed in long-term water is understand that the material referred to as the''lime marl". It could be concluded that different soil properties revealed by the positions of the different terraces.

Discussion and Conclusion

Physical and chemical properties

Soil pH varies between "neutral and moderately alkaline reaction", organic matter content between 3,31% and 9,97%, electrical conductivity between 240 µmhos/cm and 800 µmhos/cm.Plant available P contents ranged between 0, 02-1, 84 ppm which was classified as "very low" (Lindsay and Norwell 1969;FAO1990) (Table 1).

Table 1. Soils of chemical and physical properties

Samples	pH, SAT.EXT.	EC dS/M	OS, %	$CaCO_3$ %	CEC, Me/100GR	P, ppm	CLAY %	SILT %	SAND %	CLASS TEXTURED	HA, GR/cm^3
1-(0-30)cm	7,94	800	9,19	0,52	44,28	0,90	46,44	31,10	22,46	C	1,07
1-(30-55)cm	7,44	400	6,88	1,76	37,46	0,17	43,08	28,18	28,75	C	
1-(55-70)cm	7,41	610	4,40	0,59	39,73	0,33	40,36	27,71	31,93	C	
1-(70+)cm	7,72	400	3,60	6,71	37,46	0,02	43,84	17,90	38,26	C	
2-(0-35)cm	7,40	310	9,97	13,68	39,73	1,84	42,14	35,22	22,64	C	1,05
2-(35-63)cm	7,50	270	7,62	0,33	41,44	0,45	46,44	35,30	18,26	C	
2-(63-105)cm	7,56	240	4,94	0,49	31,79	0,15	50,28	44,53	5,19	SICL	
2-(105+)cm	7,22	460	4,42	0,33	32,92	0,20	61,29	8,00	30,71	C	
2-(30-70)cm	7,93	300	4,07	0,65	39,17	0,13	44,65	29,20	26,15	C	
3-(0-35)cm	7,70	440	8,54	13,68	39,73	0,58	38,44	42,05	19,52	SICL	0,91
3-(35-70)cm	7,45	250	5,27	4,75	40,30	0,48	33,91	35,10	24,99	CL	
3-(70-90)cm	7,65	420	4,92	7,33	39,73	0,15	33,49	34,94	31,57	CL	
3-(90+)cm	7,57	460	3,31	9,96	40,30	1,18	14,94	22,72	62,34	CL	

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Land Resource Assessment in Part of Helle River Basin (Bushehr Province in South Western of Iran)

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Abstract
This study is part of Helle river basin that located in north of Bushehr province. The objective was to investigative the land resources up to territorial units level and obtain the map of hydrological soils groups based on SCS method. With interpretation and detecting changes in 3D aerial photos and different components, four main land types including Mountains, Hills, Plateau and upper terraces and Fan-shaped debris were diagnosed. Mountains land type with thick layer limestone litology is used for seasonal grazing of livestock and including 2 territorial units of relatively high mountains with rounded and sharp peaks. Hills land type with conglomerate litology and alluvial deposits is just suitable for seasonal grazing of livestock and rainfed agriculture . Plateau and upper terraces land type includes lands with a relatively high relief which is used as pasture, seasonal grazing and agriculture in some areas. Shallow soils with more than 90 percent gravel in fan-shaped debris are used as arboriculture and pasture. According to the SCS method, mountains can produce the greatest amount of runoff than other land types. In addition, pursuant to hydrological group of plateau and upper terraces and fan-shaped debris, these soils have the ability to produce average runoff and compared with other land types have the greatest amount of water penetration.
Keywords: Helle river basin, hydrological groups, Land resource

Introduction

Environmental pollution and salinity of water resources and loss of balance of natural ecosystems and dozens of other problems are related to the lack of attention to the issue of land capability and incorrect usage directly or indirectly (Dewan and Rieben, 1958). Based on scientific and technical principles, land capabilities are different and the recognition of this feature is really important (Baxter and Robinson, 2001). The first phase of land suitability classification for each of uses and suitability rating in the current situation and future is breakdown of each major type to land units (Kauzeni et al., 1993). Since soil and land resource assessment studies have never been conducted in the study area, so this research has been studied in this area.

Materials and Methods

The study area is part of Hilla River subbasin with area of about 75,000 acres north west of Bushehr province and located between 51° 08́ 34″to 51° 2.1́ 45″ east longitude and 28° 54́ 56″ to 29° 14́23.9″ north latitude (Fig1). Based on available climate data from synoptic station, study area has arid climate. Basin average rainfall is 245.2 mm and annual average temperature is 26 ºC. According to climate statistics and temperature- moisture curve of study area, soils have Aridic moisture and Hyperthermic temperature regime. Geologic formation of the study area is located in Zagros folded zone. In this study, assessment of land resources have been conducted to the territorial units and 1:25000 scale maps and homogeneous land units have been selected as a soil studies units. In order to achieve the land units, land types in the area have been marked with 3-D aerial photography interpretation and field studies. Based on detecting changes in different components in 1:40000 scale aerial photographs, separation of each type and land unit's range has been done. Also with 1:25000 topographic maps of the area, each of the components have been moved on the map and a preliminary map has been examined for field studies and finally soil profiles were identified in each of the units in order to study soils. In addition the final map of land resources, using the data in 1:25000 scale and also hydrologic soil group's map are provided according to the permeability of the soil types and SCS method (Chow et al., 1988).

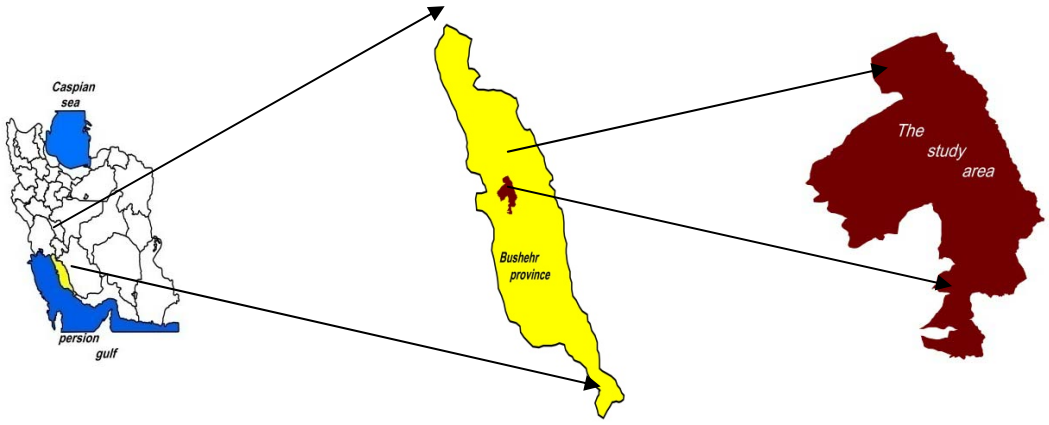


Figure 1. Location of the investigation site

Result and Discussion

Based on the results four main land types including Mountains, Hills, Plateau and upper terraces and Fan-shaped debris were diagnosed.

Mountains land type: This type's area is 22,820 hectares in the study area which is equivalent to 48.5% of the total area. Mountain's lithology follows geological formation which is thick layer of lime to mass lithology. This type of land uses for seasonal grazing of livestock and according to the shape, geological profiles is divided into land units and in total 2 units have been identified and on the land resource's map (Fig2), are marked with signs 2-1 and 4-1. Land units 2-1 contain a relatively high mountain with circular peaks with 40 percent rocks, calcareous rocks and shallow soils that can be used as seasonal pastures. It's area is 6696 hectares that includes the 14.23% of the field area. Land units 2-1 contain mountains with sharp peaks with 40 percent rocks and shallow soils that can be used as seasonal pastures. It's area is 16124 hectares that includes the 34.26% of the field area.

Hills land type: This type contains circular peaks. hills's lithology follows geological formation which is conglomerate lithology with less than 10 percent rock and according to the shape, geological profile has got just a land unit which is marked with sign 2-3 on the land resource's map. Land unit 2-3 contains hills with rounded peaks and alluvial deposits on the rocks with less than 20 percent rocks and 60% surface gravel and shallow soils that can be used as seasonal pastures and rainfed agriculture in some places. It's area is 11765 hectares that includes the 25% of the field area.

Plateau and upper terraces land type: These lands have got variable amount of gravel and general slope of 3-5 percent and side slope about 10-25 percent. and according to the shape, geological profile has got two land units which are marked with signs 3-4 and 3-7 on the land resource's map. It's area is 10983 hectares that includes the 23.34% of the field area. Land unit 3-4 contains Plateau and upper terraces with high and relatively high relief, high erosion and salt restriction with general slope of 5 percent and side slope about 20 percent. In addition relatively deep soils are mainly used as pasture and grazing season and in some areas used for agriculture. It's area is 4326 hectares that includes the 9.19% of the field area. Land unit 3-7 contains Plateau and upper terraces with relatively high relief and general slope of 5 percent and side slope about 8 percent. Deep soils are mainly used as pasture and grazing season and in some areas used for agriculture.

Fan-shaped debris land type: It's area is 1487 hectares that includes the 3.16% of the field area. It has got a land unit which is marked with sign 8-2 on the land resource's map. Land unit 8-2 contains almost flat Fan-shaped debris with a gentle slope 1-3%, 90% surface gravel with stony and shallow soils are mainly used as pasture and grazing season and in some areas used for arboriculture.

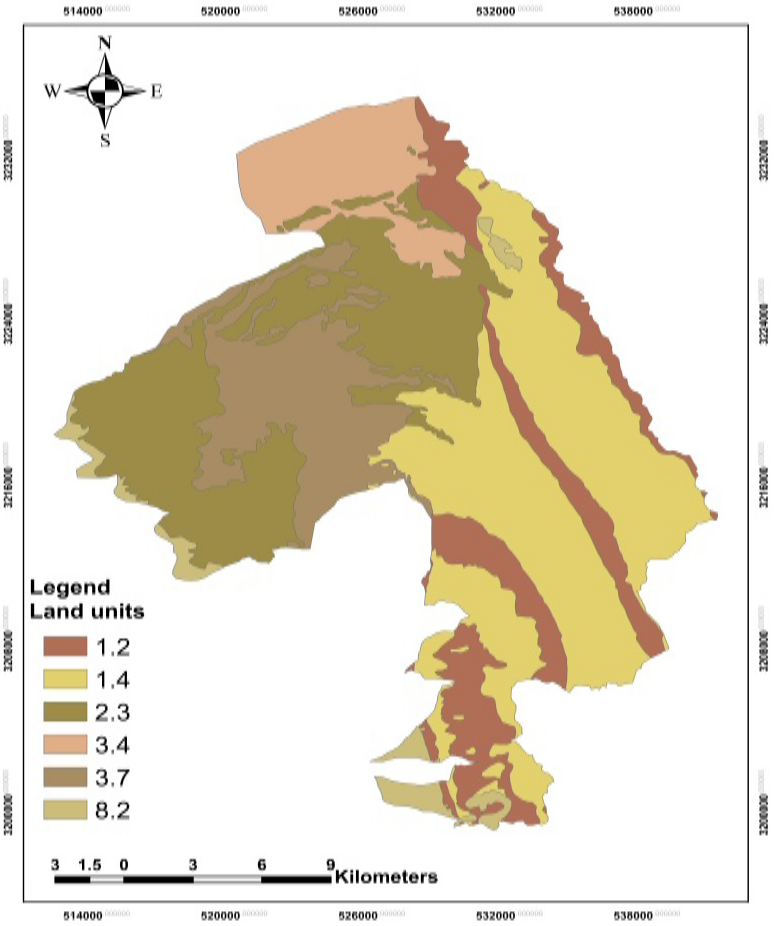


Figure 2. Land units'map

Based on SCS method, the soils have divided into three hydrologic soil groups (Table 1). Map of hydrologic soil groups is visible in (Figure 3). According to results, mountains land type's soils are capable of producing more runoff than other land types. According to the hydrological groups of the Plateau and upper terraces and Fan-shaped debris, these soils have the average ability of producing runoff and compared with other land types have the maximum amount of water infiltration.

Table 1. Hydrologic soil groups in Land units

Land main types	Land units	Hydrologic soil groups	Area(ha)	Area percentage
Mountains	1-2	D	6696	14.23
	1-4	D	16124	34.26
Hills	2-3	C	11765	25
Plateau and upper terraces	3-4	B	4326	9.19
	3-7	B	6656	14.15
Fan-shaped debris	8-2	B	1487	3.17

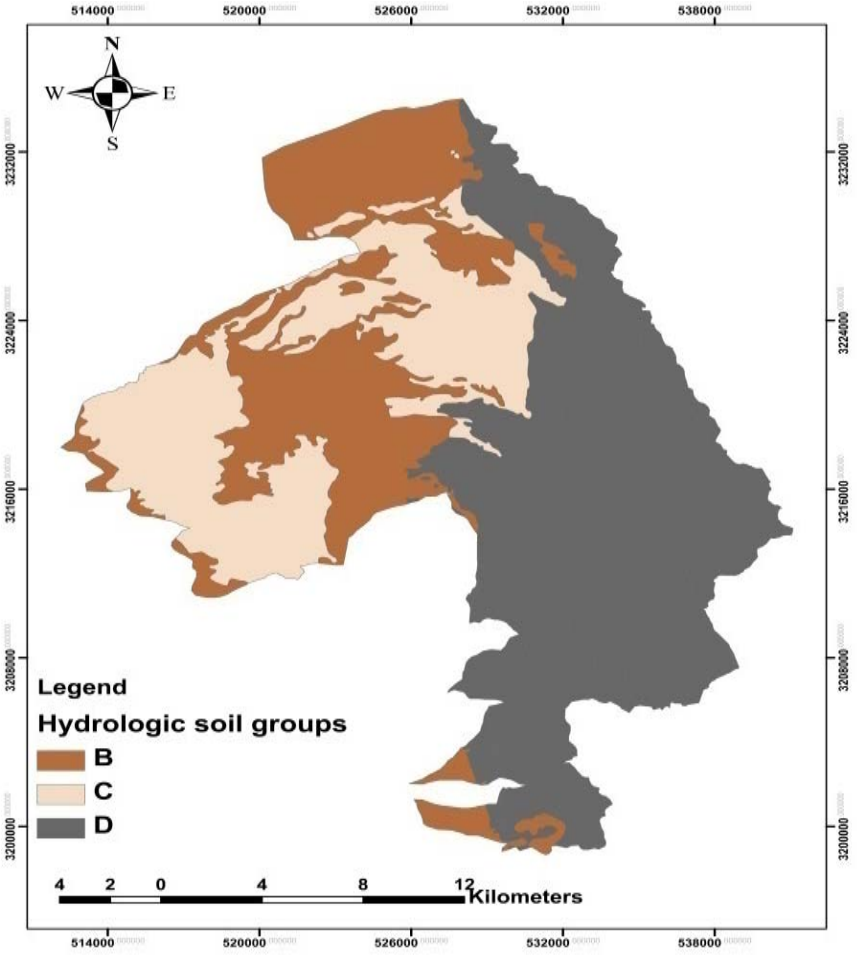


Figure 3. Hydrologic soil groups map

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The Effect of Topography on Soil Genesis, Morphological, Mineralogical Features and Soil Classification in Part of Safashahr Subbasin (South Western of Iran)

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Abstract
This study is part of Safashahr sub basin that located in north of Fars province. The objective was to investigative the effects of topography factor on soil genesis and evolution. Soils have extended on 4 physiography units including Gravelly alluvial fan, Undulated Plateau & Upper Terrace, Slightly undulated Plateau & Upper Terrace and floodplain which classified in 3 orders, 3 suborders and 8 families. Soils have included cubic stracture with weak to massive evolution and 5YR4/4 to 10YR6.5/4 color. The most important morphological phenomenon is calcic phenomenon which was identified as powdery packet and nodules. Soils on gravelly alluvial fan were identified in Calcixerepts and Calcic Haploxeralfs great groups. There are two pedons with different features on each other in Calcixerepts and Calcixerepts Thapto Calcic Haploxeralfs great groups in undulated Plateau which are indicated alternating periods of deposition - erosion and more humid climate of the past. Soils on Slightly undulated Plateau are the residual due to weathering of deposits, lake and terraces which are classified in Calcixerepts great group. Diagnostic horizons with large amounts of organic and cumulative material in flood plain are related to the past climate. Undeveloped and buried soils are in Xerorthents and Calcixerepts graet groups respectively. The dominant clay minerals are Illite, Kaolinite, Polygorskite and Smectite. The same type of minerals can be related to the same soil parent materials and relative difference in amount of minerals is linked to geomorphic status and effect of topography on soil pedogenic process. .
Keywords: genesis, topography, buried soil, Safashahr subbasin

Introduction
Soil formation is result of the interaction of pedologic and geomorphologic processes (Gerrard, 1992). Topographic changes cause more changes in soil characteristics like the amount of organic matter, moisture, soil depth and color and the rate of soil evolution (Bul1, 1991). studying of the soil in the southeast of Brazil showed that the intensity of soil formation is really dependent on topography which effects the rate of weathering, leaching of soluble salt, leaching procedures and processes, depth of solum and salt accumulation(Anjous et al., 1198). soil organic matter level and thickness of soil surface are increasing from top to bottom of slope(Mallo et al., 1974). Mineralogy as one of the most important features of soil is depended on topography , geomorphic states and chemical conditions. Soil clay minerals are very important in soil evolution. believes that different types of minerals indicate the soil weathering degree(Brady and Weil, 1999).

Materials and Methods
The study area is part of Safashahr subbasin**(**of great kor basin) with area of about 75,000 acres north west of Fars province and located between 52°, 43́, 7″to 53°, 31́, 24″ east longitude and 30° 20́ 3″ to 30° 48́ 53″ north latitude (Fig1). Safashahr includes 5 sub-basin. In this research Gerdab sub-basin has been selected. Based on climate data available from synoptic station, study area has semi-arid climate. basin average rainfall is 318 mm and annual average temperature is 10.3 ºC. According to climate statistics and temperature- moisture curve of study area, soils have Xeric moisture and Mesic temperature regime.

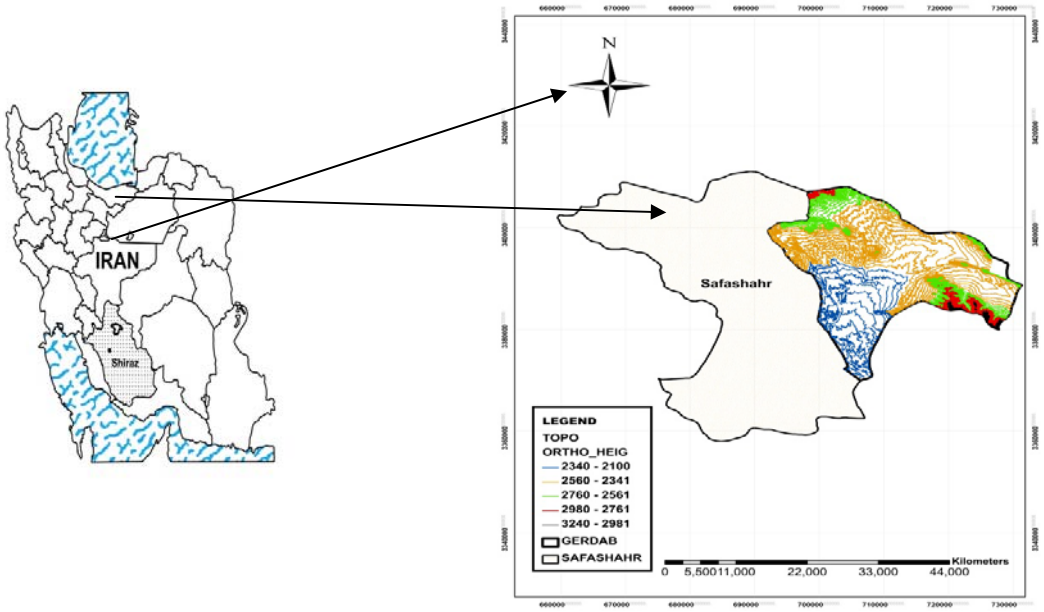


Fig. 1.Location of the investigation sites

Using air photos (1:50000), topographic maps and geological studies (1:100000) of study area, 4 physiography units in area were identified. To identify changes in soils, in each physiography unit on different landform situations including Gravelly alluvial fan, Undulated plateau & Upper terrace, Slightly undulated plateau & Upper terrace and Floodplain, some profiles were dug and field studies and sampling were conducted. Then soil samples were air dried and passed through a 2-mm sieved for physical and chemical analyses using standard methods (Blake and Hartge, 1986). "To determine the type of clay minerals and their changes in different profiles, 4 treatments were prepared from each sample of purified clay and their mineralogy were prepared and determined using XRD (Kittrik and Hope, 1963). For semi-quantitative studies of minerals, area under curve of first order peaks found in Magnesium - Glycerol treatment were used as the peak intensity (Johns et al., 1954). Peak intensity was used as a criterion to show the approximate amount of each type of clay. Soils classification and sampling method were used according to soil survey staff (2006).(Table1).

Table 1. Environmental information of soil pedons

Physiographic unit	Pedon number	Slope (%)	Elevation (m)	Soil classification	
				WRB(2007)	USDA (2006)
Gravelly Alluvial fan	1	2-3	2464	Haplic Calcisols	Loamy Skeletal, Mixed, Mesic - Typic Calcixerepts
	2	0-2	2418	Calcic Luvisoils	Fine-Loamy, Mixed, Mesic- Calcic Haploxeralfs
Undulated Plateau & Upper Terrace	3	0-2	2386	Haplic Calcisols	Sandy Skeletal, Mixed, Mesic- Typic Calcixerepts
	4	2-6	2398	Haplic Calcisols Thapto Calcic Luvisoils	Clay over Loamy Skeletal, Carbonatic, Mesic -Typic Calcixerepts Thapto Calcic Haploxeralfs
Slightly undulated Plateau & Upper Terrace	5	0-2	2333	Haplic Calcisols	Fine-Loamy, Mixed, Mesic- Typic Calcixerepts
	6	0-2	2256	Haplic Calcisols	Fine-Loamy, carbonatic, Mesic- Typic Calcixerepts
	7	0-2	2242	Haplic Calcisols	Fine, Mixed , Mesic- Typic Calcixerept
	8	0-2	2237	Haplic Calcisols	Fine-loamy, Mixed , Mesic - Typic Calcixerept
Flood Plains	9	0	2233	Haplic Regosols Thapto Haplic Calcisols	Sandy Skeletal over Fine Loamy, Mixed, Mesic - Typic Xerorthents Thapto Typic Calcixerept

Results and Discussion

Effect of topography on soil morphological, chemical and physical characteristic

Considering soil morphological characteristics of the study area (Table 2), surface horizons are denoted with massive structure, firm consistence and few to common clay films and sub surface horizons are diagnosed with strong angular blocky structure, friable to firm consistence and few to many clay films, massive structure with friable consistence and few clay films. According to physico- chemical soil characteristics (Table 3), soil texture has changed from Alluvial fan to slightly undulated plateau & Upper terrace and contain higher amount of clay, but subsequently in flood plain due to impact of seasonal streams, soils include coarser fragments which affect the character and behavior of the soil. From the high slope to low slope, amount of clay in soils are much more increased because of increasing in soil water infiltration and deposition of fine materials in low lands(wiliding, 1983). According to calcareous soil parent material, the percentage and depth of calcium carbonate are increased clearly. With slope decreasing, the amount of organic matter, A horizon's thickness and also depth of calcium carbonate are increased (landi et al., 2003). Generally, the electrical conductivity from floodplain to alluvial fans are increasing because of accumulation of water in which there are some salts and minerals. With moving from upland to lowland, soil pH is increased due to higher accumulation of calcium carbonate and alkaline elements. Most profiles have secondary lime in powder and mycelium shape. Influence of topography on soil evaluation in Iran is related to leaching of calcium carbonate from the soil surface and penetrating in deep horizons specially in semi arid regions(Abtahi, 1980).

Effect of topography on soil minerals

Results from mineralogy study showed that in the upper slope position Kaolinite and illite are dominant and in lowland intermediate chlorite and Smectite are increased. Their development is related to the degree of weathering. Presence of Illite and Chlorite in the parent material reveals that hereditary origin is the main reason for their presence . There are significant amount of Chlorite in lowland because of Chlorite-rich parent material. Increasing in amount of Smectite toward lowland could be due to deposition of the soil solution. In this situation, Smectite could be created because of increasing in solute concentration, pH and effects of irrigation on arable land. This effect has been widely studied(Dhar et el., 1989). In the lower slope, Smectite is dominant and in the upper slope Kaolinite and intermediate Smectite- Kaolinite are dominant(Abahosain et al., 1980). soil evolution on Undulated plateau are due to high leaching in past climate, destruction of Illite and Chlorite and formation of mixture minerals like Chlorite - Smectite and Illite - Smectite might be related to wetter conditions in the past. in arid and semi-arid soils Illite has been a major mineral(Smith and Boul, 1968). Calcareous parent material in this area is containing large amounts of Polygorscite. With increasing the amount of calcium carbonate, Polygorscite increases too and the maximum value is in the Petrocalcic horizon(Abtahi, 1980). According to the results dominant minerals in alluvial fan are Illite, Kaolinite and Smectite, respectively, dominant minerals in Undulated plateau are Kaolinite, Polygorskite and Smectite, dominant minerals in Slightly undulated plateau are Smectite, Polygorskite, Chlorite, mixed Chlorite - Smectite and the small amount of Kaolinite and also dominant minerals in Floodplain are mixed minerals and Polygorskite. The same type of minerals can be related to the same soil parent materials and relative difference in amount of minerals is linked to geomorphic status and effect of topography on soil pedogenic process.

Table 2. Morphological characteristics of the soil pedons

Soil horizon	Depth (cm)	Munsell color (moist)	Texture classes	Structure	Consistence		Clay film	Boundary	Roots
					moist	**wet**			
A	0-20	7.5YR4/4	CL	1m	fr	ss,sp	f	c.w	3vffver
Bk_1	20-70	7.5YR4/4	SCL	abk 1	fr	ss,sp	f	g.w	2vffver
Bk_2	70-150	7.5YR4/4	SL	abk 1	fr-fi	ss,sp	f	-	1vffver
A	0-25	7.5YR4/4	CL	m 1	fi	sp	f	cw	2vffver
Bk_1	25-60	7.5YR4/4	C	abk 2	fi	sp	c	cw	1vffver
C	60-100	7.5YR5/4	SCL	m 2	fi	so,po	vf	cw	1vf
2Btkb	100-160	5YR4/4	C	abk 3	vfi	vs,vp	m	cw	2vffver
2Bkb	160-185	5YR4/4	SL	abk 3	fi	sp	c	-	2vffver
A	0-30	10YR4/4	C	m 2	fi	s,p	c	g.w	3vffver
Bk_1	30-65	10YR4/4	C	abk 1-2	fi	s,p	m	g.w	2vffver
Bk_2	65-180	10RY4.5/4	C	abk 3	vfi	vs,vp	m	g.w	1vff
Bk_3	180-215	10YR5/4	C	abk 1-2	fi	s,p	c	c.w	1vf
C_1	215-250	7.5YR5/2	S	m 1	fi	so,po	-	-	-
A	0-35	7.5YR4/4	SCL	m 3	fi	s,p	c	c.w	2vffver
C_1	35-100	7.5YR4/4	LS	m 1	fr	so,po	vf	c.w	1vffver
C_2	100-140	7.5YR4/4	LS	m 1	fr	so,po	vf	c.w	1vf
2Bkb	140-220	7.5YR4/4	SCL	2abk	fi	s,p	c	-	2vffver

Table 3. Physico chemical properties of the soil pedons

Soil horizon	Clay%	Silt%	Sand%	pH	EC dSm^{-1}	CEC $Cmol_c$ kg^{-1}	OM%	$Caco_3$%
A	35.00	21.50	43.50	7.74	0.95	18.74	0.95	22.75
Bk_1	25.00	15.50	59.50	7.82	0.38	16.86	0.68	34.00
Bk_2	17.00	13.50	69.50	7.88	0.58	14.25	0.30	40.50
A	33.79	23.43	42.78	7.98	0.95	20.73	0.55	36.55
Bk_1	35.69	16.89	38.42	8.10	0.53	16.52	0.38	48.25
C	26.75	6.54	73.29	8.12	0.50	10.12	0.05	34.00
2Btk	40.89	21.25	37.86	8.22	0.66	22.85	0.32	42.92
2Bk	18.53	16.89	64.58	8.28	0.55	17.17	0.87	40.92
A	42.00	39.00	18.00	8.30	3.16	23.21	1.09	32.92
Bk1	43.00	37.00	20.00	8.10	3.01	17.03	0.61	45.75
Bk2	47.00	32.00	21.00	8.03	2.02	17.82	0.35	47.25
Bk_3	51.00	29.00	20.00	8.42	2.92	20.31	0.30	50.75
C_1	6.00	4.00	88.00	8.25	3.12	4.23	0.05	39.25
A	23.00	12.00	65.00	8.16	1.64	13.56	0.85	22.87
C_1	7.00	9.00	84.00	8.50	1.55	4.02	0.10	29.60
C_2	9.00	6.00	85.00	8.65	1.62	4.21	0.06	30.85
2Bk	31.00	17.00	52.00	8.15	1.82	19.53	1.18	35.82

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Evaluation of Travel Speed and Tractor Passes on Soil Sinkage and Compaction on Northwest of Iran

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Abstract
Field traffic reduces the amount of air-filled pores thus affecting a large range of physical soil properties. Furthermore, soil compaction may increase the mechanical strength of the soil and thereby impede root growth. The aim of this study was investigation of the traffic (in three levels 1, 3 and 5) and speed (in two levels high and low) of tractor on sinkage and soil compaction. Compaction of both topsoil (0-15cm) and subsoil (15-30 cm) was demonstrated with measurement of bulk density (BD) and penetration resistance (PR). Vertical soil displacement was measured by ruler from initial soil surface.
Result of this research revealed a significant impact of tractor passes on the compaction and soil sinkage. Tractor passes show significant effects on PR and BD for topsoil and subsoil. Also tractor passes affected soil sinkage significantly ($P<0.05$). Result show that travel speed affected soil compaction in topsoil and is not significant impact for subsoil. Also result show that travel speed not significant on the soil sinkage ($P<0.05$).
Keywords: Traffic, Compaction, Sinkage, Tractor.

Introduction
Twenty-first-century farm economics stimulate farmers to increase the size of their operations. To improve labor efficiency, farm equipment usually increases in size. Increase the size of tractor and other equipment couse increase in soil compaction. Soil compaction has negative effects on crop production and the environment, therefore management of tractor traffic is very important (Soane and van Ouwerkerk, 1994).
Compaction coused the soil pores become smaller and soil strength increases (Shetron et al., 1988). Aust et al. (1998) and Nugent et al. (2003) found a 30–50% increase of the penetration resistance (PR), a measure for soil strength. As root tips have to overcome soil strength to be able to elongate, root growth may be hampered. Compaction also has an influence on the environment as a whole, e.g. as soil erosion may result due to reduced water permeability
The objectives of the present travel speed and tractor passes on soil sinkage and compaction on northwest of Iran. The experiments were carried out in Iran 2011.

Materials and method
Field tests were performed during spring and summer in 2011 in Iran. The MF285 tractor (75 hp) is the main tractor in Iran and was the tractor used for this study. The MF285 tractor has a mass of 3075 kg. Weight distribution was 60% on the rear axle and 40% on the front axle.
For evaluation of soil compaction, penetration resistance (PR) and bulk density (BD) were measured. Also sinkage of soil was measured compaired with level land. Penetration resistance was measured with a penetrometer (Rimik 200 model). The cone had a 108 angle with a cone base cross-sectional area of 1 cm^2. For increase precise, PR was measurement in each treatment for 10 times. Sample bulk densities were calculated based on the volumes calculated from the length and diameter of the section, and dry weights of the soil samples.
The experiments were done in clay soil in different numbers of tractor passes (1, 3 and 5) were imposed on the same track. Three replications were arranged in a completely randomized design. The second variable is speeds of tractor in three levels (3, 5 and 7 km/hr). Treatments were replicated three times in a completely randomized design. Each plot was 30 m in length and 4 m wide.

Results and Discussion
The results show that tractor's passes has a significant effect on the soil compaction. One pass significantly increased PR and BD, the tractor's first passes produced a greater PR increase than the three or five passes. Greater PR differences were seen in the 10-cm depth interval than in other

depths (Figure 1). Also analyses of data show that tractor's passes has a significant effect on the soil sinkage and maximum sinkage occurs in five centimeter depth in five passes treatment (Figure 2). Result show that travel speed affected soil compaction in topsoil (0-20) and is not significant impact for subsoil (20-30 cm). Also result show that travel speed not significant on the soil sinkage ($P<0.05$). Results of this study inform that tractor's passes is an important factor in field management and farmer avoid from additional tractor's passes in field.

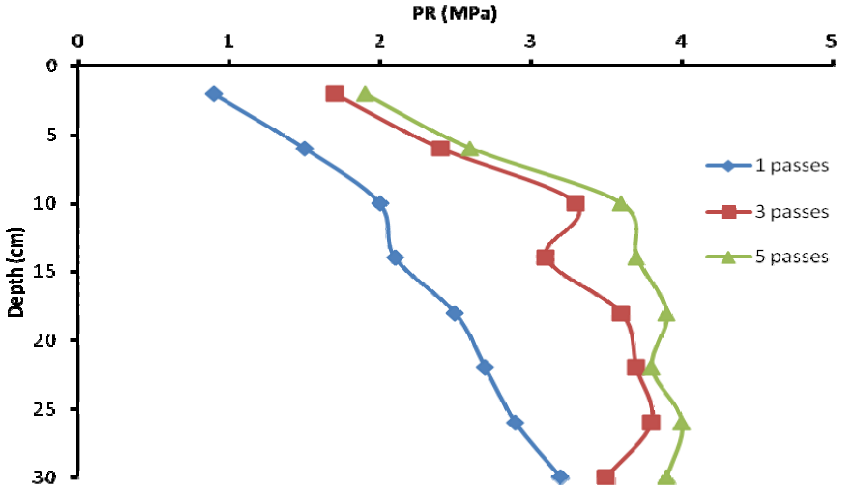


Figure 1. Impact of tractor passes on penetration resistance (PR) in field at the 0- to 30-cm depth.

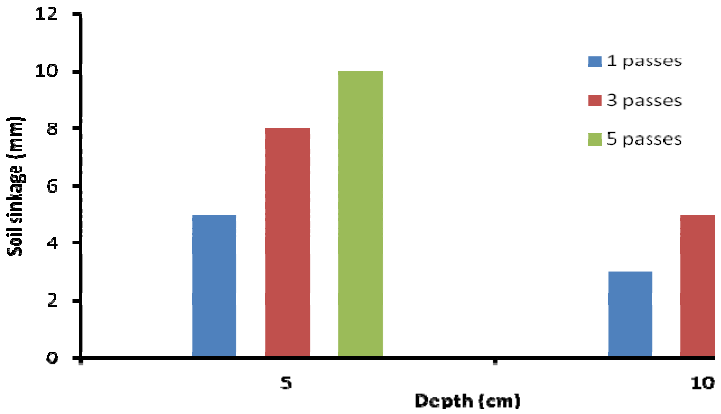


Figure 2. Impact of tractor passes on soil sinkage in field at the 5 and 10-cm depth.

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Pliocene pedogenesis in the Western Transbaikalia (Russia): Estimating of soil organic carbon stocks

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Abstract
Stability of the carbon cycle in the biosphere is maintained by the fossilization of organic carbon, in which a certain portion of this element is removed from the active circuit, partly preserved in paleosols, and in the enclosing sediments for thousands and even millions of years. The investigation was aimed at estimating of soil organic carbon stocks in the Pliocene paleosols and sediments (Western Transbaikalia). The basic objects of study are the Neogene sediments with paleosols of the paleontologycal sites Udunga and Tologoy. These soils kept the humus-accumulative horizons and exogenic processes often carry them to the surface that could lead to the mineralization of organic carbon. Mean SOC storage (kg C m^{-2}) was calculated for total organic carbon, carbon of humic and fulvic acids as the next source of replenishment of the carbon cycle, as well as the carbon component of humin, the most strongly associated with the mineral part of the paleosols.
Keywords: soil organic carbon stocks, Pliocene paleosols

Introduction
One of the most ill-defined factors in global element cycles is the stabilization of organic matter in terrestrial environments. The total stock of organic carbon in sediments, soils and marine dissolved organic matter exceeds the amount of the atmosphere carbon by orders of magnitude. Stability of the carbon cycle in the biosphere is maintained by the fossilization of organic carbon, in which a certain portion of this element is removed from the active circuit, partly preserved in paleosols, and in the enclosing sediments for thousands and even millions of years. Part of the organic carbon is returned to its circulation under certain conditions, but rather a significant part of the current is detected as a residual of stored carbon, as a reserve supply of CO_2 in the atmosphere.
Study of the organic carbon fossilization in continental conditions was initiated by publications of Glazovskaya (1996, 1997, 2009), which noted the need to incorporate carbon sinks in the continental deposits in the global cycle. She has calculated reserves fossilized carbon in the main soil types of the East European Plain, showed that the total reserves of the stable carbon deposits on the continental strata of the order exceeds its reserves in the active layer (0-100 cm) of recent soils. The approximate rate of outflow of organic carbon in the fossilization fund determined. Such record to the modeling of the carbon cycle has not been provided.
Our investigation was aimed at estimating of soil organic carbon stocks in Pliocene paleosols and sediments. Neogene sediments were formed under favorable climatic conditions, so the soil humus horizons remained significant.

Materials and Methods
The basic objects of study are the Neogene sediments with paleosols of the paleontologycal sites Udunga and Tologoy (the Western Transbaikalia). The site Udunga is located in the river Temnik valley, the site Tologoy- in the river Selenga valley. The Western Transbaikalia is a part of the Baikal rift zone within Eurasian continent. An area bounded by high and medium-mountains, which are the orographic barriers to the different climate, landscape and zoogeographic zones. Together with the Northern Mongolia is a single reduced-Selenga middle mountains region.
During the Pliocene red-clay deposits occurred in the Western Transbaikalia, which were formed by erosion of Miocene montmorillonite hydromica weathering crust. This weathering crust is extended from the foothills of the Carpathians to Transbaikalia. In the Pliocene deposits of red clay fraction dominates, but with a mixture of a large number coarse debris. Vegetation in the Pliocene, according to palynological data, presented coniferous and deciduous forests (Bazarov, 1986; Kalmykov, 2003).

In our work we use the pedohumic method (Dergacheva, 2003), when the pedogenic humus properties of site sediments analysed and used as the basis for reconstructing soil-forming processes.

As a result of study the Pliocene sediments with loamy and silty reddish brown soils in the Udunga site has revealed three different pedogenetic cycles, depending on water regime and duration of pedogenesis in subtropical environment. The stratigraphic section of the Tologoy site has 4 zones of pedogenesis that are distinguishable by pedogenic humus and other features, and consequently by the character of ancient soil forming processes. The lower part of the Tologoy site is thickness of red clay with a lot of sand lenses and inclusions of gravel. According to paleontological data, this part has been attributed to Eopleistocene - Pliocene. The residues of the humus horizon and the underlying its pink horizon were studied inside the thickness. Morphological features and physico-chemical properties of soil fragments studied it possible to compare it with the modern analogue of red-brown soil with calcareous concretions sub arid regions.

Results and Discussion

Estimating of soil organic carbon stocks based on the results obtained on the total organic carbon content (TOC) in the Pliocene subaerial sediments, the proportion of different groups of humic substances and the available data on the average bulk density for the basic rocks and paleosols horizons. Average bulk density values in the Pliocene sediments and soil horizons varied within a small range 1,61-1,69 g cm^{-3}. In the studied sediments averaged 1,68 g cm^{-3}, while a very small portion of the deposit has a volume of less than 1,60 g cm^{-3}.

In the reddish brown and dark brown soils of the paleontologycal site Udunga three horizons of humus accumulation (thickness 30-60 cm) has been allocated. The total organic carbon content (TOC) varies from 140 to 340 mg g^{-1}. 10-50 % of TOC is the carbon of humic acids, 10-20% stabilized in the carbon of fulvic acid, and 30-80% is the carbon component of humin. Mean total stock of organic carbon in the entire thickness of the Pliocene deposits Udunga site was 7,7 kg C m^{-2} storage, at 1 meter thick humus horizon – 3,2 kg C m^{-2} . The structure of the organic carbon stock: about 65% are humins, 25% - on humic acids, 10% - on the fulvic acids.

The Pliocene part of the Tologoy site is about 2 m thickness of red clay with a lot of sand lenses and inclusions of gravel. The residues of the humus horizon and the underlying its pink horizon of red-brown soil were studied. The TOC varies from 170 to 350 mg g^{-1}. Mean total stock of organic carbon in the entire thickness was 9,0 kg C m^{-2} , at 1 meter thick humus horizon – 4,5 kg C m^{-2} . The structure of the carbon stock is similar to the paleosols of the Udunga site.

Thus, the studied paleosols still retain quite significant reserves of soil organic carbon in spite of the long-term burial (million years). Our data on the Pliocene sediments of the Western Transbaikalia allows complement similar estimates made Glazovskaya (2009) for the Holocene and Pleistocene sediments and soils of the East European Plain and Western Siberia.

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Effect of Particle Size on Organic Carbon Content of the Loess-Derived Soils of Golestan Province, Northern Iran

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Abstract
Organic matter has important roles in agriculture and applying appropriate management practices to serve carbon in the soil as a sink to reduce CO_2 emission is of prime importance. Investigations on the dynamics and interrelations of organic matter and the soil mineral phases therefore are highly necessary. The loess-derived soils of Golestan province, northern Iran were selected to examine the preservation of soil organic carbon by mineral phases. Studying the relationship between mineral and organic phases showed that organic carbon had strong correlation with (silt+clay) content (<20 µm fraction) including as an average of 75.98 ± 6.92% of the total organic carbon. In contrast, sand had no significant correlation with organic carbon content of the soils.
Key words: Soil organic carbon, Soil particles, Iran

Introduction
The knowledge of how soil forming factors and soil management affect soil organic carbon (SOC) contents and quality allows to determine soil productivity levels and soil behavior against degradation processes (Hevia et al., 2003). The protection of SOC against biodegradation upon sorption to mineral phases is assumed to result from the formation of strong bonds that limit desorption (Mikutta et al., 2007).
There is some evidence that clay concentration may explain variation in rates of SOC accumulation. The maximum and average SOC content increase with increasing soil clay content across several sites on the Great Plains (Nichols, 1984; Burke et al., 1989). It has been recognized that soil texture and soil structure have a predominant effect on organic matter decomposition. It is generally accepted that there is more physical protection in fine-textured soils than in coarse-textured soils (Jenkinson, 1988; Van Veen and Kuikman, 1990). It has been demonstrated that SOC depends on soil texture, as the amount of fine-sized fractions (silt+clay) increases the water holding capacity of the soil, the biological activity, and therefore, the deposition rates of organic residues to the soil and SOC contents (Buschiazzo et al., 1991).

Materials and methods
Description of the study area
The study area includes the southern alluvial and piedmont plains of Gorgan River extended from east to west direction in Golestan province, Iran. The soils include 18 series and the samples were taken from plough layer (0-30 cm).

Soil sampling and analyses
Amelung and Zech (1999) method was used to determine Particulate Organic Matter (POM) which is the fractionation of mineral soils to estimate the relationship between SOC and soil texture. Bulk soil samples were dry screened to remove particles > 2 mm. Four particles size classes i.e. 250- 2000 µm diameter as coarse sand, 53- 250 µm diameter as medium sand, 20- 53 µm diameter as fine sand and 20µm diameter as silt plus clay were considered. A Carlo Erba NA 2000 elemental analyzer was used to determine SOC.

Results and Discussion
The relationship between SOC and soil texture are shown on Table 1.
Organic carbon (OC) related with coarse sand (cS) fraction was between 1.94 to 24.77 % of total OC and on average 10. 78 ± 5.31 %. OC correlated with medium sand (mS) fraction was between 1.71 to 9.80 % of total OC and on average of 4.84 ± 2.54 %. OC related with fine sand (fS) fraction was

between 5.92 to 11.79 % of total OC and on average of 8.38 ± 1.74 %. The coarse sand fraction had higher correlation with organic carbon in sand fractions with a high standard deviation. Fine sand fraction had a higher relationship with organic carbon compared to the coarser fraction with a low standard deviation.

Table 1. SOC content related to fractions of soil particle

Soil Series	OC %	OC (cS) %	OC (mS) %	OC (fS) %	OC (San %	OC (Silt+clay) %
Dahane	1.79	1.94	2.50	9.36	13.81	86.19
Sufian	1.47	8.97	4.51	9.06	22.54	77.46
Minoudasht	1.83	11.77	4.03	8.40	24.19	75.81
Galikesh	1.63	4.06	2.51	7.08	13.66	86.34
Sarli	0.86	3.09	1.71	6.17	10.97	89.03
Shahpasand	1.43	8.63	2.69	7.88	19.19	80.81
Ramian	1.83	10.45	7.68	10.86	28.98	71.02
Daland	1.13	13.53	3.55	8.42	25.50	74.50
Amir abad	1.88	12.23	3.43	7.78	23.43	76.57
Haji kalateh	1.99	24.77	7.95	7.49	40.21	59.79
Behalkeh	1.84	11.00	4.39	11.79	27.17	72.83
Ali abad	1.56	13.49	3.06	7.14	23.69	76.31
Kord kouy	1.53	16.17	2.41	6.92	25.51	74.49
Qare sou	1.97	10.84	9.47	6.77	27.08	72.92
Hashem abad	2.59	15.37	4.69	8.45	28.50	71.50
Gorgan	1.43	12.89	9.80	9.72	32.41	67.59
Rahmat abad	2.02	7.95	7.53	5.92	21.40	78.60
Masoum abad	2.25	7.02	5.33	11.64	24.00	76.00

In general, OC content related with sand fraction was between 10.97 to 40.21 % of total OC with an average of 24.01± 6.92 %. Maximum content was found for Haji Kalateh series and minimum content for Sarli series. This result is in agreement with other researchers, who expressed soil organic carbon in the coarse fraction can account for up to 40% of total OC (Carter et al., 2003; Yang and Kay, 2001). Haji Kalateh series had maximum sand fraction and minimum clay fraction. Sarli series had maximum clay content and also minimum OC content. According to previous data (Ministry of Agriculture and Natural Resources of Iran, 1973) there was 1.7 % OC in Sarli series which decreased to 0.86 % OC in 2007. This remained amounts of OC is believed to be protected by fine fraction (silt + clay).
Consequently, OC content related with silt plus clay fraction was between 59.79 to 80.03 % of total OC and an average of 75.98± 6.92 %. Silt + clay fraction had a highest correlation with OC which is in consistent with other studies (Oades, 1988; Buschiazzo et al., 1991; Hassink, 1997; Zhao et al., 2006).

Conclusions

By considering the important role of fine fraction of the studied soils in preservation of OC, further studies are needed to understand the mechanisms of preservation. This would help for future management strategies of OC preservation.

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Weathering of palygorskite under acidic conditions

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Abstract: Palygorskite and sepiolite are considered as highly susceptible clay minerals to dissolution in acid environment compared to other common clay minerals. Neoformation of palygorskite in soil requires alkaline environment with high Mg concentration. It does not form in soil under pH 5.6 even with high Si concentrations. By experience it is suggested the pH of the environment must not be lower than 4.5 while removing carbonate from soil as a pretreatment for the clay separation. Under this pH palygorskite might dissolve. In order to test the weatherability of this mineral under acid treatments, different pH solutions of 3, 3.5, 4, and 4.5 were prepared using HCl and Na-acetate.Two soil and sedimentary sources of palygorskite were examined. 1g of palygorskite was treated overnight and also for a week in a water bath at 70 ºC under different pH conditions. XRD analyses were performed on the samples both before and after treatments.

The results showed that the one week treated samples showed higher degrees of weathering than the overnight treated ones. Moreover it was found that the duration of time in which clay samples are exposed to acidic solutions are highly important in the dissolution of palygorskite. HCl was found to be more effective than the Na-acetate in dissolution of palygorskite.
Keywords: Palygorskite, weathering, acid treatment

Introduction

Palygorskite-containing soils occur almost exclusively in arid and semiarid areas of the world. Palygorskite and sepiolite are considered as highly susceptible clay minerals to dissolution in acid environment compared to other common clay minerals. Different source of palygorskites have different dissolution behavior (Neaman and Singer, 2000). Under acidic conditions, sepiolite is destroyed more rapidly than palygorskite because of its magnesic composition and the larger size of its structural microchannels (Myriam, 1998). The chemical composition of palygorskite, and therefore the divalent/trivalent cation ratio, varies with the origin of the sample (Corma et al., 1990). Differences in divalent/ trivalent cation ratio will also affect the proportion of trivalent ions located at the edges and at the interior of the octahedral sheet, and lead to differences in physical and chemical

behaviour, especially response to acid leaching (Corma et al., 1978). Based on experimental research they concluded that acid attack takes place mostly at the external surface, with practically no penetration of the channels. Thus differences in response to acid treatment between sepiolite and different types of palygorskites should be related to the accessible surface rather than chemical composition. They believe that the higher the external surface of the mineral causes the more susceptibility to acid leaching.

Backshandeh et al (2011) compared the weatherability of soil and sedimentry source of palygorskite in rhizospheric condition by pot experiments. Their results showed that sedimentary palygorskite weathered almost totally compared to soil palygorskite under acidic condition of rhizosphere.

Neoformation of palygorskite in soil requires alkaline environment with high Mg concentration. It does not form in soil under pH 5.6 even with high Si concentrations. By experience it is suggested the pH of the environment must not be lower than 4.5 while removing carbonate from soil as a pretreatment for the clay separation. Under this pH palygorskite might dissolve.

This paper describes the effect of hydrochloric acid solutions buffered with sodium acetate treatment on two palygorskites with different origin including sedimentary palygorskite compared to those from soil.

Materials and Methods

The soil derived palygorskite comes from a Btk horizon of a previously studied Calcidic Haplustalf with dominant palygorskite (>60%) in its clay fraction from the Larestan region of southern Iran (Khormali and Abtahi, 2003).

Buffered acidic solutions with different pH of 3, 3.5, 4, and 4.5 were prepared using mixtures of 1N sodium acetate and 1N HC1 solutions in different ratios.

1g of palygorskite was treated by HC1 solutions under different pH and time in 250 ml batch reactors, keeping the suspensions stirred. The reactor was treated overnight and also for a week in a bath which temperature controlled at 70°C. The treated palygorskites were dried at 110°C and XRD analyses carried out.

Results and discussion

X-ray diffractogram of sedimentary palygorskite from overnight and one week treated samples showed no significant difference relative to untreated ones. (Fig 1 and 2). The resistance of sedimentary palygorskite against acidic attack could have been attributed to following factors:

1) Acidic concentration: It seems that by using low acidic concentration in early stage of dissolution amorphous SiO_2 is adsorbed onto the surface of palygorskite fibre and the reaction between palygorskite and acid is obstructed (Yuanfeng and Jiyue, 2008). 2) Time: It seems that 24 hours is not sufficient for dissolving mineral structure. With the elapsing of time, or the increasing of the acid concentration, the amorphous SiO_2 flocculates, and then the channels of chemical reaction are reopened. Acidic concentration used in this study were below 2N and are not enough poweful to dissolve crystal structure of sedimentry palygorskite.

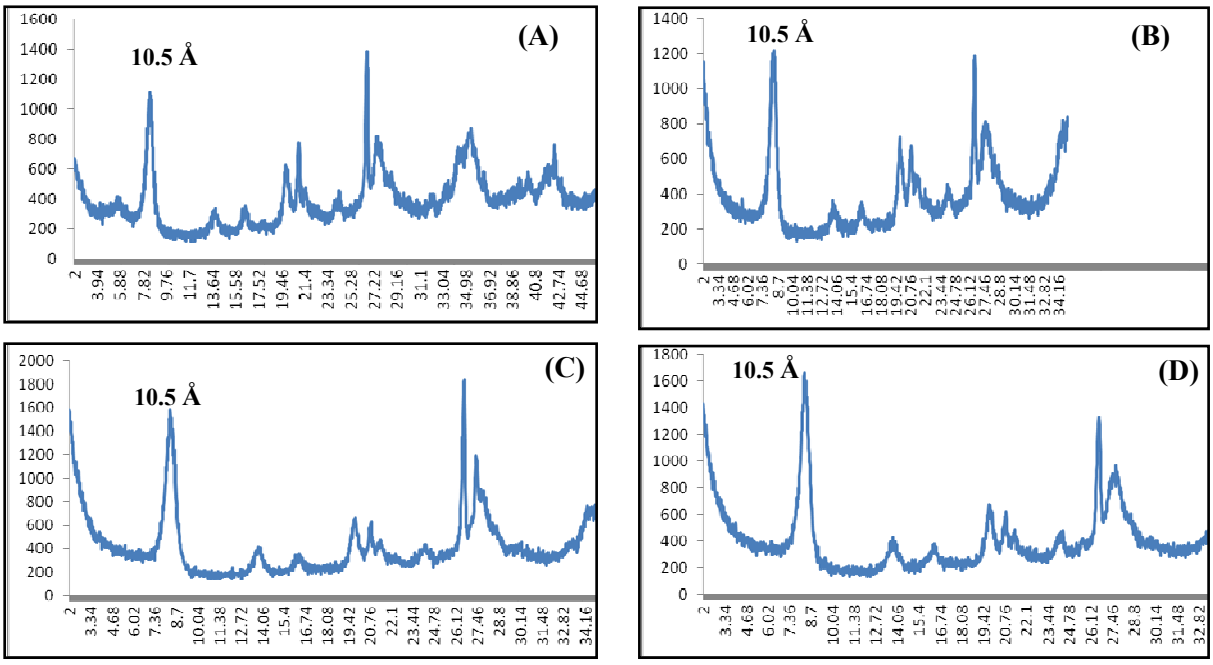


Fig1: XRD patterns of sedimentary palygorskite with no treatment (A) and overnight treatment with: (B) pH= 3.5, (C) pH= 4.5 and (D) pH= 5 solutions.

X-ray diffractogram analysis of one week treated sampled of soil palygorskite showed higher degrees of weathering than the overnight treated ones indicating more suseptibility of soil palygorskite aginst acidic attack (fig 3). This phenomenon should have been related to difference in composition or structure of soil palygorskite compared with sedimentary palygorskite. In fact soil palygorskite has a greater surface area and lower crystallinity that make it more susceptible to acidic dissolution. In other hand, it has been suggested that chemical compositions difference of octahedral sheets is responsible for resistance degree of palygorskite (Corma et al, 1990). More magnesium amount of soil palygorskite may make it less stable in acidic environments of chemical solutions.

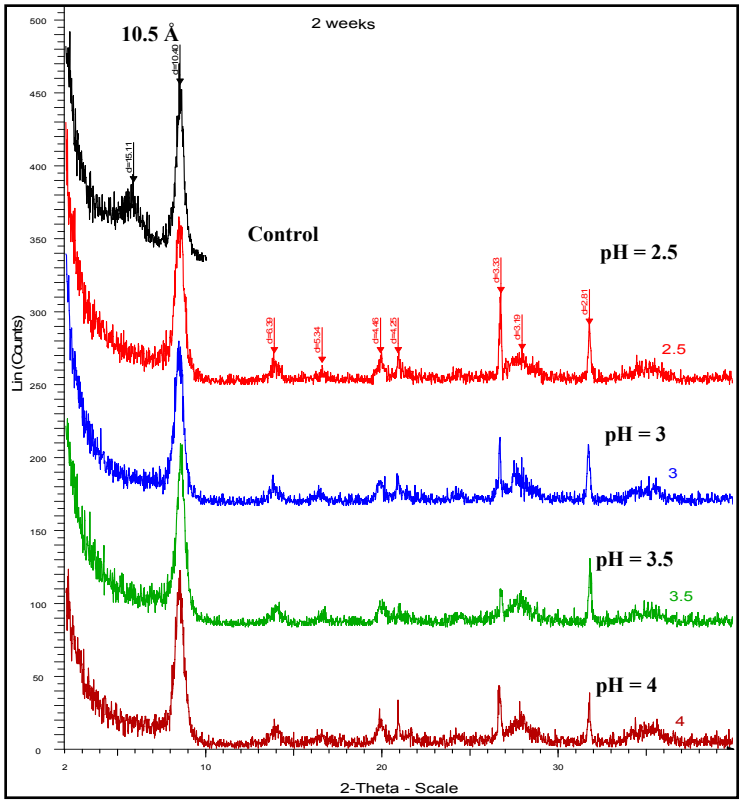


Fig 2: XRD pattern of sedimentary palygorskite after one week treatment with different pH of acidic solutions.

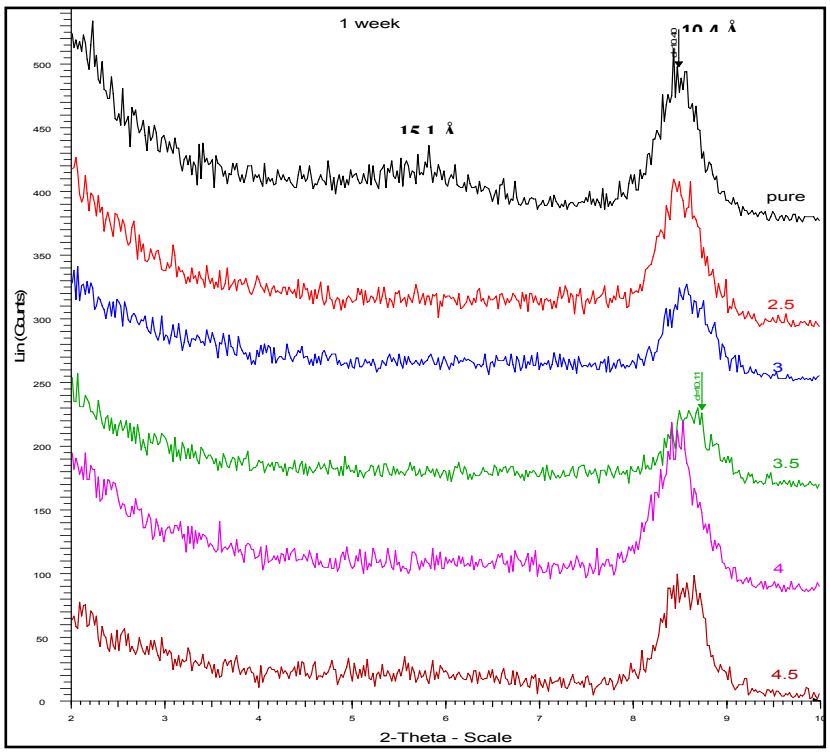


Fig 3: XRD pattern of soil palygorskite after overnight treatment with acidic solutions.

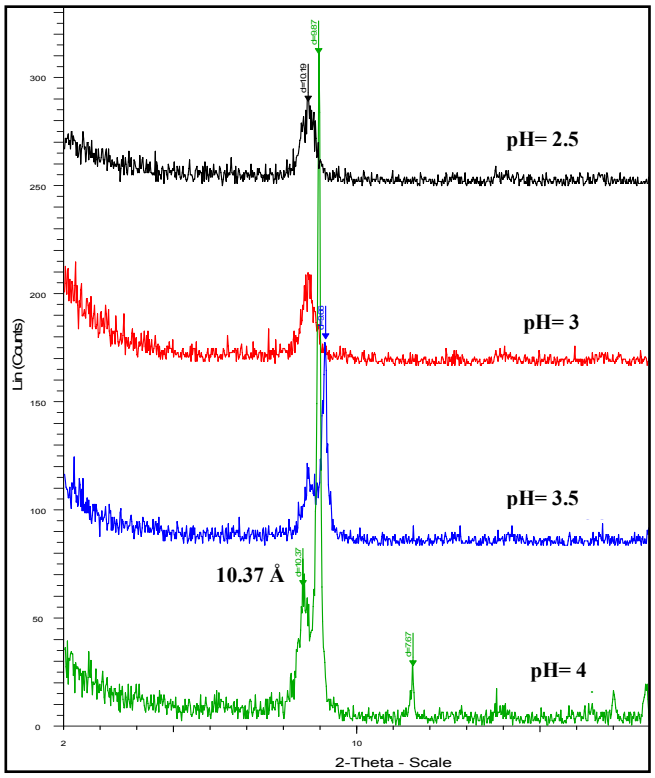


Fig 4: XRD pattern of soil palygorskite after one week treatment with different pH of acidic solutions.

Conclusions

In brief, it can be concluded that weatherability of palygorskite is highly innfluenced by its origin and environment where it is crytallized. The precence disequilibrium between the geologic and pedogenic environments influence the weatheability of geologic minerals. It was found that the duration of time in which clay samples are exposed to acidic solutions are highly important in the dissolution of palygorskite**.**

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Palygorskite distribution along a soil climosequence derived from calcareous parent materials in southern Iran

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Abstract: Clay mineralogy of 44 representative surface (0-20 cm) and subsurface (20-40 cm) calcareous soils collected from different climatic zones of southern Iran was investigated to find factors affecting palygorskite distribution. The minerals were identified with XRD. Smectite, chlorite, illite, palygorskite, vermiculite, kaolinite, quartz, and interstratified minerals were detected in the clay fraction of the studied soils. Larger amount of smectite was observed in more humid soils, while palygorskite was more common in drier soils. Results indicated that palygorskite constituted up to 50% of the clay fractions in the studied soils (averages of 14 and 17% in the surface and subsurface soils, respectively). There was a negative correlation between palygorskite and smectite contents. Palygorskite was not found in areas with the annual rainfall higher than 350 mm. Also, there are two different trends in palygorskite distribution throughout soil pedons in well- and poorly drained soils. In poorly drained soils, no significant difference in palygorskite content between surface and subsurface soils was observed, but in well-drained soils, subsoils had higher amounts of palygorskite. It seems that palygorskite-smectite transformation is an important process in the studied soils.
Keywords: palygorskite; calcareous; drainage; gypsum

Introduction

Palygorskite as a magnesium silicate mineral is a major clay mineral in soils of arid and semiarid regions. The diverse lithologic, topographic, and climatic conditions in southern Iran create soils with different contents of palygorskite. Millot (1970) distinguished three mechanisms of minerals formation. These mechanisms are inheritance, neoformation, and transformation. Inheritance origin means that a mineral originated from parent material and rocks and is stable in its present environment. Mineral neoformation means that a mineral has precipitated from soil solution, and transformation means that a mineral has undergone only little changes in its structure (Eberl, 1984).
The occurrence of palygorskite in calcareous soils of Iran has been reported by many researchers (Khademi and Mermut, 1998; Khormali et al., 2005; Owliaie et al., 2006). Palygorskite neoformation due to calcite and gypsum precipitation may be the main reason for occurrence of this mineral on plateaus of arid regions of Iran, but inheritance from parent rocks has less importance (Owliaie et al., 2006). Khademi and Mermut (1998) concluded that association of palygorskite with gypsum in gypsiferous soils of centeral Iran may be due to the formation of palygorskite after precipitation of gypsum and consequently increase in soil solution pH and Mg/Ca ratio.

One of the most important factors in palygorskite occurrence, stability, and distribution may be soil drainage as well as climatic condition. We hypothesized that vertical distribution of palygorskite in calcareous soil may be affected by climatic condition and some soil properties like gypsum and calcite contents, and drainage status. Therefore, the present research was conducted to determine palygorskite occurrence in calcareous soils of southern Iran and to find factors affecting its distribution.

2. Materials and methods

2.1. Soils and physicochemical analysis

Based on previous study by Najafi Ghiri (2010), 56 soil series were selected from Fars province, southern Iran (Figure 1), pits were dug, described and classified, according to Soil Survey Manual (Soil Survey Staff, 1993) and Keys to Soil Taxonomy (Soil Survey Staff, 2006). Different soil horizons were sampled, air-dried and sieved (<2 mm) for laboratory analyses. After preliminary physical and

chemical analysis and climatic, physiographical, and pedogenesis studies, 48 representative surface and subsurface soils were considered for further mineralogical analyses.



Figure 1. Location of Fars province, southern Iran.

Soil particle size distribution (Rowell, 1994), calcium carbonate equivalent (Salinity Laboratory Staff, 1954), organic carbon (Nelson and Sommers, 1982), cation exchange capacity (Chapman, 1965), soil pH (Salinity Laboratory Staff, 1954), and electrical conductivity (Salinity Laboratory Staff, 1954) were determined. All analyses were carried out in three replicates and the results are presented as mean.

2.2. Mineralogical analysis

Mineralogical analysis was carried out according to the methods of Kittrick and Hope (1963) and Jackson (1975). Gypsum and soluble salts, carbonates, organic matter, and free Fe oxides were removed by water, sodium acetate buffered at pH 5, 30% H_2O_2, and citrate dithionate (Mehra and Jackson, 1960), respectively. The clay was separated from the sand and silt by seven to ten times sedimentation and decantation. The clay fractions were saturated with KCl and $MgCl_2$. The Mg-saturated samples and glycolated ones X-rayed with a Philips D500 diffractometer using Ni-filtered Cuka radiation (40 kV, 30 mA). The K-saturated samples (air-dried and 550°C treated) were X-rayed. The content of minerals was determined semiquantitatively, using peak areas on the diffractograms of ethylene glycol solvated specimens according to Johns et al. (1954).

3. Results and discussion

3.1. Physicochemical properties of the soils

The studied soils belong to Inceptisols (n = 4), Entisols (n = 4), Vertisols (n= 4), Aridisols (n = 5), Alfisols (n = 4), Mollisols (n = 1), and Histosols (n = 2) according to Soil Taxonomy. The soils have aquic, xeric, ustic or aridic moisture regimes and mesic, thermic or hyperthemic temperature regimes (Banaei, 1998). The soils were developed on alluvial plains, piedmont plains, lowlands, or plateaus.

Means and standard deviations (SD) of general analyses for surface and subsurface soils are shown in Table 1. The soils are calcareous with $CaCO_3$ content of 42.0 and 41.7% for surface and subsurface horizons, respectively. Gypsum content in the subsurface soils (up to 90%) were significantly higher than that in the surface soils. Generally, clay constituted 1 to 75 % of the soils. Values of pH were

neutral to slightly alkaline (6.7 to 9). The highest salinity was observed in the soils of dry and warm lowlands, but EC values were lower than 4 dS m^{-1} for soils with xeric and mesic soil moisture and temperature regimes, respectively.

Table1. Some physicochemical properties of the studied soils.

Variable	Surface soil (0-20 cm)		Subsurface soil (20-40 cm)	
	Mean	SD*	Mean	SD
Sand (%)	28.8	14.8	26.5	20.1
Silt (%)	44.0	9.9	41.6	11.3
Clay (%)	27.2	15.7	31.9	17.1
pH	7.5	0.2	7.6	0.2
Calcium carbonate equivalent (%)	42.0	16.9	41.7	17.5
Gypsum (%)	0.4	1.2	2.9	11.2
Organic carbon (%)	1.3	1.1	0.6	0.7
EC (dS m^{-1})	2.8	3.2	2.2	4.2
CEC (cmol(c) kg^{-1})	14.7	8.9	14.2	10.2

* Standard deviation

3.2. Mineralogy of the studied soils

Smectite, palygorskite, illite, chlorite, and interstratified minerals are the predominant clay minerals. Trace amount of vermiculite, kaolinite and quartz was also detected in the surface soils. Smectite was the main mineral in the clay fraction and reach up to 72 and 76 % for surface and subsurface soils, respectively. Mica in the clay fraction was in the range of 2 to 30 %. Palygorskite constituted up to 50 % of the clay fraction. Palygorskite contents in the surface and subsurface soils were averaged 13 and 16 %, respectively. Chlorite contents were averaged 23 % for surface and subsurface soils. Results were consistent with finding of Khormali and Abtahi (2003), and Owliaie et al., (2006) for arid and semiarid soils of southern Iran.

Table 2. Relative percentage of clay minerals in the surface and subsurface soils.

Variable	Surface soil (0-20 cm)		Subsurface soil (20-40 cm)	
	Mean	SD	Mean	SD
Mica	18	6	17	7
Chlorite	23	9	23	11
Smectite	38	18	39	18
Palygorskite	13	12	16	14
Others*	8	4	5	6

* Interstratified, kaolinite, vermiculite, and quartz

As shown in Figure 2, there is a negative significant relationship between palygorskite and smectite contents in the studied soils. This result is consistent with findings of Khormali and Abtahi (2003) and Owliaie et al. (2006) for calcareous soils of Iran. According to this relationship, palygorskite-smectite transformation in the studied soil must always be kept in mind when discussing the origin of clay minerals in the studied area. Smectite to palygorskite transformation has been shown by many researchers (Bouza et al., 2007; Owliaie et al., 2006). Weaver and Beck (1977) and Elprince et al. (1979) stated that palygorskite is more stable than smectite in soils with high Mg or Si activities or increase in pH.

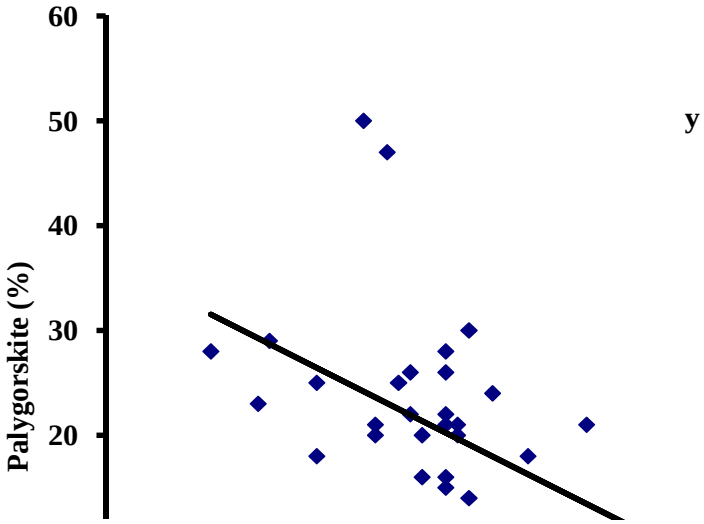


Figure 2. Relationship between palygorskite and smectite contents in the studied soils.

Palygorskite distribution as a function of climatic conditions is shown in Figure 3. The lowest content of this mineral was found in soils with mesic and xeric soil temperature and moisture regimes, respectively. Generally, palygorskite was not found in areas with the annual rainfall higher than 350 mm. Paquet and Millot (1972) concluded that palygorskite transforms to smectite at precipitation levels above 300 mm.

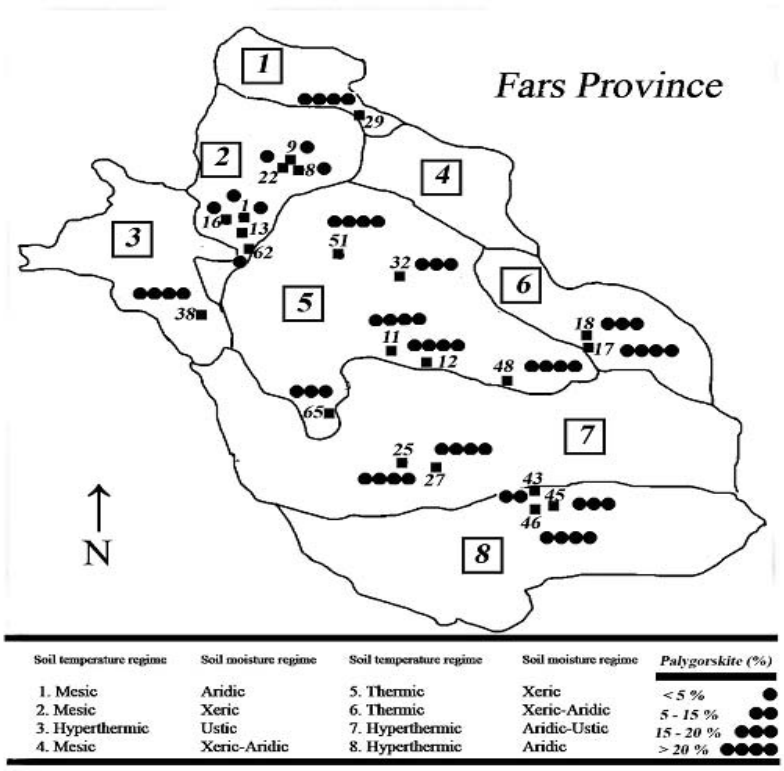


Figure 3. Palygorskite distribution in relation to soil moisture and temperature regimes.

Palygorskite distribution with depth is shown in Figure 4. There are two different trends in palygorskite distribution throughout soil pedons in well- and poorly drained soils. In poorly drained soils, no significant difference in palygorskite contents between surface and subsurface soils was observed (21 vs. 19), but in well-drained soils, subsoils had higher amounts of palygorskite (28 vs. 18). This difference may be due to the unstable nature of this mineral in well-drained soil. On the other hand, high amounts of palygorskite in the subsurface horizon of well-drained soil may be due to the illuviation of this mineral from surface to subsurface horizons. Khademi (1997) for some soils developed on colluvial fans observed a high amount of palygorskite in the subsurface rather than surface soils and suggested that palygorskite may be formed in the soil during the gypsum accumulation.

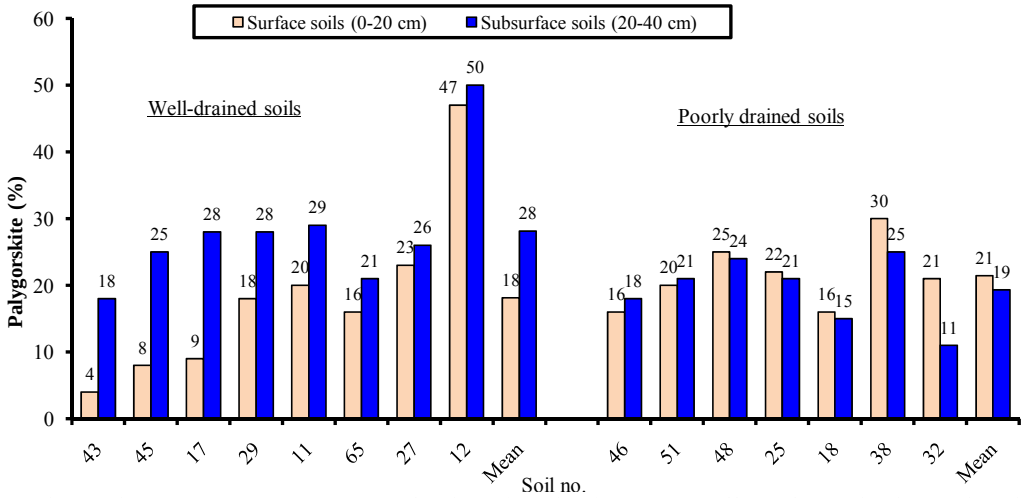


Figure 4. Palygorskite content in surface and subsurface horizons of well- and poorly drained soils.

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Land suitability evaluation for dry and irrigated winter wheat in Khoramdareh agribusiness areas of Zanjan Province

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Abstract

In this research land suitability evaluation has been determined for dry and irrigated winter wheat in Khoramdareh agribusiness areas. In this study the physical and chemical characteristics of soils and the climatic characteristics have been surveyed. Based on the detailed Soil survey results, the studied area is occupied by 7soil Family and 20 soil units. Limitation methods (Simple limitation & Number and intensity of limitation) and parametric methods (Square root and Storie) were used as land evaluation methods. The results of the Square root method are closest with the real condition in the area. The units for irrigated wheat are highly suitable (S_1), moderately suitable (S_2), and marginally suitable (S_3). The limiting factors for this crop are topographic and physical characteristics. The suitability classes for dry wheat are moderately suitable (S_2) and marginally suitable (S_3). The climate and physical characteristics of soil are limiting factors.
Key words: Land suitability evaluation**,** Wheat, Limitation methods**,** parametric methods

Introduction

Land evaluation is the assessment of land performance when used for specified purposes. As such it provide a rational basis for making land use decision based on analysis of rational between land use and land ,giving estimates of required input and projected outputs(FAO,1983).
The principal objective of land evaluation is to select the optimum land use for each defined land unit (Sys et al. 1991).
Land evaluation is the first stage of planning for optimal land use. With respect to potential and efficiency of the land, optimal land use management should improve inappropriate uses of land, So that it can maintain the natural sources particularly soils for the future generation through an appropriate way of optimization.
This concept that different uses demand various requirements is the basis of land evaluation. Land suitability is the fitness of a given type of land for a defined use .Since FAO established a frame work for land evaluation (1979), different studies were carried out using it. Among these studies, a work by Sys et al is noticeable that it formed the basis of this research.

Materials and Methods

Khoramdareh agribusiness area is located in Zanjan province, Iran. The study area is about 910 ha. It is lying between$49^{o}\ 12^{/}$-$49^{o}\ 14^{/}$ East latitude and $36^{o}\ 11^{/}$ - $36^{o}\ 14^{/}$ North longitude.
The climatic data were collected form Khoramdareh synoptic climatology station. According to the results, annual mean temperature, absolute minimum temperature and absolute maximum temperature were $12.5°c$, $-15.6°c$, and $39°c$, respectively. Similarly annual rainfall and relative humidity were reported 278.7m and 45.3%, respectively.
Temperature regime is Mesic (Banaei, 1998) and moisture regime is dry Xeric. The physiographic land forms of study area are plateau and piedmont alluvial plain.
Detailed Soil survey was carried out and results were used as the base information in this research. Based on the survey results the studied area is occupied by 7 soil family and 20 soil units (Fig.1). According to USDA (2003), soil classified in two Orders of Entisols and Inceptisols. Two soil Families for Entisols and five soil Families for Inceptisols were identified (Table 1).

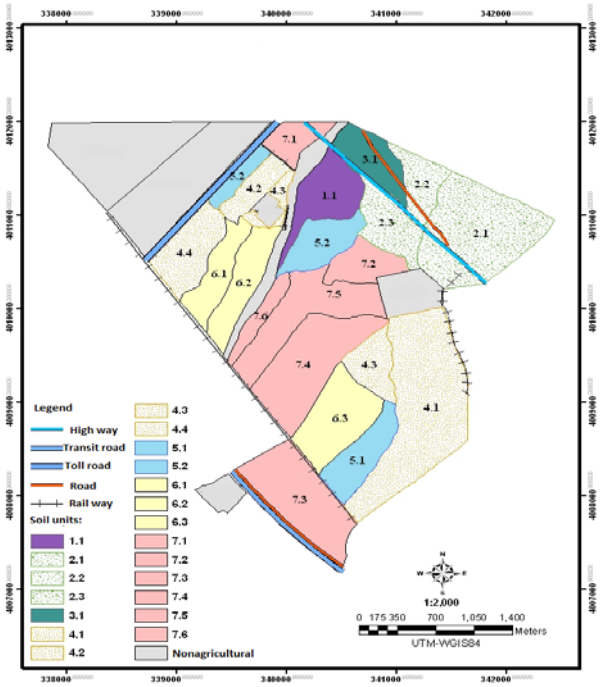


Figure1.Land units map of Khoramdare agribusiness area

Table1.Soil classification of Khoramdare agribusiness area

Land form	Soil No.	Soil classification		
		Family	Subgroup	Order
Plateau	1	Fine loamy, mixed, mesic	Typic Haploxerepts	Inceptisols
	2	Fine loamy, mixed, mesic	Typic Calcixerepts	Inceptisols
	3	Loamy skeletal, mixed, mesic	Typic Calcixerepts	Inceptisols
Piedmont plain	4	Fine, mixed ,mesic	Typic Calcixerepts	Inceptisols
	5	Fine loamy, mixed, mesic	Typic Haploxerepts	Inceptisols
	6	Loamy skeletal, mixed, mesic	Typic Xerorthents	Entisols
	7	Sandy skeletal, mixed, mesic	Typic Xerorthents	Entisols

Land suitability classification, using the guidelines of FAO (1976) is divided into Order, Class, Sub Class, and Unit. In this system, orders are divided in to Suitable(S) and Not Suitable (N). Suitable order includes three classes of highly suitable (S_1), moderately suitable (S_2) and marginally suitable (S_3). Not Suitable order consists of two Classes of Currently not suitable (N_1) and permanently not suitable (N_2).

The Subclasses are a more detailed division of classes based on land quality and characteristics. Sub classes show kind of limitation. Some of limitation is shown with following lower-case letters in present study.

c: Climatic limitations,

t:Topographic limitations,

s:Soil physical properties limitations(consist of texture and structure, soil depth and coarse fragment problems)

f: Soil fertility limitations,

n :Soil salinity& alkalinity limitations.

Land suitability unit is reflecting minor differences in required management within subclasses. Land evaluation is a process for matching the land characteristics with the land use requirements using scientific techniques. In this research land use requirements including land (soil and

topographic characteristics) and climatic characteristics are provided from Sys et al (1991) and Givi (1998). Then, with regard to the regional conditions and the cultivars of the study wheat, some modifications were carried out on these data to evaluate the land suitability for these crops; four methods including Limitation methods (Simple limitation & Number and intensity of limitation) and parametric methods (Storie & Square root) were used. Simple Limitation method: land use requirements compare with climatic or land characteristics and suitability classes determined for those. Lowest suitability class for characteristics is known as the final climatic or land suitability class.

Number and intensity of limitation method: Up on the number of climatic limitations, intensity of climatic limitations is determined. It is put together with land limitations and finally land suitability class is determined.

Parametric methods: Parametric methods carried out following two procedures include Storie and Square root methods. After compare between climatic and land characteristic with land use requirements, one rating between 0 and 100 is given to every climatic or land characteristic. According to the selected method (storie or square root method), at first stage with use of equation1 or equation2, Climate Index (CI) is calculated. Afterwards Climate Rating (CR) is estimated on the basis of equation 3. At second stage, with using of Climate Rating (CR) and land characteristics rating, Land Index (LI) is calculated for selected method (equation1 or equation2). On the basis of amount of LI, land suitability class is determined. For storie and square root methods, suitability classes are defined as follows:

- LI >75 are in S_1 (Highly suitable) class
- 50< LI <75 are in S_2 (moderately suitable) class
- 25< LI <50 are in S_3 (marginally suitable) class
- LI < 25 are in N (non-suitable) class

- Storie method: Eq.1

$$I = A \times \frac{B}{100} \times \frac{C}{100} \times \ldots$$

I : Land Index (LI) or Climate Index (CI)

$A, B, C, \ldots$: Rating of characteristic

- Square root method: Eq.2

$$I = R_{\min} \times \sqrt{\frac{A \times B \times C \times \ldots}{100}}$$

I : Land Index (LI) or Climate Index (CI)

$R_{\min}$: Minimum rating of characteristic

$A, B, C, \ldots$: Rating of other characteristics

If CI< 25 ⇒ CR= I6.67 + 0.9 CI Eq.3

If 25< CI< 92.5 ⇒ CR= 1.6 CI

Result and discussion

The results of regional climatic data and estimations indicated a growing period of 154 days from November 15 to April 17. Since there is no completely intersection between growing cycles of dry and irrigated winter wheat and the regional growing period, this study recommends irrigated winter wheat for this area. If dry cultivars are used, we have to implement supplemental irrigation during the vegetative stage to ripening stage.

Climatic suitability class for irrigated winter wheat is highly suitable (S_1).For dry winter wheat; climatic suitability is moderately suitable (S_2). Main limitation of climatic suitability is monthly rainfall for ripening stage.

Qualitative land suitability subclasses for dry and irrigated winter wheat in study area, was evaluated by mentioned methods (Table 2).

Obviously, in most of units, the results obtained from these methods are not completely the same for one crop. With respect to the real condition of study area, out puts during the last years, experiences of local farmers and result of academic thesis and researches, it seems that the results of Square root method is more realistic than other methods. Therefore the results of the Square root method became the base of concluding and interpreting.

For irrigated winter wheat, 2.1, 2.2, 2.3 and 4.3 soil units evaluated in subclass S_{2t}. These soil units have Topographic limitations that caused by slope limitation. 4.2, 4.4, 5.2, 6.1, 6.2, 6.3, 7.1 and 7.2 land units have soil physical properties limitations and evaluated in S_{2s} sub class. All of these units have high gravel percentage limitation, furthermore, There is existence of limiting layer problem in 4.4 and 5.2 soil units.

Table 2. Land suitability subclasses for 20 soil unit of study area for irrigated& dry winter wheat

Soil Unit	Irrigated winter wheat				Dry winter wheat			
	SL	NIL	Storie	Square root	SL	NIL	Storie	Square root
1.1	S_{2ts}	S_{2ts}	S_{3t}	S_{2ts}	S_{2cs}	S_{2cs}	S_{3c}	S_{2cs}
2.1,2.2	S_{2t}	S_{2t}	S_{2t}	S_{2t}	S_{2c}	S_{2c}	S_{3c}	S_{2c}
2.3	S_{3t}	S_{3t}	S_{3t}	S_{2t}	S_{2c}	S_{2c}	S_{3c}	S_{2c}
3.1	$S_{3t,s}$	$S_{3t,s}$	$S_{3t,s}$	$S_{3t,s}$	S_{2cs}	S_{2cs}	S_{3c}	S_{2cs}
4.1	S_1	S_{2s}	S_{2t}	S_1	S_{2c}	S_{2c}	S_{2c}	S_{2c}
4.2	S_{2s}	S_{2s}	S_{2s}	S_{2s}	S_{2cs}	S_{2cs}	S_{3c}	S_{2cs}
4.3	S_{2s}	S_{2s}	S_{2t}	S_{2t}	S_{2cs}	S_{2cs}	S_{3c}	S_{2c}
4.4	S_{2s}	S_{2s}	S_{2s}	S_{2s}	S_{2cs}	S_{2cs}	S_{3c}	S_{2cs}
5.1	S_{2s}	S_{2s}	S_{2s}	S_1	S_{2cs}	S_{2cs}	S_{2c}	S_{2c}
5.2	S_1	S_{2s}	S_{2s}	S_{2s}	S_{2c}	S_{2c}	S_{3c}	S_{2cs}
6.1,6.2,6.3	S_{2s}	S_{2s}	S_{2s}	S_{2s}	S_{2cs}	S_{2cs}	S_{3c}	S_{2c}
7.1,7.2	S_{2s}	S_{2s}	S_{2s}	S_{2s}	S_{2cs}	S_{2cs}	S_{3c}	S_{2cs}
7.3	S_{3s}	S_{3s}	S_{3s}	S_{3s}	$S_{3s,c}$	$S_{3s,c}$	$S_{3s,c}$	$S_{3s,c}$
7.4	S_{3s}	S_{3s}	S_{3s}	S_{3s}	$S_{3s,c}$	$S_{3s,c}$	$N_{2s,c}$	$S_{3s,c}$
7.5	S_{3s}	S_{3s}	S_{3s}	S_{3s}	$S_{3s,c}$	$S_{3s,c}$	$N_{2s,c}$	$S_{3s,c}$
7.6	S_{3s}	S_{3s}	S_{3s}	S_{3s}	$S_{3s,c}$	$S_{3s,c}$	$N_{2s,c}$	$S_{3s,c}$

SL: Simple Limitation NIL: Number& Intensity Limitation

In 7.4 land unit, there is limiting layer problem. 1.1 soil unit has limiting layer, slope and gravel percentage problems and evaluated in S_{2ts} subclass. Very high gravel percentage and slope problem caused 3.1 unit evaluate in $S_{3t,s}$ subclass. 4.1and 5.1 soil unite have not significant limitations for irrigated winter wheat and evaluate in S_1 suitability class.

There are Climatic limitations for dry winter wheat in khoramdareh agribusiness area. 2.1, 2.2, 2.3, 4.1, 4.3, 5.1, 6.1, 6.2 and 6.3 soil units have S_{2c} suitability subclass.

7.3, 7.4, 7.5 and 7.6 soil units have very high gravel percentage and 7.4 unit has gravelly limiting layer in the depth of 50 cm .these limitation causes mentioned units evaluate in $S_{3s,c}$ subclass.

Suitability subclass for 1.1, 3.1, 4.2, 4.4, 5.2, 7.1 and 7.2 soil units is S_{2cs} .there are limiting layer in 1.1, 4.4 and 5.2 soil units in depth of 80cm.

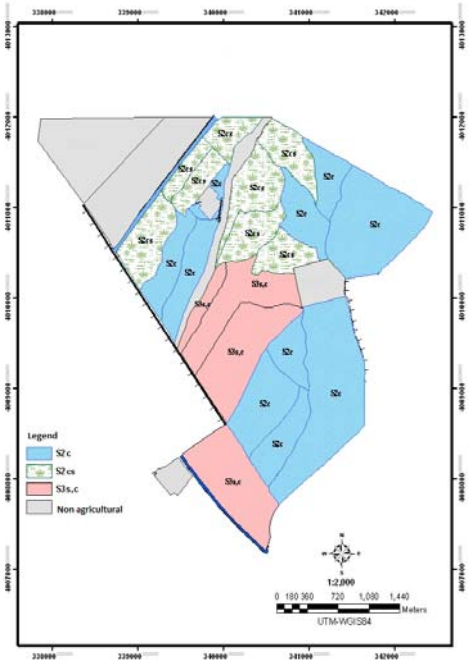


Figure2.Land suitability map for irrigated winter wheat in Khoramdare agribusiness area

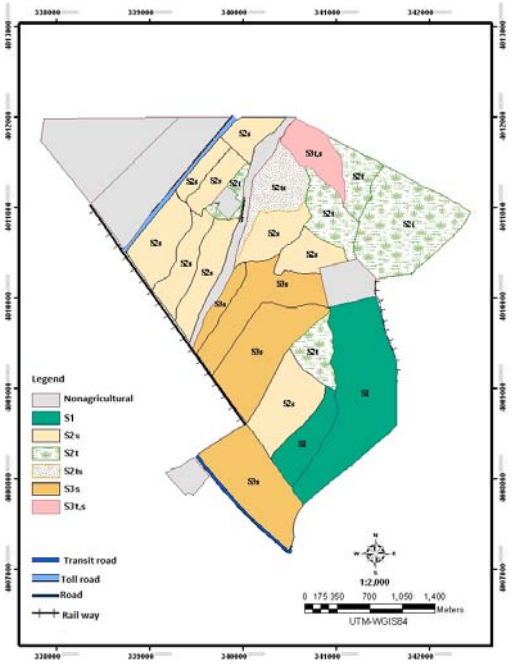


Figure3.Land suitability map for dry winter wheat in Khoramdare agribusiness area

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Integrating New Soil Data into the European Soil Database 1:1.000.000: A New Approach Tested in Turkey

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Abstract
The European Soil Database (ESDB) version 2.0, released in 2004, is the resulting product of a collaborative project involving all countries of the European Union and a large part of the former USSR. The ESDB is the only harmonized soil database across Europe. It consists of a number of components including: the Soil Geographical Database of Eurasia (SGDBE) at scale 1:1,000,000, which is a digitized European soil map and related attributes; a PedoTransfer Rules Database (PTRDB), which is a set of attributes that have been derived using pedotransfer rules on the attributes of the SGDBE; and the Soil Profile Analytical Database of Europe (SPADBE), that contains a number of observed and estimated soil profiles for Europe. The ESDB has been used successfully in numerous applications at European scale, as documented by the European Soil Data Centre that acts as custodian of the database. The European Soil Database (ESDB) aims at providing users with a harmonized set of soil parameters for agro-meteorological and environmental modelling at regional, national, and continental level for Eurasia and North African countries. The next revision (version 3.0) sees an extension into the Mediterranean Basin through the inclusion of data for Turkey. The development of a soil geographical database for Turkey at a scale of 1:1,000,000 under a common understanding and nomenclature allows the integration of these data into the existing ESDB. In order to comply with its structure, a number of key attributes (soil texture, parent material, WRB classification, land use) have been derived from supplementary local, regional and national soil datasets while other attributes have been obtained from auxiliary environmental datasets derived by remote sensing systems and geospatial processing techniques such as interpolation.

Keywords: European Soil Database, Turkey, soil attributes, Remote sensing

Introduction
In 1985, the Commission of the European Communities (EC) published a paper soil map of the EC at a scale of 1:1,000,000. In 1986, the soil map was digitized to create a soil database named European Soil Database of the European Community that would be included in the CORINE project. In response to the needs of the crop yield forecast models, the European Soil Database was improved by the MARS project (Monitoring Agriculture by Remote Sensing) in the period 1990-1991 (King et al., 1994). Following the recommendations of the Soil and GIS Group of Experts, the database was extended in 1998 covering the 15 Member States of the European Union and the potential new Member States.

The latest version of the European Soil Database (v. 2.0) includes a number of improvements and contains several new components that affect both the form and content of the geographical database. In this context, ESDB at scale 1:1,000,000 currently covers 25 Member States European Union, a number of candidate and potential candidate countries, and neighbouring states (e.g. Eurasia, North Africa and Middle East) (Lambert et al., 2003).

The main objective of the paper is to describe the methodology used to prepare the “Soil Geographical Database of Turkey” according to the specifications of the European Soil Database (ESDB). The methodology is proposed as a “roadmap” for the countries which wish to or are in the process of integrating their data into the ESDB (North African, Caucasian countries, Middle East). The methodology includes new proposed aspects such as the use of remote sensing for the derivation of attributes relative to the ESDB.

Parallel to the International Soil Science Congress on “Land Degradation and Challenges in Sustainable Soil Management", the SOIL Action of the Joint Research Centre of the European Commission is organising an key-meeting with all countries in the Mediterranean region, North Africa

and Caucasus with a final objective the extension of the European Soil Database to those countries. The output of this meeting will be a scientific report describing the soil resources in the participating countries.

Methodology - Results

The preparation of soil the geographical database of Turkey at a scale of 1:1 million was initiated at the end of 2008 and finalized in the beginning of 2010. The first part of the work flow involved the identification and collection of data from different sources in Turkey. The second phase involved the development of the database, followed by a final effort: integration into the ESDB (Fig. 1).

At the core of the ESDB is the relationship between a Soil Mapping Unit (SMU) and the constituent Soil Topological Unit (STU) (Lambert et al., 2003). At a scale of 1:1,000,000, it is not feasible to delineate the STUs. Therefore they are grouped into SMUs to form soil associations and illustrate the functioning of pedological systems within the landscapes (Panagos, 2006). The development of this structure for Turkey is a major development. Based on the 1:1,000,000 Soil Map of Turkey (shape file of 544 polygons) (Dinc et al., 2005), the Soil Mapping Units (SMU) have been processed and classified reclassified according to the ESDB structure.

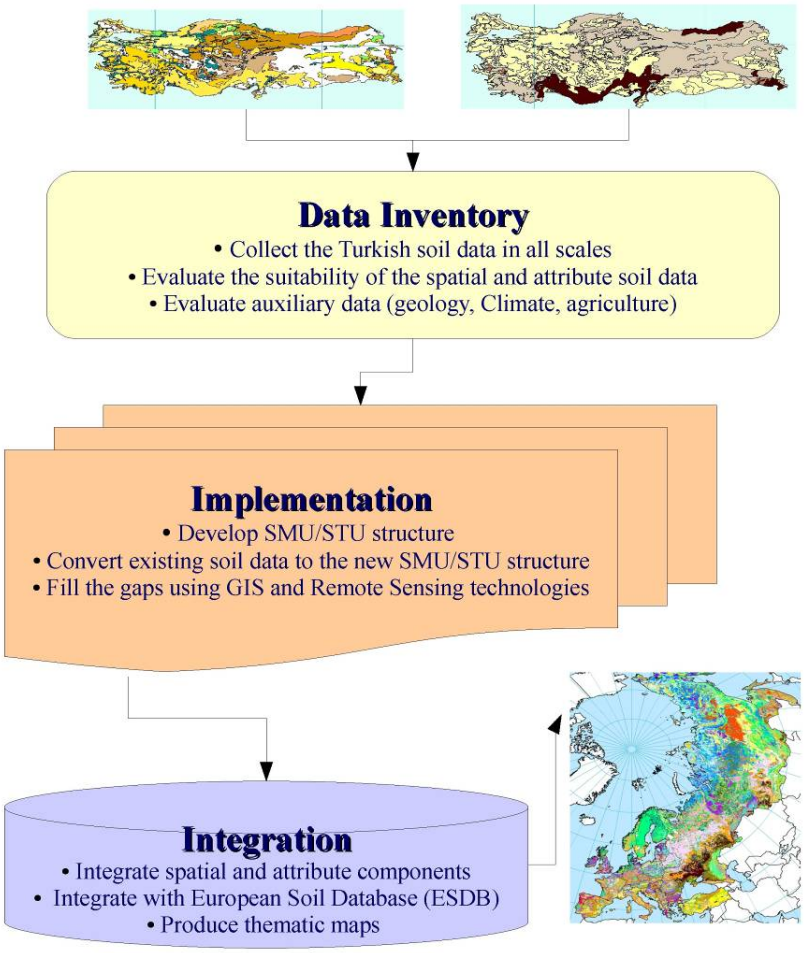


Figure 1. The work methodology

The database contains a number of STUs. Besides the soil names, these units are described by variables (attributes) specifying the nature and properties of the soils (for example, texture, water regime, stoniness, etc.). Each SMU corresponds to a part of the mapped territory and as such is represented by one or more polygons in a geometrical dataset (Fig. 2). Conceptually, Soil Mapping Units (SMU) are geographic objects that have a clear and well defined geometric shape and location. Some SMUs can be pure in which case they are composed of only one Soil Typological Unit (STU) covering 100% of the SMU. In most cases SMUs are not pure, i.e. they represent soil associations, also called soil complexes. This is due to the fact that some soil types (i.e. STUs) can be identified (i.e. semantically defined by their name, texture, and all other descriptive characteristics) but cannot be located precisely on the map (i.e. their shape and location cannot be determined with a better precision than their SMU "container"). This system is set-up to account for the difference in resolution between the semantic and the geometric information which commonly occurs in soil surveying: soil types are identified and described with a higher level of precision than their geometry. The database structure reflects this system to avoid as well as possible any loss of the information provided by the soil scientist (Daroussin et al., 2006).

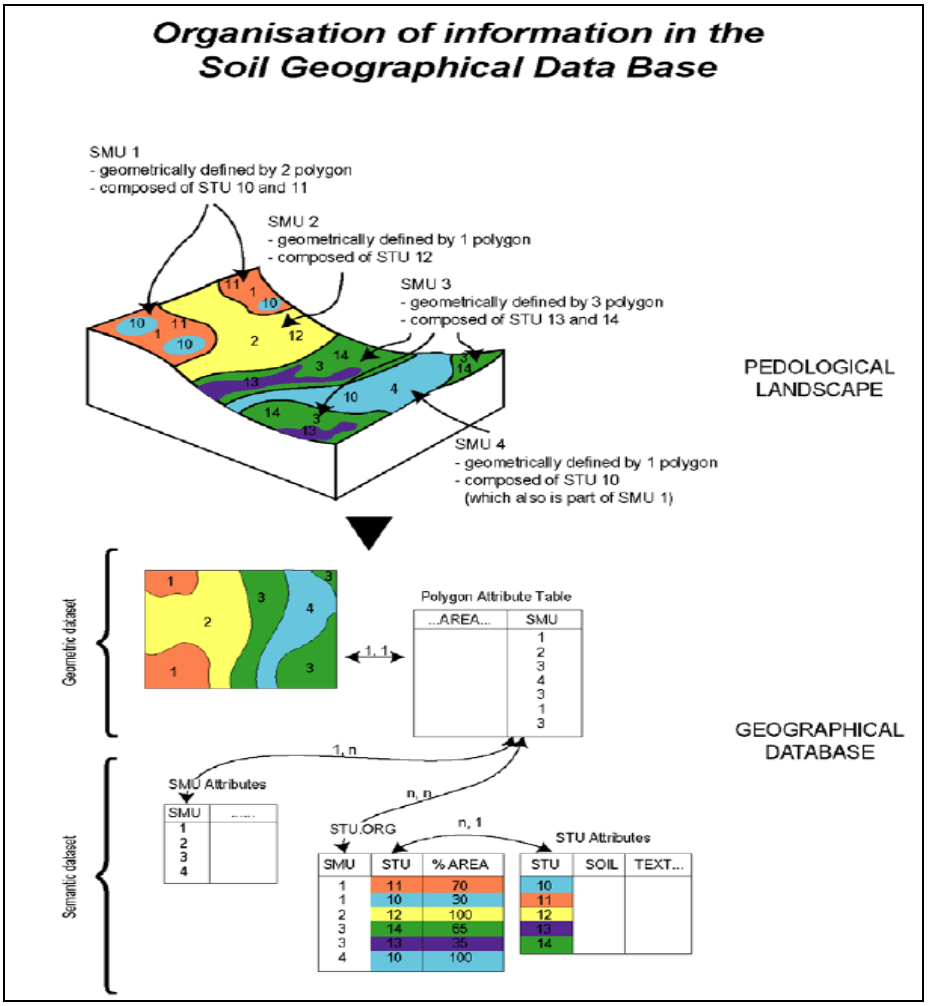


Figure 2. Information Organisation in the Soil Geographical Database of Europe

Each of the identified major soil types (STU) in Turkey has been classified according to WRB taxonomy and sorted according to their coverage percentages within each SMU. As a result, a number of SMUs and STUs are determined in the SMU-STU structure. Each SMU has been assigned a unique identifier based on the international dialling prefix of Turkey. SMUs are therefore identified by codes 90001 – 90xxx. The same methodology has been followed to assign unique STU identifiers.

The next critical step involves the matching of the European Soil Database and the Turkish polygons at the borders. Polygon surfaces have been joined together and corrected by using editing GIS techniques. The standard legend files of the European Soil Database have been applied in order to produce thematic maps as the one in Fig. 3.

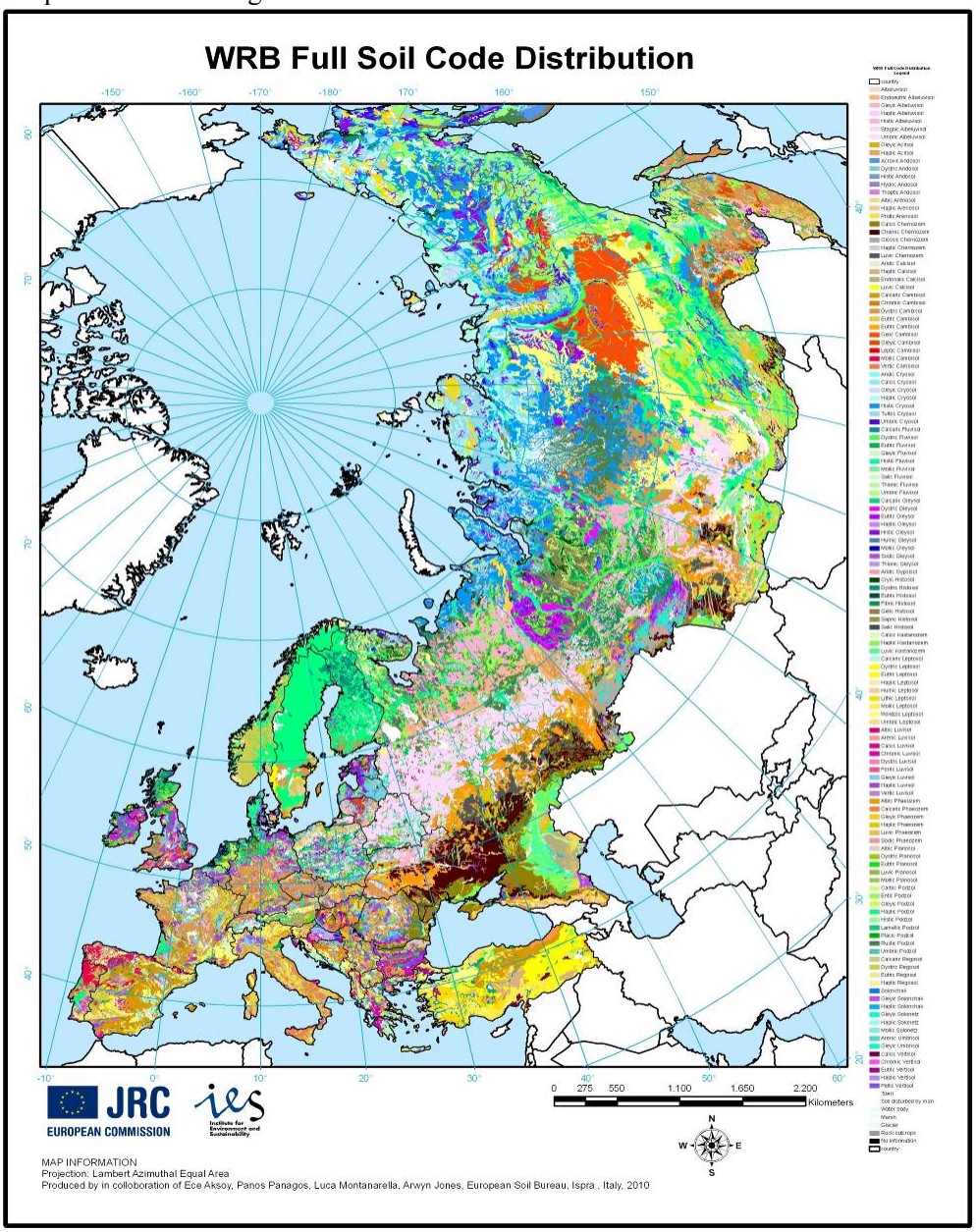


Figure 3. WRB Full Soil Code distribution mapped from the European Soil Database

Conclusions

On the basis of this study, the following conclusions can be drawn:

- Countries with existing soil data may follow the roadmap described in this paper in order to adapt their data into the European Soil Database. The proposed structure is based on the SMU/STU relationship which is defined according to the dominant soil type in an area.
- Development of common nomenclature (using WRB system as a basis) between the European authorities and the country representatives helped in order to proceed faster in the data integration.
- The Integration of Mediterranean, North Africa, Middle East and Caucasus countries data into the European Soil Database contributes further to the development of the European Soil Data Centre (ESDAC) (Panagos et al, 2012).

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