3rd UNCCD Scientific Conference

9-12 March 2015, Cancún, Mexico

"Combating desertification/land degradation and drought for poverty reduction and sustainable development: the contribution of science, technology, traditional knowledge and practices"

Book of Abstracts

The Scientific and Traditional Knowledge for Sustainable Development (STK4SD) Consortium

United Nations Convention to Combat Desertification | UNCCD | AGROPOLIS INTERNATIONAL | DesertNet International | CGIAR Consortium | OSS | IADIZA CONICET U.N.CUYO GOBIERNO DE MENDOZA

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http://3sc.unccd.int

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The contents of this document do not represent the views of the UNCCD or of its member Parties

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Introduction

The 3rd UNCCD Scientific Conference on ***"combating desertification/land degradation and drought for poverty reduction and sustainable development: the contribution of science, technology, traditional knowledge and practices"*** presents a wide range of scientific and local knowledge that can be harnessed to achieve poverty reduction and sustainable development in areas susceptible to desertification, land degradation and drought.

The conference aims at developing **new scientific insights and recommendations to policy makers with regard to the assessment of vulnerability of socio-ecosystems to climate change and current and future capacities to adapt.** The conference thus is expected to contribute to the combat against desertification and land degradation and to address impacts of drought, by delivering the following outcomes:

- Better anticipation and prevention of the impact of climate change on land degradation and desertification, through capacity building;
- Identification and promotion of sustainable and adaptive methods of using ecosystems to reduce poverty and environmental degradation, while achieving sustainable development;
- Identification of pathways towards land degradation neutrality: by way of reducing degradation processes and scaling up restoration activities, the objective is to maintain and improve the quantity and quality of productive land.

The conference called for contributions from scientists and experts in the three following areas:

1. **Diagnosis of constraints:** How to best characterize and understand the vulnerability and adaptive capacities of ecosystems (in particular agro-ecosystems) and populations in affected regions, including regions newly susceptible to the consequences of climate change?
2. **Responses:** How to build efficiently on available knowledge, success stories and lessons learnt to promote implementation of better adapted, knowledge-based practices and technologies?
3. **Monitoring and assessment:** What are the new monitoring and assessment methods available to evaluate the effectiveness of these practices and technologies that provide improved insights on whether or how their implementation should be scaled up?

This document gathers the abstracts of the 197 contributions presented at the conference in these three sessions. These abstracts and related posters presentations are also displayed online on the conference website: **http://3sc.unccd.int**

The 3rd UNCCD Scientific Conference is held from 9 to 12 March 2015 in Cancún, Mexico, during the 4th special session of the Committee on Science and Technology (CST S-4) of the United Nations Convention to Combat Desertification (UNCCD).

It has been organized, jointly with the UNCCD Secretariat and the CST Bureau, by five scientific organizations which joined their forces under the "*Scientific and Traditional Knowledge for Sustainable Development*" (STK4SD) consortium. A Steering Committee, comprising representatives of the UNCCD Secretariat, the CST Bureau, the STK4SD consortium and the host country, has been in charge of following-up the conference preparation.

An international Scientific Advisory Committee (SAC) was set up to provide guidance on the scientific content of the conference. This committee was responsible for the selection of contributions submitted to the conference, with the support of a wider abstracts' review board. The SAC also commissioned an 'impulse report' to stimulate discussion and debate during the conference, which is published as a separate document.

The conference has been organized thanks to the generous offer of the Government of Mexico to host the CST-S4 and its 3rd Scientific Conference. In addition to the generous contribution by the Government of Mexico, voluntary contributions were provided by the governments of China, Finland, France, Germany, Latvia, the Republic of Korea and Switzerland for the activities leading up to the organization of the 3rd UNCCD Scientific Conference.

Conference organizers

The UNCCD

Together with the United Nations Framework Convention on Climate Change and the Convention on Biological Diversity, the United Nations Convention to Combat Desertification (UNCCD) (http://www.unccd.int/) is one of the three conventions set up after the 1992 Rio Earth Summit. The UNCCD is the sole legally binding international agreement linking environment and development issues to the land agenda. The UNCCD has a subsidiary body, the Committee on Science and Technology (CST), to provide it with information and advice on scientific and technological matters. Since 2009, special sessions of the CST have been organized in a scientific conference-style format, with the objective to strengthen the scientific basis underpinning the Convention. Two previous such scientific conferences have been organized, in 2009 in Buenos Aires on "*Bio-physical and socio-economic monitoring and assessment of desertification and land degradation to support decision making in land and water management*" and in 2013 in Bonn on "*Economic assessment of desertification, sustainable land management and resilience of arid, semi-arid and dry sub-humid areas*".

The "Scientific and Traditional Knowledge for Sustainable Development" (STK4SD) Consortium

Following a call for proposal, the STK4SD Consortium was appointed by the CST Bureau to organize the 3rd UNCCD Scientific Conference. It is composed of five major organizations, bringing together a high level of scientific expertise and practical skills in the organization of international conferences with a long established commitment to the operations of the UNCCD. Its members are actively involved in all the regions concerned by the UNCCD, with the ability to mobilize resources, organizations and stakeholders at all levels:

- **Agropolis International** (http://www.agropolis.org/) is an association based in Montpellier supported by central and local government. Its members include nearly 30 research centers and higher education establishments in the Languedoc-Roussillon region, with 2,300 scientists, working in the fields of agriculture, food, biodiversity and the environment, much of their work focusing on the Mediterranean and tropical regions. As the leader of the consortium, Agropolis International benefits from the collective expertise of the **French Scientific Committee on Desertification (CSFD)** (http://www.csf-desertification.eu/) and hosts the Committee on its premises. CSFD includes 20 members from French universities and scientific institutions appointed by the Ministry for Higher Education and Research, and chosen to represent a wide range of expertise on desertification.
- **DesertNet International** (http://www.csf-desertification.eu/) is an international scientific network for research into desertification that brings together more than 300 experts from 50 countries and provides a platform for international science policy discussion.
- The **CGIAR Consortium** (http://www.cgiar.org/) is a global research partnership for a food secure future. The CGIAR aims to reduce rural poverty, improve food security, human health and nutrition and encourage more sustainable management of natural resources. The research is carried out by the 15 centers that are members of the CGIAR Consortium, including the ICARDA and the ICRISAT, and which work closely together with hundreds of partner organizations.
- The **Sahara and Sahel Observatory (OSS)** (http://www.oss-online.org/en) is an intergovernmental African organization based in Tunisia, focusing on concerted, sustainable management of natural resources in arid, semi-arid and dry sub-humid areas in Sahel - Sub Saharan Africa. The OSS members include 22 African countries, 5 non-African countries and 10 international, sub-regional and non-government organizations.
- The **Argentine Dryland Research Institute (IADIZA)** (http://wiki.mendoza-conicet.gob.ar/iadiza) is an institute of the Argentine National Scientific and Technical Research Council (CONICET), whose aim is to improve understanding of the structure and functioning of arid zones and the transfer of technology and know-how through education/training and capacity-building.

Participants to the Steering Committee

UNCCD Secretariat

STK4SD Consortium

Bernard HUBERT, Chair, President of Agropolis International (France)

Richard ESCADAFAL, Vice-Chair, President of the Comité scientifique français de la désertification (CSFD) (France)

Mélanie BROIN, Scientific Officer, Agropolis International (France)

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The SAC comprises 12 experts, two from each of the five United Nations regions: Africa (AF), Asia (AS), Central and Eastern Europe (CEE), Latin America and the Caribbean (LAC), Western Europe and Other Groups (WEOG), plus two global experts (GE):

Mariam AKHTAR-SCHUSTER, Senior Scientific Advisor at the Project Management Agency PT-DLR, Berlin, Germany and coordinator of the advisory board of DesertNet International (GE)

Miriam DIAZ, Emeritus Professor at the Center for Ecology and Arid Lands, National Experimental University Francisco de Miranda, Coro, Venezuela (LAC)

Cristobal Felix DIAZ MOREJON, Environmental Specialist at the Environmental Directorate of the Ministry of Science, Technology and the Environment, Havana, Cuba (LAC)

Patrice DJAMEN NANA, Sub-regional Coordinator for West and Central Africa at Africa Conservation Tillage Network, Ouagadougou, Burkina Faso (AF)

Gordana GRUJIC, Environmental Specialist at Oasis association, Belgrade, Serbia (CEE)

Sahibzada Irfanullah KHAN, Provincial Project Coordinator for the Sustainable Land Management Program (SLMP), Planning & Development Department, Civil Secretariat in Peshawar, Peshawar, Pakistan (AS)

Ashot KHOETSYAN, Professor at the Department of physical geography and hydrometeorology of the Yerevan State University and the Armenian State Pedagogical University, Yerevan, Armenia (CEE)

Pietro LAUREANO, President of the International Traditional Knowledge Institute, Roma, and Director of Ipogea (Traditional Knowledge Research Centre), Florence, Italy (WEOG)

William Albert PAYNE, Dean and Professor at the College of Agriculture, Biotechnology, and Natural Resources and Director of the Nevada Agricultural Experiment Station at the University of Nevada, Reno, USA (GE), Chair of the SAC

Melanie REQUIER-DESJARDINS, Scientific Administrator at the International Center for Advanced Mediterranean Agronomic Studies – Agronomic Mediterranean institute of Montpellier (CIHEAM – IAMM), Montpellier, France (WEOG), Vice-chair of the SAC

Graham Paul VON MALTITZ, Senior Researcher, Council for Scientific and Industrial Research, Pretoria, South Africa (AF)

Tao WANG, Director of the Key Laboratory of Desert and Desertification and Research Professor at the Cold and Arid Regions Environmental & Engineering Research Institute, Chinese Academy of Sciences, Beijing, China (AS)

Members of the abstracts' review board

Vicente ANDREU, National Research Council of Spain (CSIC), Moncada, Spain; **Nabil BEN KHATRA**, Observatoire du Sahara et du Sahel (OSS), Tunis, Tunisia; **Hichem BEN SALEM**, International Center for Agricultural Research in the Dry Areas (ICARDA), Amman, Jordan; **Martial BERNOUX**, Institut de Recherche pour le Développement (IRD), Montpellier, France; **Marc BIED-CHARRETON**, Comité scientifique français de la désertification (CSFD), Montpellier, France ; **Mourad BRIKI**, Observatoire du Sahara et du Sahel, Tunis, Tunisia ; **Antoine CORNET**, Comité scientifique français de la désertification (CSFD), Montpellier, France ; **Isabelle DROY**, Institut de Recherche pour le Développement (IRD), Bondy, France ; **Giuseppe ENNE**, DesertNet International (DNI), Sassari, Italy ; **Richard ESCADAFAL**, Institut de Recherche pour le Développement (IRD), Toulouse, France ; **Bernard HUBERT**, Agropolis International, Montpellier, France ; **Alexandre ICKOWICZ**, Cirad, Montpellier, France ; **Ratko KADOVIC**, University of Belgrade, Belgrade, Serbia ; **Maria Jose MARQUES**, Universidad Autónoma de Madrid, Madrid, Spain ; **Snezana OLJACA**, University of Belgrade, Belgrade, Serbia ; **Theib Y. OWEIS**, International Center for Agricultural Research in the Dry Areas (ICARDA), Amman, Jordan ; **Pier Paolo ROGGERO**, University of Sassari, Sassari, Italy ; **Dusko SUNARIC**, Academy of engineering sciences of Serbia, Belgrade, Serbia; **Maxime THIBON**, Observatoire du Sahara et du Sahel (OSS), Tunis, Tunisia ; **Richard J. THOMAS**, International Center for Agricultural Research in the Dry Areas (ICARDA), Amman, Jordan

Disclaimer

This document presents the abstracts of the contributions for the 3rd UNCCD Scientific Conference. All of them are presented as posters in the different parallel workshops.

Please note that the abstracts are published as they have been submitted by their authors on the online conference submission system without any editing. The references and figures cited in the abstracts are not published in this book. For more inofrmation about these contributions, please visit the conference website: http://3sc.unccd.int where the related posters are displayed.

This document is only meant to help the conference participants to select the workshops they wish to attend and the contributions of specific interest for them.

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Abstracts of contributions presented in session 1:
DIAGNOSIS OF CONSTRAINTS

How can key vulnerabilities of ecosystems and populations with regard to climate change in the various situations in the world be identified? How can they be characterized?

The prevalence of poverty and environmental degradation in areas where desertification, land degradation and drought occur reflects not only the difficulty of sustainably using natural resources but also the lack of development models appropriate to these zones, in which the availability of natural resources is strongly influenced by climate variability. In particular, the management of unpredictable events is key to rural communities' adaptation to climate change. Under such conditions, knowledge of the properties that enable a good understanding of ecosystems and production systems to adapt to fluctuations in the natural environment is of fundamental importance to ensuring system sustainability and to building rural development models. What have been the effects of the successive crises rural communities have had to face? What factors increase or decrease the resilience of farming and other land use systems? What strategies are implemented by communities in rural zones to address vulnerability and risk? What is the current capacity of resource-user communities in these regions, and what are their needs for capacity building to better cope with the situation? What are the long-term development trajectories for these communities and their various land use activities?

Such information should be built up from local and traditional sources, through research, from local communities and the various organizations involved in the area.

Session 1.1: Climate change

IMPACT OF CLIMATE CHANGES ON PRODUCTIVITY AND BIODIVERSITY OF GRASSLAND IN WESTERN UKRAINE

PANAKHYD, Galina; KOTYASH, Ulyana; BUGRYN, Lyubomur; YARMOLYUK, Micael; SMETANA, Sergij; PUKALO, Danylo; KOBURENKO, Yulya; DIDUCH, Galina; KONYK, Grygoriy

Institute of Agriculture of Carpathian Region of the National Academy of Agrarian Sciences of Ukraine, Ukraine

panakhyd-galia@ukr.net

The most of meadow grasses, which are the formed of firm phytocenosis, are weather-resistant, but they are significant consumer of water. Therefore the herbages have scarcity of water susceptibility. Shortage of water is caused reducing productivity of grassland and is promoted the falling-out of same kind of meadow grasses from grass canopy. A lot of researches are noted a significant climate changes [Trnka et al., 2011] and influence of it on agrocenosis [Calanca et al., 2005, Alkemade et al., 2011]. The aim of this study is determination impact of climate change on biodiversity and yield of grassland in western Ukraine. This makes it possible to establish relation of productivity with weather conditions and this allow recognizing the most way of productivity increase with biodiversity retention at the same time.

The investigation was carried out under the conditions of the stationary permanent experiment (was sowed in 1974) (Stavchany 49°41' N 23°50' E, altitude 320 m) on the dark grey podzolic sandy loam soils. The experiment was conducted in 1999-2013. The local climate is semicontinental. It has been formed by the Atlantic Ocean (a lot of precipitation and rapid changing of temperature) and by continental atmospheric masses.

Hydrothermal coefficient has been used for description of conditions plants vegetation period (HTC). An analysis of correlation [Dospehov, 1979], were determined. The results were processed with a set of statistical tools of the program Windows (Microsoft Excel 2003).

During 1991-2013 significant fluctuation of precipitations were noticed. 11 research years from 23 years had unnecessary precipitations, 9 has water-short and only in 3 years rainfalls approximated to norm. In 20 years indexes of temperature were above the rate. Increasing of sum active temperature of vegetation period was fixed every following year. Such climate change had considerable impact on growth of grasslands.

Reduction of mesophytes from 85% to 59% was recorded on unfertilized grassland, at once xeromesophytes increased from 11% to 34% on such variant. There was replacement of tall bent grass (*Agrostis gigantea*) and red fescue grass (*Festuca rubra*) by meadow grass (*Poa pratensis*) and birds-foot trefoil (*Lotus corniculatus*), these plants being not afraid of overheat and dehydration. The highest yield of this grassland (4.04 t ha^{-1}) was in 2009, when rainfall was by 181.5 mm more than norm, and temperature was by 0.7 ºC more than norm. At that correlation between yield and HTC sharply increased.

Such appreciable influence of climate changes was on grassland, when phosphorus-potassium fertilizers (PK) were applied. PK promoted a better development of legume, notably birds-foot trefoil. Therefore percent of xeromezophytes increased from 15% to 51%. Correlation between yield and HTC is positive in wet years and negative in dry years.

Application of full mineral fertilization (NPK) decreased percent of xeromezophytes only by 4-5%. Correlation between yield and HTC visible reduced, particularly for even distribution (r = 0,123 – 0,321). If N fertilizer was not applied early in spring weak correlation was only in period 1996-2000 with unstable weather conditions (see table).

Considerable factor of impact on grasslands is weather conditions and climate change. They decrease mezophytes on unfertilizing and insufficient fertilizing plots, and they further replacement of these grasses by more resistant species. Applications of NPK are smooth impact of weather condition and become the principal factor of yield and biodiversity control.

Optimal dozes of NPK fertilizers will allow regulating species composition and will permit to receive 8-9 t ha^{-1} dry matter in condition of semicontinental climate independently to weather conditions and age of grassland.

ANALYSIS OF CLIMATE CHANGE IMPACT BY MODELING HYDRIC EROSION TO SOILS OF AGUASCALIENTES, MEXICO

LÓPEZ, Santos Armando (1); MARTÍNEZ, Santiago Santos (2);
GERARDO, Arriaga Gerardo (3)

1: Universidad Autonoma Chapingo, Mexico; 2: Posgrado Uruza-Uach; 3: Instituto Nacional De Investigaciones Forestales, Agrícolas Y Pecuarias, Mexico

alopez@chapingo.uruza.edu.mx

Rationale

Nowadays the hydric erosion of the soils (HES) it´s recognized as the main global problem in the land degradation, because has been exacerbated not only by human action, but also by the intensification of climate variability in recent years. Satavi and Lal (2104), say that the degradation of natural resources reaching the 23% at the World surface, with an annual rate of 5-10 million ha, and the HES encompassed around of 10.9 x 10^8 ha. Some studies reporting that HE is the second cause of soil loss in Mexico, whose future influence has not been enough evaluated (SEMARNAT, 2008). Therefore, the aims of this research were: 1) Determine the distribution and impact of climate change in water erosion on the soils of the State of Aguascalientes, Mexico in the future scenario A2, period 2010-2039; and 2) Warn future risks in primary activities by the deterioration of soil resources.

Methods

For this, Aguascalientes state was taken as the studio unit (SU), which is located (Latitude between 21.616° & 22.466° N and Longitude between -101.833° & -102.866° W), in the zone knowing as "Region del Bajío". The SU has a surface of 5621 km^2, the main climate types are: BS and Cw (arid, semi-arid and temperate sub-humid), have mean annual values to temperature and rain of 17.4 °C and 526 mm, respectively.

LARS-WG (Long Ashton Research Station Weather Generator) program was used it as downscaling method, which allowed the processing of regionalized climatic models, same that are included it in the IPCC Fourth Assessment Report (AR4) described by Conde & Gay (2008). The AR4 was used database particularly to Mexico, the Caribbean Region and Central America, from this was extracted it to SU the rain data for the future scenario A2. This was supported by daily data of climate from 17 Weather Station (WS) from Mexican National Service selected based in quality data.

Next, according the methodology described by Lopez-Santos *et al* (2013) were modeled some variables related with biophysical characteristics (topography, edaphology, and physiography) and human activities (land use), based in:

$$LHESR = ARI \times SSI \times STI \times LUI \times TFI \quad \text{(Eq 1)}$$

$$ARI = 1.244(GROPE) - 14.7875 \quad \text{(Eq 2)}$$

$$GROPE = 0.2408*(MAR) - 0.0000372*(MAR)^2 - 33.1019 \quad \text{(Ec 3)}$$

where LHESR, is the laminar hydric erosion rate (t $ha^{-1}yr^{-1}$); ARI is the aggressiveness rain index; SSI is the soil sensitivity index; STI is the soil texture index; LUI is the land use index; and TFI relationship the main physiography and topographic characteristics. The GROPE, is defined as the number of days per year with suitable water availability and favorable conditions for the establishment of a crop; MAR is the mean annual rain in mm.

Finally were calculated the magnitude of changes and the local impacts on the SU, same that were detected spatially explicitly, which was possible calculate the laminar hydric erosion (LHE) of soils, and with this were possible assessing changes and local impacts for the historic (LHE_H) and to the futures future scenario A2, period 2010-2039 (LHE_{EA2}).

Results

The mean annual rain (MAR) analyzed, showed that the changes and impacts between historical and scenario A2. Will be possible that would to have an average increase until 53.4 mm of rain annually representing 11.2%, which is observed more marked at the upper limit between compared ranges, passing this to 647.9 to 738.1 mm, representing a positive difference of 13.9%, while the lower limit would be 5.3% (Table 1).

The changes above indicated consequently had a direct effect in two indices: ARI and GROPE, both are keys in the soil erosion quantification, so that the $LHSER_{EA2}$, due to future changes would to be average soil losses of 1,360 t ha^{-1} yr^{-1}, which representing until 3.3 m of soil los in almost 30 years.

Outcomes

Soil loss as an initial state of environmental degradation in the territory of Aguascalientes, is a problem probably underestimated, as can be seen in previous studies, because some not including the issue of climate scenarios, where it is considered to rain as one of its main variables.

The calculated rate of soil erosion indicates that the nearby stage (2010-2039), LEHSREA2, should addressed by prevention policies and practices, conservation and protection of natural resources, if not, will loss it a layer of soil that is currently serving key roles in stability, one in the ecosystem services, and other represents a choice of income linked to primary activities.

Session 1.1: Climate change

PROJECTED PATTERNS OF PRECIPITATION AND TEMPERATURE ANOMALIES IN OMAN UNDER RCPS SCENARIOS OF CIMP5

CHARABI, Yassine Abdulrahman; AL-WARDY, Malik Mohamed;
AL-RAWAS, Ghazi Ali

Sultan Qaboos University, Oman

yassine@squ.edu.om

Rationale

The annual precipitation in Oman varies between 27 and 400 mm/year. The lowest average annual rainfall is encountered in the interior plains and coastal areas along the Arabia Sea. The highest average annual rainfall is found around peaks in the Al Hajar Mountains. Most of the highland areas of the country experience average annual rainfall within a narrow range between 50 and 100 mm/year. During winter (November to April), northern cold frontal troughs are responsible for the rain in north of Oman (average seasonal rainfall between 20 and 60 mm for northern parts, and between zero and 20 mm for the rest). While during the summer months (June to September), the southern part of Oman, is swept by Indian summer monsoon (Average seasonal rainfall is between zero and20 mm for the overwhelming majority of the country and 20 to 60 mmin the southern mountains) (Charabi, 2009; Charabi and Al-Hatrushi, 2010, (Charabi and Al-Yahyai, 2013; Luminda an Al-Rawas, 2014). Water availability and groundwater deterioration have been identified as major factors causing land degradation. This paper aims to study the spatial patterns of temperature and precipitation change projections for Oman based on Representative Concentration Pathways (RCPs) under the Coupled Model Inter-Comparison Projects 5 (CMIP5) of the Inter-governmental Panel on Climate Change (IPCC).

Data sets and Methodology

For this study, four RCPs scenarios (RCPs 2.6, 4.5, 6 and 8), under CMIP5, based on Hadley Global Environment Model 2 - Earth System (HadGEM2-ES), with a spatial resolution of 30 seconds, were performed for the period 1950-2060. Climatic baseline over 1950-2000 was used to compare and calculate spatial projected changes (anomalies) for the average annual temperature, and annual precipitation. The pattern of temperature and rainfall anomalies was calculated for each raster cell grid using GIS processing tools, for short term (2011-2040).

RCPS Scenarios based rainfall and temperature change projection for short term projections

Figures 1(a-d), show the simulated average annual rainfall changes during 2041-2060. As it can be seen in these figures, all the RCPs scenarios clearly show that majority of the country will become drier. For RCPs 2.6 and 4.5, large portion of the Western Al Hajar Mountains is projected to receive up to 20 mm less in annual rainfall. On the other hand, model results for RCPs 6.0 and 8.5 show that the Eastern of Al Hajar Mountains will become wetter. For the southern part of the country, all RCPs scenarios indicate that summer monsoons are expected to intensify, leading to increased rainfall. By 2041, the coastal zone and the Mountains of Dhofar are projected to receive up to 28 mm more in annual rainfall (RCPs 2.6 and 4.5), with up to 60 mm according to RCPs 6.0.

Figures 1(e-h), show the simulated average annual temperature changes during 2041-2060. All the RCPs scenarios show an increase in future annual temperature for the entire country with high coherence of warming patterns. Temperature will increase gradually form the coastal areas to the open desert. RCPs 2.6, 4.5 and 6.0 scenarios show an increase in future annual average temperature in the range of 1.3°C to 3.3°C. For RCPs 8.5, the range of warming is more pronounced for the entire country through 2040, with increase in the range of 1.9°C to 4.1°C.

Conclusion

North of Oman is likely to face declining rainfall in the coming decades. In a region where historic average annual rainfall levels are between 50 and 100 mm for the northern coastal area, climate change is expected to result in 10 and 20 mm less average annual rainfall (reduction by 20%) by 2040. The expected decrease in rainfall in the northern areas will have a negative impact on surface water flow and aquifers recharge. When combined with continued socioeconomic growth, current challenges in balancing water supply and demand will become more difficult, as will the capacity to maintain water quality standards. Temperature in Oman is also expected to increase significantly during the next decade, which will lead to great evapotranspiration and reduction in soil moisture. In locations where both precipitation and soil moisture decrease, land surface drying is magnified, and areas are left increasingly susceptible to the deterioration of ecosystems in the region, mainly in mountainous areas.

Session 1.1: Climate change

ASSESSING THE VULNERABILITY OF RANGELAND ECOSYSTEMS TO GLOBAL CLIMATE CHANGE IN THE DRYLAND AREAS OF THE MIDDLE EAST AND NORTH AFRICA REGION

LOUHAICHI, Mounir (1); OULED BELGACEM, Azaiez (2)

1: CGIAR/ICARDA, Jordan, Hashemite Kingdom; 2: CGIAR/ICARDA, Dubai, UAE

M.Louhaichi@cgiar.org

Rationale

Climate change projections provide little information on how this risk might affect rangeland plant communities in specific regions. Rangelands are by far the most widespread land use type in the dry areas, and are home to most of its poorest inhabitants. Having low productivity and potential, the people they support remain largely marginalized. A large area of the Middle East and North Africa (MENA) region is arid or semi-arid with shallow and low fertility soils and poor plant cover and pastoral/agro-pastoral use are dominant production systems.

This study evaluated the impact of climate change on the geographical distribution of selected native rangeland species in the MENA region. Assessments of the potential impact of climate change on the geographical distribution of two economically important species, *Salsola vermiculata, Atriplex leucoclada* (Boiss) in comparison to *Haloxylon salicornicum* (Moq.) and *H. schmittianum*, non-palatable species, in the MENA region was conducted.

Methods used and partnership set up

The ecological niche concept (Phillips et al. 2006) expressed by the occurrence of the rangeland community or species in relation to its environmental requirements, was applied. The species distribution modeling software MaxEnt (Maximum Entropy) was considered the most suitable model. An ecologically-based quantitative niche model was developed to assess the vulnerability of selected species to climate change scenarios. Model input values included the occurrence (spatial location) of individuals from the target species in relation to eight climatic variables (GIS layers), three soil property layers, one altitude layer, and one grazing pressure layer. Climatic variables included in the study varied across three time periods; current year, 2020 and 2050.

Climatic projections, using the same eight variables as the current situation, were achieved for the years 2020 and 2050 using the average of predictions of the widely used global circulation model HADCM3, within the frame of the A2 scenario of CO2 emissions (IPCC 2000).

Since environmental parameters only enable assessing the sensitivity of target species to climate change, the use of socioeconomic parameters describing the human pressure is necessary to assess the species vulnerability (O'Brien et al. 2004). In this case grazing is the main common use in the MENA region. Consequently, the socioeconomic layer was represented by a synthetic variable called the Coefficient of Overgrazing (CO), which aims to estimate the current state of the species in relation to animal pressure (i.e. species are overgrazed, moderately grazed or under grazed).

Results

The results of the study validate the common belief that desired rangeland species reductions will likely occur with the combined effect of climate change and anthropogenic influences. This combination has the potential to shift environmental conditions that favor the establishment of the unpalatable species and eliminate range species that are found within the host ecosystem. Furthermore, the results indicated that threatened species showed high vulnerability to climate change. However, species with low palatability and broad ecological niches had an advantage due to the reduced competition for water and nutrients.

In the study areas, *S. vermiculata* and *A. leucoclada* were apparently highly vulnerable to ongoing climate change combined with human pressure, i.e. grazing. The main environmental variables restricting the geographical distribution of these key species were the variation of seasonal temperatures followed by mean annual precipitation. The precipitation of the wettest month (15–18 %) was the third most important limiting variable. The socioeconomic variable (i.e.

CO) contributed 11%, and seemed to enhance the former climatic parameters' impact on the species' resilience capacity. *Salsola vermiculata* is a highly palatable range species and continuously threatened by overgrazing. Unlike *S. vermiculata* the model outputs showed an important invasion of study areas by *Haloxylon spp.* by 2020 and even more so in 2050. It is apparent that the ongoing climate change will favor these species and lead to ecological conditions similar to those required for their establishment and growth. The mean annual precipitation was the main factor explaining these trends with 55–60 % contribution. Decreased rainfall will enhance invasion of the study areas by these Haloxylon spp. Temperature seasonality (14.6–16.4 %) and minimum temperature of the coldest month (10.2–13.5 %) came in second and third, respectively. Together these three parameters explained 80–90 % of the expected geographical distribution of these species. Moreover, *Haloxylon spp.* apparently had greater tolerance for warmer and drier conditions.

Outcomes

Land managers and development projects are well equipped to better monitor, assess and manage their natural resources and in particular arid and semi-arid rangelands. The suggested protocols and tools provide valuable information for assessing the impact of climate change, livestock/wildlife grazing, and spread of degradation/desertification rates. If utilized correctly, such information can improve rural community livelihoods by mitigating possible negative trends.

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IMPACT OF CLIMATE CHANGE ON LAND-WATER-ECOSYSTEM QUALITY IN POLAR AND MOUNTAINOUS REGIONS: IDENTIFYING THE KNOWLEDGE GAPS

STOTT, Tim (1); DERCON, Gerd (2); JUREK, Matthias (3)

1: Faculty of Education, Health & Comunity, Liverpool John Moores University, United Kingdom; 2: Soil and Water Management & Crop Nutrition Laboratory, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Austria; 3: Polar & Cryosphere Division, GRID-Arendal, Austria

t.a.stott@ljmu.ac.uk

Rationale

Knowledge about climate-change impacts, adaptation, and vulnerability has more than doubled between 2005 and 2010 (Stocker *et al.*, 2013). However, serious knowledge gaps on the impact of climate change on land-water-ecosystem quality still exist, particularly in the vulnerable and remote polar and high mountainous regions. This paper attempts to summarize key research themes, indicating where there is an urgent need for further climate change impact research.

Methods used and partnership set up

This gap analysis was carried out as part of the International Atomic Energy Agency (IAEA)'s Interregional Technical Co-operation Project INT/5/153 (2014-2018) on "Assessing the Impact of Climate Change on Soil and Water Resources in Polar and Mountainous Regions", which is organized and funded by the IAEA and supported by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. The project involves scientists from twenty-three countries representing thirteen benchmark research sites located in all continents (Figure 1) and designed to assess the impact of climate change on land-water-ecosystem quality in polar and mountainous regions. The overall objective of the interregional project is to improve the understanding of the impact of climate change on fragile polar and mountainous ecosystems at the local and global scale for their better management and conservation. This project is unique in that it will use common methods to compare the impact of climate change on land-water ecosystem quality, using isotope and nuclear technologies.

Results

Through the development and analysis of a database of 769 scientific publications (published since 2000) derived from internet searches and benchmark site scientists, the analysis identified and quantified the knowledge gaps. All entries in the database were assigned up to three key words so that a total of 1015 unique key words were used to describe the papers. These were then grouped into five broad categories based on four categories used by Field *et al.* (2014) plus one other proposed by the authors. The number of keywords in each category (in brackets) and the % of all key words in that category were: (1) Snow and ice (366), 36.1%; (2) Terrestrial Ecosystems (carbon and nutrient cycling) (260), 25.6%; (3) Water (173), 17%; (4) Livelihoods (146), 14.4% and (5) Land degradation (70), 6.9%. As indicated by the number of key words per category, the first two categories have been heavily researched as reported by the IPPC (2013) fifth assessment report (Stocker *et al.*, 2013).

Outcomes

Due to the different numbers of papers provided by benchmark site researchers, data were normalized and the priorities for future research on climate change impact in polar and mountainous regions, as summarized in Fig. 1, should be considered in the following rank order:

- Impact on **land degradation**: soil erosion, sediment redistribution and slope stability,
- Impact on **livelihoods**: food and feed production, agricultural sustainability, soil and water quality, land and water availability for cropping, irrigation, livestock and forestry systems, energy production and hydropower,
- Impact on **water**, runoff, river discharge dynamics,
- Impact on **carbon and nutrient cycling**: soil organic carbon dynamics, greenhouse gas emission and feedback mechanisms,
- Impact on the **cryosphere** (snow cover, glacier dynamics and permafrost) – land-water-ecosystem quality interactions.

If information from the Zackenberg site is removed however, then terrestrial ecosystems (C and N cycling) goes up significantly from fourth to second place, and livelihoods and water move down one place. Improved knowledge may assist marginal farming communities in mountain regions and regional policy-makers to adapt to, and mitigate against, the impacts of climate change through improved soil and water management and conservation measures. Communities proximal to mountain ranges in Africa, Asia, Europe, and North and South America will benefit from this information.

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DROUGHT FREQUENCY AND INTENSITY AT REGIONAL LEVEL IN MEXICO

GOMEZ DIAZ, Jesus David (1); MONTERROSO RIVAS, Alejandro Ismael (1); LECHUGA GAYOSSO, Lizeth Margarita (1); GARCIA RODRIGUEZ, Jorge Luis (2); VILLEGAS FLORES, Joel (2)

1: Universidad Autonoma Chapingo, Mexico; 2: Comision Nacional Forestal

dgomez@correo.chapingo.mx

Drought is a natural hazard that has adverse impacts on humans and in ecosystems (Rhee and Carbone, 2011) and can affect all the climatic regimens. Drought is defined as the deficiency of precipitation relative to what is expected that, when extended in over a season or a longer period of time, results in the inability to meet the demands of human activities and the environment (Hayes et al., 2011). Considerable research efforts have gone into the quantification of drought severity, and, at present one of the most widely used indices are the Standard Precipitation Index (SPI) developed by McKee et al., (1993) and measures precipitation deficit at a variety of time scales (Guttman, 1999). The SPI uses only precipitation data and is appropriate for monitoring drought over large areas since the values are comparable over space and time because of the standardized transformation process (Guttman, 1999). Drought is one of the most costly natural hazards and affects more inhabitants than any other.

The severity of annual drought was estimated from 1961 to 2012 using the Standard Precipitation Index (SPI) for 325 meteorological stations that the National Meteorological Service of Mexico uses for that purpose. The meteorological stations were grouped according their location in each of the fourteen Precipitation Regions of Mexico defined by Gomez et al., (2008) in order to analyze the frequency and severity of drought at regional level. For each region we found differences in frequency and severity of drought and decide to subdivide the regions into two or four zones each having at the end 37 zones.

The number of annual droughts from exceptional to moderate for each zone of the fourteen precipitation regions are presented in Table 1, as is show, the number of droughts in zone goes from 9 to 23 in the 52 years of the study. Even we don't found a change patron in the frequency and in the severity of drought in the different zones, the results for each decade shows the following: For the decades from 1961-1970, 1971-1980, 1981-1990, 1991-2000, and 2001-2010, the zones with exceptional drought in some years of every decade account in total 11, 7, 16, 14 and 6, respectively. The zones with extreme drought in some years of every decade account in total 19, 21, 24, 21, and 21, respectively. The zones with very severe droughts in some years of every decade account in total 14, 24, 25, 18, and 17, respectively. The zones with moderate drought in some years of every decade account in total 63, 61, 44, 60, and 48, respectively. For the last two years of the study (2011-2012), the zones with exceptional drought were 8, the extreme drought were 6, the very severe were 6 and the moderate drought were 11, this results shows that there are a more occurrence of the drought with higher intensity in these period of time. The drought occurrence within each region varies in number and intensity.

Acknowledgements

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VARIATIONS IN METEOROLOGICAL PARAMETERS LEADING TO LAND DEGRADATION AND DESERTIFICATION: A MICRO LEVEL CASE STUDY FROM SOUTH INDIA

MUDIGERE SANNEGOWDA, Umeshbabu; NAUTIYAL, Sunil

Institute for Social and Economic Change, India

umesh@isec.ac.in

Drought and land degradation is one among the major disasters affecting the people and environment very often and it is severe in the areas of arid and semi arid areas. Desertification and land degradation is a universal issue and it is affecting largely (about 30 %) on the people resided in developing and least developing countries. Furthermore the people depended on agriculture and natural resources for their household income are suffering severely due to their sensitivity to negative variations of climatic factors. As an example several studies from UN organizations, FAO and others have drawn conclusion on similar aspects (Thomas, 1997; Geist et al, 2004; Nkonya et al, 2011). A thorough understanding with this background we have chosen a case study at micro level i.e Chamarajnagar district in south India which is falling under the category of arid and hilly zone. The part of this district has reserved forest and rest is lying on arid agriculture system. Most of the agricultural activities are depended on the distribution of rainfall. This study made an attempt to understand the issues associated with land degradation and desertification and its economic impacts on environment and society and also, tried to develop suitable strategies to deal with possible impacts in the region.

This study followed specific econometric analysis methods such as Principal Component Analysis (PCA), Factor Analysis (FA) and Contingent Valuation Methods (CVM) to assess the economic impacts of drought and land degradation. The primary data are obtained from various stakeholders through household survey. The household survey conducted based on the Integrated Approach method (IA). IA is found as a suitable method because, it includes consultations from officials, farmers, beneficiaries, non beneficiaries, NGOs, policy makers and other diplomats from related institutions. The preliminary findings of this study are challenging to farmers as well as officials to adapt or cope up with. The key findings such as rise in soil infertility (28 %), reduced in cropped area (33 %) especially high during second crop (winter crop), production loss (29 %), change in agriculture area from traditional to introduced crops (35 %) and rise in agriculture input cost (42 %): largely on labour, fertilizers and pesticides are influencing to change in land use. Moreover, the quantity and distribution of rainfall is fluctuating largely (37 %) towards negative growth (Gore et al, 2011). Furthermore warmer days are increasing over the period.

The state and central government have introduced some arid and semi arid area development schemes but not successful in meeting the requirements. Besides, farmers have adapted some local techniques such as cultivating less period high yielding verities, changing the cropping pattern from food crops to cash crops while accessing ground water but not completely satisfied. Presently, livelihood activities of the households are orienting towards non agriculture activities. As a result people are migrating towards urban areas in searching of suitable opportunities. Based on this findings we have developed some strategies which are suitable to arid and semi arid regions of the country and as well as world. The developed strategies include linking traditional knowledge with scientific ideas to conserve and maintain the existing land use pattern. Secondly, suggested a high value – low volume crops, soil fertility regeneration techniques and applications of organic manure etc. Many more findings of this case study are helpful to policy makers and also government agencies to introduce development schemes and programmes relating to arid and semi arid regions.

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PRECIPITATION TREND AND ITS IMPACTS ON LAND DEGRADATION IN SOUTHERN OMAN

AL RAWAS, Ghazi Ali; AL WARDY, Malik Mohamed; CHARABI, Yassine AbdulRahman

Sultan Qaboos University, Oman

ghazi@squ.edu.om

Rationale

On-shore southwesterly monsoon currents occur from June to September and bring humid conditions accompanied by frequent drizzle, fog, mist and rain (khareef) in Dhofar coast and bordering mountain areas. During the khareef season, parts of Dhofar region are transformed into lush landscapes of green field and verdant vegetation. This area is already affected by different extent of land degradation due to the extensive overgrazing, touristic activities and urban sprawl (NAP/UNEP/ROWA, 2005). In addition to these, precipitation may play a potential role in defining the density of the vegetation cover. The monsoon season in Dhofar region brings 100–400 mm of rainfall. Recent Climatic studies have shown that the inter-annual variability of Southern Oman Summer Monsoon is influenced by the Indian Ocean Dipole (IOD) and its atmospheric component the Equatorial Indian Ocean Oscillation (EQUINOO). Monsoon plays a vital role in the economies in the southern Oman where animal husbandry is practiced on an extensive scale. The aim of this paper is investigate the annual variability and trend of the longest data record of homogeneous precipitation time series since 1980. This coupled with the analysis of vegetation cover at the foothills and mountains would give a potential indication and linkage between precipitation trend and land degradation.

Datasets and Methodology

For the purpose of this study Salalah meteorological station, which have the longest data record of homogeneous climate time series since 1980. The data from this station were quality controlled in two stages:

- A check for physically implausible data (e.g., negative rainfall) and analysis of outliers which are identified by numerical and visual checks. These were evaluated by comparing their values to nearest stations in order to determine whether the flagged values were associated with real or anomalous weather events. A few physically implausible values have been set to missing.
- Data homogeneity is assessed using the RHtestV3 software which uses a two phase regression model applied to monthly data in order to check for multiple step change points that could exist in a time series.

For this study, the precipitation cycle was analyzed, and the data were divided into cumulative rainfall of 2, 2.5, and 3 years covering the period from 1980 to 2012. The status of vegetation cover over the study period was assessed based on NDVI values calculated from two SPOT scenes dated in April 1994 and May 2012.

Results and Discussions

The longest time series of rainfall clearly shows statistically significant negative trend as shown in Figure 1. These results show consistency with other previous studies conducted by Charabi (2009) and Luminda & AL-Rawas, (2014), showing strong variability for all cycles. Figure 1 also shows long consecutive dry spells in Dhofar Mountains. Authors believe that the effect of possible extreme events on rainfall trend in the longer cycles (2.5 and 3 years) is minimized. Therefore, these cycles give a better representation of rainfall pattern and its potential effect on land degradation. Notice that the 3 year cycle, shows the highest decrease of rainfall trend over the study period. Based on this cycle trend, the decrease of rainfall is around 69 mm/decade. The above results clearly show that rainfall variability and negative trend has contributed to the observed process of land degradation during the last four decade. The process of land degradation was quantitatively assessed based on the analysis of two high resolution SPOT imageries for the period 1994 and 2012. The analysis of NDVI values from both scenes showed severe decline in the vegetation cover.

Conclusion

The current study emphasizes the potential linkages between the strong annual rainfall variability and negative trend with the status of the vegetation cover and hence on land degradation. The study area is tremendously under growing pressure from anthropic factors, in addition to the climatic factor. The concomitant effects anthropic and climatic factors will accelerate the process of land degrading in coming years.

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THE IMPORTANCE OF REGIONAL COOPERATION AND COMMUNICATION IN THE CASE OF LAND DEGRADATION CAUSED BY NATURAL DISASTERS: SAVA RIVER BASIN CASE STUDY

BRZINA, Aida; HUSNIC, Elma

FEA - Forestry and Environmental Action, Bosnia and Herzegovina

abrzina@fea-bh.com

Rationale

Through this paper, we will try to prove the following hypothesis: *The regional communication and cooperation is essential for prevention of negative consequences of land degradation caused by natural disasters*. The hypothesis is guided by UNCCD Comprehensive Communication Strategy. Dealing with negative consequences of land degradation caused by natural disasters demands the engagement of all sectors (governmental, non-governmental, private) as well as the scientific community, the media and the public at large. Floods that happened in the Balkan region, specifically Sava River Basin, in May 2014 provide very good basis for a case study. The government, which has one of the most important and influential roles, has proved ineffective, solely focused on the problems within their own borders, where the non-governmental sector and the general public demonstrated significant cross-border engagement and efficiency. However, results were less than satisfactory, which proves our hypothesis.

Methods used and partnerships set up

Qualitative research was carried out, which aimed to include as many relevant stakeholders in order to obtain an answer to the question of how communication and coordination of activities among countries is essential to solve the problem of land degradation. Floods in May 2014, that have affected the region have been extensively studied, in order to demonstrate the importance of cross-border cooperation in solving of the problem.

In order to obtain the actual state of the cross-border cooperation a desk analysis was carried out, which included processing of a series of documents about regional cooperation and communication. Scientific literature, numerous scientific paper and articles which were published after the disaster caused by the floods were also included as part of the desk analysis. As part of the research four focus groups were established whom included representatives from NGO's, governments, experts in the field of land and population affected by the floods. Every focus group was made up of five to seven participants who discussed which necessary steps and actions needed to be taken to prevent future floods and its catastrophic consequences. Observations and visits of the affected areas were followed by the formation of the focus groups. Apart from the above mentioned methods, two in-depth interviews were conducted with professors from the Faculty of Agriculture and Faculty of Forestry in order to obtain a scientific point of view.

The previous mentioned methods and analysis of the data led to the main conclusions presented in this paper.

Results

Bosnia and Herzegovina has been identified as a country affected by the problem of land degradation, and as a member of the UNCCD, has an obligation to include this issue in its strategic documentation and suggest practical solutions towards this problem. BiH and neighbor countries, Croatia and Serbia, were faced with unprecedented floods few months ago. The floods have firstly occurred on May 15th along the rivers with smaller catchments, and after that continued with an enormous inflow from the right-bank tributaries which lead to a fast increase of the Sava water levels in the bordering sections between BiH, Croatia and Serbia. The question is: what could have been done to prevent such a disaster, or at least to mitigate its effects? The one thing is certain, cross-border cooperation and timely communication between countries could help combating the catastrophe. Bilateral and multilateral cooperation is emphasized in the UNCCD (articles 11 and 12) as a basis for combating land degradation. This especially applies to less developed countries such as BiH. Cooperation between countries is also mentioned as of

great importance in the document "Framework Agreement on the Sava River Basin", where countries have agreed to establish a coordinated or joint system of measures, activities, warnings and alarms in the Sava River Basin for extraordinary impacts on the water regime. Unfortunately, it turned out that countries did not invest in the establishment and maintenance of such systems. Conservation of natural resources should be observed at the regional level, involving scientific expertise and capacities of all member countries of the region. The survey showed a strong need for exchange of knowledge and experiences, technology, scientific and technical resources, joint scientific and research projects whose implementation would achieve the result at the regional level.

Outcomes

Land degradation, regardless of the cause, is a global problem. In particular, land degradation caused by natural disasters has imminent negative environmental, economic and social consequences that may reach such proportions where they become not just one country's problem but for the whole region and beyond. Successful and functional regional cooperation and communication can have far reaching impact when it comes to reducing land degradation and repairing damage caused by natural disasters. On the other hand, disorganization and poor engagement of key stakeholders (government, non-government, private sector, the scientific community, the media and the public at large) and inefficient use of available communication tools and forms of cooperation can have long term negative impact.

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ESTIMATING SPATIAL PRODUCTIVITY OF A TEMPERATE FOREST OVER THE DISTRIBUTION AREA OF PINUS ARIZONICA AT THE NORTH OF MEXICO

MARTINEZ-SALVADOR, Martin (1); MATA-GONZALEZ, Ricardo (2); VALDEZ-CEPEDA, Ricardo-David (3)

1: National Institute For Forestry, Agriculture And Livestock Research, Mexico; 2: Oregon State University; 3: Universidad Autónoma Chapingo

martinez.martin@inifap.gob.mx

Rationale

One of the main needs for planning and management of forest species is predicting their growth in areas with heterogenous productivity because of differences in topographic, climatic and edaphic conditions. The estimation of forest land productivity has been traditionally performed by determining stand quality, based on the site index approach (Clutter et al.,1983). Site index depends on a variety of edaphic, topographic, climatic and biotic components (Pritchet, 1986). Thus, site index models might be utilized to identify the influence of ecological variables (climate, soil, topographic, etc.) upon development of the species, and this information could then be used to generate spatial models with GIS techniques. One of the greatest advantages of using GIS is the opportunity to add multiple criteria information, which permits to create spatial models for managing complex ecosystems (Ratsirarson et al., 1996). As a result, a better investment returns and more efficient management of natural resources can be obtained.

The objectives of this study were 1) to develop site index models for *P. arizonica* applicable to southern Chihuahua, Mexico and 2) to create a spatial model to display the landscape productivity for the target species.

Method

In order to create a spatial model of productivity for Pinus arizonica in the north of Mexico, we applied a method using a site index model (SI), a field sampling of soil, topography and climate variables, and geographic information systems (GIS). The study area is known as 'Guadalupe y Calvo', Chihuahua, Mexico. This region encompasses 904,000 ha and is located between 26º 41' and 25º 34' North latitude and from 106º 25' to 107º 42' West longitude.

We randomly selected 42 dominant and co-dominant *P. arizonica* trees from different growth conditions. Then, we carried out a stem analysis under the basis of the methodology proposed by FPC (1998). In order to fit the best model to build the site index curves, the Schumacher (Schumacher, 1939) and Chapman–Richards (Pienaar and Turnbull, 1973) equations were evaluated. These models were tested by using the Guide Curve (GC) and the algebraic difference methods in its anamorphic (ana) and polymorphic (pol) forms.

In addition, 220 plots of 1000 m^2 were sampled by using a 5 km systematic design over areas covered by *P. arizonica* within the study area (INF, 2010). Every site was georeferenced and then height and age of the dominant trees were noted in each plot. Moreover, registered soil depth (cm), gravel (%), slope (°), aspect (azimuth), and vertical dissection were also included to the database, and climate variables.

Using the best fitted model, we classified the 220 plots on three groups of productivity (high, medium and low) comparing the tree's data (height-age) of sampling sites with the selected site index model. Then, an analysis of variance (ANOVA) and a Tukey test ($\alpha = 0.05$) were performed using climate, soil, and topography considering each productivity level as a possible response. Finally the Euclidian distance was applied to compare the values of the significant variables of the highest level of productivity to the current values of the study area in order to identify the level of productivity, and create the forest productivity map.

Results

Both polymorphic and anamorphic forms showed higher values for calculated F than the GC models; therefore, they appear to be the best fitted models; however, the anamorphic and polymorphic models of Schumacher and Chapman-Richards obtained with the algebraic difference showed obvious growth pattern deviations with respect to the observed values for young trees and the best site index. And according to the graphical analysis the most adequate fit was associated to the Schumacher model employing the guide curve methodology. Residuals of this model do not show a trend. As a consequence, we used the Schumacher curve guide as the model to identify the productivity of each sampled site where the data of physical variables (soil, topography, and climate) were collected.

The results showed statistical differences among productivity levels for slope, vertical dissection, exposition, minimum and maximum temperature, precipitation, and soil depth. So in our study case, and as a strong result, the values associated to the high productivity level of *P. arizonica* through the selected Schumacher model used with the guided curve form were 12° of slope, 45 cm or more of soil depth, 234 m km² of vertical dissection, 5 °C and 18 °C of minimum and maximum temperature respectively, over 849 mm of precipitation, and north and northwest zenithal directions.

Once we classified the maps of each variable by using the Euclidian distance equation as an index of similarity, the final model of productivity was created. It shows the three productivity levels (Fig. 1). The estimated areas were 531,300 ha for low productivity, 342,100 ha for medium productivity and 31,900 ha for high productivity.

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NEXUS AMONG WATER, SOIL, FOOD AND BIODIVERSITY IN MEXICO

OSWALD-SPRING, Ursula

National Autonomous University of Mexico (UNAM), Mexico

uoswald@gmail.com

The linkages among water, soil, food and biodiversity (WSF&B) reduce human security from a dual focus as freedom from want and freedom from disaster impacts. Mexico has extended drylands where 77% of the people live and produce 87% of GDP, but receives only 31% of the precipitation. Mexico is also an oil exporting country with the fourth most important reserves of shale gas. Land-use changes, overexploitation of aquifers, chaotic urbanization and export agribusiness in drylands have increased the impacts of global environmental and climate change with severe soil erosion and biodiversity loss. The overexploitation of aquifers in coastal regions due to export agriculture in arid climate and a growing urban population have produced intrusion of sea water into the aquifers in several coastal areas. This intrusion is increasing the on-going salinization process in agricultural land, triggered further by higher evapotranspiration and evaporation due to climate variability. Less precipitation and longer and more intensive droughts are affecting also the natural cover of biota, but requires also more water for irrigation. Crop yields get reduced due to brackish water and soil get increasingly salinized, while the return water into aquifers raises further the amount of salt content in groundwater. This WSF&B nexus has increased both the social and the environmental vulnerability of the poor and often marginalized rural and urban populations and contributes to their human insecurity. Longer and more intensive droughts related to climate variability increase this dual vulnerability.

The paper addresses the following research question: How could the human security of the people be enhanced that are impacted by the nexus of the WSF&B with climate change impacts and sea water intrusion? To address this question the presentation is structured as follows: After an introduction into the human security concept, the WSF&B nexus is examined for Mexico. It addresses first the feedbacks between water and soil, land-use changes and food production and their impacts on biodiversity loss. Climate change with more frequent and severe droughts and rare flash floods have increased the costs in human lives and for the economy. The nexus among scarce water, overexploited and salinized aquifers, deforested areas, disasters, high food prices, and lack of rural support has raised poverty among vulnerable people. Furthermore, fracking activities may destroy the quality of aquifers and soils, thus limiting the potential to mitigate the impacts of climate change in drylands. This will reduce furthermore the governance and increase the risks of social uprising. The lack in governance requires from affected people bottom-up efforts for adaptation and resilience to increase their human security.

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QUANTITATIVE APPROACH TO CHARACTERIZE AND UNDERSTAND THE NATURE OF WIND EROSION APPEARANCE UNDER UNTYPICAL CONDITIONS OF UKRAINE WEST FOREST ZONE

KOLIADA, Valerij Petrovich; TIMCHENKO, Dmytro Olegovich

National Scientific Centre "Institute for Soil Science and Agrochemistry Research named after O.N. Sokolovsky", Kharkiv, Ukraine ", Ukraine

kolada@bk.ru

The aim

The aim of this study was determination of the wind erosion degradation processes that had spread in Volhynske Polissya (North-West part of Ukraine) region in the last decade under uncharacteristic conditions for this area such as long drought periods of high wind speeds, increasing pressure of agriculture activities on already partially degraded soils of light granulometric composure and drained organic soils (Myrka V.V., 2008). Use of drained soils for field crops and intensive grass farming is the most effective under conditions of significant restructuring drainage system lands. The aim of such drainage systems was disqualification of excessive amounts of water for irrigation of crops and simultaneously flooding prevent and siltation of adjacent areas, keeping them stable (satisfactory) under agroecological condition. But after the collapse of the former Soviet Union control over their support and position was suspended due to the limitations of funding, partial transfer of land into private ownership and the lack of scientific and environmental monitoring that provoked spreading of degradation processes (Prister B. S. and others, 1993).

Methods

Below there are some of the investigation methods that have been used by the degree of appropriate implementation of them: "in-site" mappers in the local spots with wind erosion risks and "off-site" modeling of soil samples resistance to wind in conditions of aerodynamic installation in NSC ISSAR, agrochemical and agrophysical analysis of soil parameters that form soil aggregates stability and make them inclined to wind erosion. Information about climate parameters (wind direction, duration and velocity, moisture, temperature, etc.).

Results

Received results show high correlation between wind velocity (critical) and equivalent diameter of soil aggregates (size) and amount of soil particles (>1 mm) (cloddinness). Modeling in aerodynamic installation provided us with information about possible wind erosion local processes during 2008-2012 that happened every year on drained organic soils (peats) under agricultural land farming. Indirect influence of climate factors was taken into account as a number of thawing-freezing cycles of soil surface in the cold periods of the year (Timchenko D.O. and others, 2014). The general list of soil types according to their resistance to wind was formed on the base of granulometric composure fractions of send (0,25-1,00 mm) that dominate in soils of this region. Due to this statistics of deflated lands soil erosion spots data are lowered.

Perspectives

According to obtained parameters and conditions during investigations it was recommended to exchange soil agrophysical information and modern technological materials with environmental and conservation organizations sending accordance with generally accepted initiatives to restore degraded lands and to prevent the negative processes in the nearest future.

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DESERTIFICATION - A THREAT WHICH CAN BE STOPPED

DEGODYUK, Edyard; DEGODYUK, Stanislav

Institute of Agriculture, Ukraine

degodyuk@mail.ru

Objective: To show the extent of natural and man-made desertification in terrestrial ecosystems on different continents, organize nature desertification associated with desertification (the expansion of deserts) and desertysation (expansion of the range of the desert on the spot) and develop renewal technologies of deserted lands through complex environmental landscape programs with including of plant-techniques and reclamation technologies based on energy and water provision by natural resources.

Methods used: In the study implementation the methods were used a systematic approach to the problem of desertification, assess the extent of desertification directly in Ukraine and in the world.

Results: Comprehensive program for semi-arid areas and deserts provides artificial agrocenoses creation on types with from the surface drained by shielding. We can create solid maas for continuous cultivation of crops and the introduction of technologies and planting of trench type for fruit, ornamental and conservative trees and shrubs. We grounded the independent solution of energy and water problems in arid areas in our integrated project "Oasis" acting under artificial agrocenoses in arid zones, on the basis of closed cycle. The essence of the solution of energy supply is to create a set of equipment for the accumulation of solar energy. In a reactor built on the principles of absorption of solar energy, Ukrainian scientists used a number of "know-how", which increases the utilization of solar energy to 65%, this is significantly higher compared to alternative methods of converting solar energy and the cost of 1 kW / h. does not exceed 0,1-0,07 cent.

Water supply in arid zones - the main condition for farming. In this project it is solved by creating special facilities for condensation of water vapor suspended in the air. To do this, we use the energy obtained by forming heat-accumulated materials from solar radiation. A fundamentally new technology is worked out to extract from air clean water capacity 2400 liters/day of energy consumption 95 kW / h. The technology allows obtaining condensation at high ambient temperatures, which is especially valuable for arid zones. Due to savings termotransformations of heat the market price of water obtained in this equipment, ranging 3,5-10,5 dollars per 1 m3. A closed cycle of energy and water supply on created agrosoils will allow - to grow agricultural products in a closed loop without creating of additional infrastructure and will mark a breakthrough in combating with desertification. Contamination of land in the oil mining regions of the Earth's interior is associated with casting of oil and formation of oil sludgestorades. With the development of our technology for oil contaminated sites is a complex program of remediation which is carried out, depending on the nature of contamination, by conducting of planting and technical works and agro, chemo-, biological and fitomeliorations. Back to reproduce biomes - 1-2 growing season. Biodegradation of oil studies in the landfill carried out by homogenizing with the bacteria - Biodestructors and other fillers for 6-12 months, whereas in vivo it is necessary to 200-300 years. The process of biodegradation is the breakdown of carbohydrates into simple compounds with possible subsequent conversion destructed oil sludges to safe fertilizer under our technology. An integral part of creating of agrosoils and their development is the production of bioactive organic-mineral fertilizers on our technology, the advantage of which is environmentally friendly, presence of humate, reclamation sorption and biotic framework that provides high efficiency by on the base of bringing them under crops in doses of 1-2 t / ha. Their production can be natural (sapropels, peat, lignite, etc.) and anthropogenic (manure, poultry manure, compost) compounds from both conventional and organic farming.

Prospects: Comprehensive implementation of these technologies will be noticeable contribution to the idea of a "green revolution" because the problem of desertification is a real threat to modern society in the nearest future. The united team of Ukrainian scientists, with the necessary financial support for the project, can take over the functions of the development model of "Oasis", and remediation of oil-contaminated land and biodegradation of oil sludges in any country of the Arabian Peninsula and North Africa. Prospects of the project realization are to analize the objects to identify the nature of desertification or pollution, making the necessary analytical work and the development of specific methods and technologies of development of arid lands or rehabilitation of contaminated land. Model objects after their cultivation will serve for replication elsewhere with the author accompanied to take account of local conditions.

1. Diagnosis of constraints

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AEOLIAN DESERTIFICATION AND ITS CONTROL IN NORTHER CHINA

WANG, Tao

Chinese Academy of Sciences, China, People's Republic of

wangtao@lzb.ac.cn

Aeolian desertification is land degradation through wind erosion mainly resulted from the excessive human activities in arid, semiarid and part of sub-humid regions in Northern China. To compare the analyses results of remote sensing data in late of 1950, 1975, 1987, 2000 and 2010, we can summarize that the development of aeolian desertified land in Northern China had being accelerated for 5 decades, as its annual expanded rate was 1,560 km² during late of 1950 and 1975, 2,100 km² between 1975 and 1988, 3,600 km² from 1988 to 2000 and -1375 km² from 2000 to 2010. The whole situation of desertification comes to be depraved before 2000 and to be improved after 2000.

The human impact is much more active than natural one on the process of aeolian desertification which mainly incarnates on the changes of the landuse fashion (from rangeland to farmland) and enhance of landuse intensity (over-cultivation, over-grassing and over-fuelwood collection). The natural vegetation had been destroyed by the human activities that had accelerated to the development or/and control of aeolian desertification. China has made much progress in understanding and combating aeolian desertification through many efforts for decades and there were many projects have been carried out. One of among them is the National Project of Grain for Green Program and 1060 counties in 22 provinces have been included into this project. The objective is to withdraw 3.67 million ha of dry land farming and degraded steppe, and 5.13 million ha of aeolian desertified land suited to reforestation and revegetation will be rehabilitated. There are about 8 million ha of lands under the threats of aeolian desertified land will be brought under control in the next ten years and 26.67 million ha of windbreaks will be planted. The total financial input is estimated to 75 billion Yuan (11 billion US$) what is entirely from the central government.

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CONSERVATION AND RECONSTRUCTION OF THE OASIS ECOSYSTEM OF LOIYANGALANI - PROJECT TO COMBAT DESERTIFICATION AND FOR WATER RESOURCES MANAGEMENT - TURKANA LAKE, LOIYANGALANI DISTRICT, MARSABIT COUNTY

VALLERINI, Lorenzo (2); BUONO, Nicoletta (1); FALQUI, Alfonso (3)

1: Veterinaires Sans Frontieres - Germany (VSF-G), Kenya; 2: University of Florence; 3: Water Right Foundation

vallerini@archlandvallerini.com

Rationale

The Oasis of Loiyangalani (391,000 hectares with about 10,000 inhabitants) is a closed ecosystem in a barren land area with sterile soils, much warmth and strong winds, which is part of a wider water system that recollects surface and underground Mount Kulal's waters and drains them through the arid area around the mountain to the final receiver, the Turkana Lake. Unfortunately the great mass of water of Turkana Lake is unsuitable for drinking and irrigation due to the strong alkalinity of water.

The Oasis itself constitutes a fundamental habitat for the livelihoods of pastoral communities as well as being a first outpost for the monitoring of the ongoing desertification process and all related climate changes. This habitat is extremely fragile; soil, water, and vegetation are strongly interlinked factors and the absence or reduction of any of these factors negatively affects the others. This vicious cycle amplifies continuously soil and vegetation degradation and biological impoverishment. This project aims at the reconstructing of the Oasis habitat by starting an *Oasis Effect* with the establishment of a sustainable virtuous cycle which will invert the desert effect, by the re-creation of the oasis microhabitats contrasting the ongoing desertification process.

Methods used and partnership set up

The Research Study and a Feasibility Project *"Conservation and Reconstruction of the Oasis Ecosystem of Loiyangalani"* (2008-2010) faces the three main problems related to the desertification such as Water, Soil and Vegetation, using wherever possible, local traditional knowledge[1]:

1- To protect and to reconstruct the Oasis ecosystem as a key factor in order to combat desertification;

2- To realize prototypes of "new vegetation" to expand the Oasis, to increase food production for the local populations and to supply new areas of "pasture" for local livestock. Livestock farming is the main livelihood in the area and livestock grazing is one of the main causes of land degradation in the oasis;

3- To develop water resources available both for potable and irrigation purposes;

4- To support local population in the realization and management of water resources, the area-prototype and other areas for new vegetation.

The aforementioned actions are the starting point for local people that, once acquired techniques and construction capabilities, will have the skills and knowledge to scale up the intervention to expand the Oasis Ecosystem, now in progressive depletion, and to develop a truly sustainable economic and social development.

A key role in the process of empowerment of local populations is played by information and education activities on various relevant themes.

Results

The study conducted led to the development of a technical project that was integrated in development project in a consortium led by VSF Germany and funded by the EU. The project is going to be implemented from 2014 to 2017.

The technical project encompasses the following component:

OASIS RECONSTRUCTION

Reconstitution of different oasis environments: Production of compost (soil biological re-activation) - Construction of dry stone walls for wind/animal protection and moisture retention and an irrigation network (ground canals).

Introduction of best practices for efficient use of water and for moisture retention.

Pilot cultivation for animal pasture with *Vetiveria zizanioides* Linn, a not invasive grass, suitable for animal feeding.

Plant growing nursery and M&C centre: establishing an efficient nursery for the on-site growing of all the species (grass, bushes and trees) with an indoor planting nursery, a compost plant and an outdoor planting nursery for the growing of food and health integration plants.

IMPROVE WATER ACCESS

The assessment conducted allowed to clarify the situation of aquifers in Loiyangalani and to find the proper area for drilling selection taking in consideration the quality of water (potable) and availability of water all year round.

AWARENESS RAISING AND COMMUNITY ENGAGEMENT

Vocational training with scholarships to selected members of Nanyori Group, local CBO, in order to improve local technical skills and knowledge in the fields of Agronomy, Botany, Techniques cultivation and nursery management, PC operation and ICT.

Ensuring strong community ownership through a series of events raising community awareness on the importance of oasis reconstruction, vegetation growing, planting nursery. The action has been identified by Kenya NDMA[2] as a pilot experience and possible model replicable in other similar contexts in arid and semiarid areas in North Kenya.

[1] Promotion of Traditional Knowledge - The United Nations to Combat Desertification, 2005

[2] National Drought Management Authority

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WIND EROSION QUANTIFICATION AND MOVING DUNES IMPACTS IN THE SOUTH EAST NIGER

ABDOURHAMANE TOURE, Amadou (1); RAJOT, Jean Louis (2); TIDJANI, Adamou Didier (1); MARTICORENA, Béatrice (3); GARBA, Zibo (1); MAMADOU DABOUA, Mahamadou (1)

1: Abdou Moumouni University, Niger, JEAI-ADE; 2: IRD - IEES Paris; 3: CNRS - LISA

doudu2000@yahoo.fr

Introduction

In the south-estNiger, activities of the population are dominated by traditional pastoralism and agriculture develops on sandyhill soils. The region is characterized by a continuousdegradation of soil structure by wind erosion. The most productive soils lost more than a quarter of their surface in twenty yearsbecause of wind erosion witch transform cultivated area to moving dunes (Tidjani, 2008). However on the cultivated area and moving dunes of this locality, there isn't a quantitative measurement of wind erosion allowing understanding and organizing the fight of the desertification of this semi-arid zone.The present study was conducted on traditional cultivated fields, grassland and moving dunes and aims to characterize quantitatively wind erosion in the south-est Niger on the types of encountered surfaces. Specifically, it aims to determine the optimum period of dunes movements and the wind in cause.

Materials and methods

Studied site

The studied siteis located close at Kilakina (13°42'N; 10°45'E) a Nigerien village located approximately 1250 kmeast of Niamey.The soil is extremely sandy. As a result, surface roughness isessentially controlled by the annual millet crop cycle on cultivated area and weeds on grassland. This vegetation is linked to theclimatic cycle in this semi-arid zone with less than 300mm of annual rainfall.the soil Cover is determined using photographs.

Meteorological parameters

Masts equipped with 4 anemometers, a weather cock and a tipping bucket rain gauge havebeen implanted in the cultivated area in 2012 then in the grassland in 2013 and 2014. Aerodynamic roughness length Z0 is derived from the verticalwind speed profile (Zobeck et al., 2003) on the two surfaces. It corresponds to the height at which wind speed becomes zero. Indeed, erosion threshold tends to increase when the aerodynamicroughness length increases (AbdourhamaneTouré et al., 2011).

Horizontal flux measurement

Horizontal or saltation flux was monitored using three Big SpringNumber Eight sand traps (BSNE) (Fryrear, 1986) mounted on poles atheights of about 10, 25, and35 cm, i.e. in the saltation layer.

Results

Meteorological parameters

The first rains occur in the Monsoon season, generally after the endof May. Rains have an extremely temporal and spatial variability. Aheadof these systems, extremely high wind speeds (more than 15m/s) are responsible forsudden and intense erosion events of very short duration (10 to30 min).Wind speeds do not present aseasonal dynamic as marked. The maximum daily average of 5 min windspeed is regularly higher than 7 m/s, and the strongest wind speeds occur mostly at the beginning of the Monsoon season from May tomid-July.

The vegetative cycle and aerodynamicroughness (Z0)

Vegetative cycle can be monitoring by the Z0 evolution. On cultivated field, Z0 very weak ~10^{-4}m while the wind speeds is higher. It increase from July with the growth of millet plants and it reaches its maximum 10^{-2}m in September. On grassland, Z0 still higher than on cultivated field. From September to Jun Z0 decrease in order of the decrease of the soil cover by weeds and reaches its maximum in August-September ~10^{-2}m. The aerodynamic roughness of the moving dunes is like from a bare soil ~10^{-6}m.

Dynamics of wind erosion

Wind erosion occurs particularly between May and July while 80-90% of saltation fluxes were recorded on cultivated field and grassland. Figure 1 shows an intense erosion period from May to mid-July, which corresponds to the beginning of therainy season. This Aeolian erosion period can be explained by the occurrence of extremely intense winds.

Wind erosion intensity strongly decrease from August. In the dry season (October – May) wind erosion is almost nil. On cultivated field wind erosion is higher in 2012 (~1000kg/m.yr) than in 2013 (~400kg/m.yr). This observation is right for grassland. On this surface wind erosion intensity is more than two fold lower than on cultivated field.

Close the foot of dune, the dynamic of wind erosion intensity is like on the grassland or cultivated field by it still more than four stronger than on cultivated field. It appears that the monsoon wind is the most agents of dunes moving particularly at the beginning of the rain season (Jun-September). However wind erosion intensity is most high close the top of moving dune even in the dry season. At this place the dune movement can occur all year.

Conclusion

- Aerodynamicroughness of cultivated field and grassland developed on sandy hill soil from south-est Niger is weak, less than 10-2m at its maximum.
- Wind erosion intensity has an intra annual variability on cultivated field, grassland and moving dune. It occurs between May to July in relation with the Mesoscale Convective System.
- Grassland and cultivated field were eroded essentially during May to july.
- On moving dune, wind erosion had a temporal and spatial variability. It appears that the foot was eroded particularly between May and july while the top can be eroded all the year.

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FOREST ECOSYSTEM RESILIENCE AND RAINFALL VARIABILITY ANALYSIS, A BRIDGE BETWEEN CLIMATE CHANGE AND DESERTIFICATION PROCESS ASSESSMENT, THE CASE OF MADAGASCAR

RAKOTO RATSIMBA, Harifidy (1); RATOVOSON, Arimino Aina Navale (1); RAKOTO, Percy Yvon (1); RAVOKATRA, Tovo (1); RABENILALANA, Mihajamanana (1); RAMAMONJISOA, Bruno (1); BOGAERT, Jan (2)

1: Département des Eaux et Forêts de l'Ecole Supérieure des Sciences Agronomiques, Université d'Antananarivo, Madagascar; 2: Unité Biodiversité et paysage, Gembloux Agro-Bio Tech, Université de Liège, Belgique

rrharifidy@moov.mg

Rationale

Remote sensing-based approaches provide a wealth of opportunities for the monitoring of the Earth's surface. One such opportunity is the monitoring of vegetation, which represents the main component of the terrestrial biosphere and a crucial element in the climate system (Foley et al., 2000). In Madagascar, with more than 5% of world's biodiversity, the monitoring of forest ecosystem is one of the most important challenges for a sustainable natural resources management ay national scale.

This study is a national upscale of a pilot study done in the South eastern part of Madagascar where NDVI has been used to track the "behavior" of forests in response to rainfall variability. However, this pilot study has been done in more specific conditions with dry and transitional forests and the upscale has to consider not only wider areas but also more complex and variable conditions in terms of climate and forest ecosystem.

Materials and Methods

In this research, chlorophyll activity or greenness is measured using the NDVI based on remotely sensed MODIS images (reflectance and NDVI derived images) with 1km spatial resolution. Such moderate resolution is used to fit with the climate data resolution. NDVI is used for this purpose in a way to enhance the vegetation signal, while minimizing solar irradiance and soil background effects (Jackson and Huete, 1991). Two MODIS images per month are used from 2000 to 2014 with a combination of monthly rainfall spatial data and monthly maximum rainfall. The seasonal variability is also assessed in order to consider changes in photosynthesis level linked with seasonal and inter-annual changes in precipitation (Weiss *et al.,* 2004). All forest ecosystems of the country have been assessed particularly humid forest, dry forest, spiny forest, transitional forest and spiny bushes.

The satellite images were acquired at different dates for different seasons for phenological changes analysis. Images correction procedure followed three steps: radiometric, atmospheric and geographic corrections.

A land use map has been created for a consistent definition of the different forest classes. Two images of 2013, one on wet and one on dry season with no clouds were chosen as reference map with ground truthing procedure. Semi-supervised classification (pixel spectral characteristics oriented) was carried out on those images, a combination of unsupervised and supervised classifications.

Besides spectral characteristics, the images have been also processed with an indirect measure of vegetation growth through the calculation of vegetation indices. NDVI is determined by the degree of absorption by chlorophyll in the red wavelengths, which is proportional to leaf wavelength density, and by the reflectance of near infrared radiation which is proportional to green leaf density. This index is physiologically a measure of the photosynthetic capacity of the canopy and bulk stomatal or canopy resistance to water vapor transfer (Tuckers and Sellers, 1986). This relationship can help to determine the sensitivity of various vegetation forms to climate variability.

Results and Discussions

In all seasons and for each class, NDVI values decrease from humid to drier ecosystems (from humid forest to spiny bushes). This shows that net primary production and greenness of the vegetation vary with the type of ecosystem. The response of the vegetation to precipitation varies between geographical regions and the type of the vegetation (Li *et al.,* 2004). The average NDVI shows low amplitude of NDVI values in the humid forest unlike the dry and spiny bushes. For the spiny bushes, dry and transitional forests, NDVI is significantly correlated with accumulated rainfall over two months (current and previous month). For the humid forest, there is a limit of amount of rainfall corresponding to a given vegetation index. From the threshold of 1000mm of rain per year, the relationship between NDVI and rainfall becomes logarithmic because of the saturation of the index (Nicholson et al., 1990).

These results confirm that vegetation greenness in semi-arid environments is strongly related to soil moisture, a function of rainfall accumulated over a period of time, than to instantaneous rainfall. This is also why there is a correlation between rainfall of the first previous month and NDVI. The soil plays a role as a water reservoir despite its capacity is limited in dry situation. The results clearly show that all transitional forests tend to have the same "behavior" and are more vulnerable to long "no rain" period and may give more areas for the development of more resilient ecosystem as dry forest and spiny bushes.

Outcomes

This research gives a better understanding of the changes that happen in forest ecosystem linked to the rainfall variability and shows the effects that have changes on climatic parameters of vegetation dynamics. These changes may affect the biodiversity but also the local communities' livelihoods and resilience and has to be used as a tool for policy makers.

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LAND-USE IMPACTS ON PLANT DIVERSITY AND CARBON STORAGE AT ITAPARICA RESERVOIR, NORTHEAST BRAZIL

ALMEIDA-CORTEZ, Jarcilene (1); SCHULZ, Katharina (2); SENA, Fernando Henrique (3); TAVARES, Fernanda Meira (4); LUSTOSA, Bruno Melo (5); OLIVEIRA, Déborah Alani (6); CIERJACKS, Arne (7)

1: Universidade Federal de Pernambuco, Brazil; 2: Department of Ecology, Technische Universität Berlin, Germany; 3: Programa de Pós-Graduação em Ecologia (PPGE), Universidade Federal Rural de Pernambuco Recife, Brazil; 4: Programa de Pós-Graduação em Ecologia (PPGE), Universidade Federal Rural de Pernambuco Recife, Brazil; 5: Programa de Pós-Graduação em Biologia Vegetal (PPGBV), Universidade Federal de Pernambuco, Recife, PE, Brazil; 6: Programa de Pós-Graduação em Biologia Vegetal (PPGBV), Universidade Federal de Pernambuco, Recife, PE, Brazil; 7: Biodiversity of Useful Plants Working Group, Biocenter Klein Flottbek, University of Hamburg, Hamburg, Germany

jacortez@ufpe.br

Rationale

The Innovate Project aims to develop scenarios for sustainable use of water and soil, associated with energy production in semi-arid regions. In particular, the project intends to reduce the impacts of climate change within the model area of Itaparica reservoir, submedium São Francisco River. Biodiversity and carbon sequestration are ecosystem services which are expected to mitigate the consequences of land use and climate change (Millenium Ecosystem Assessment 2005). As the impact of different land-use options on these ESS is not sufficiently investigated yet, this study relates different land-use options to plant diversity and organic carbon (OC) storage in vegetation and soil of ecosystems near the Itaparica Reservoir. Furthermore, land-use impacts on the population ecology of key species are analyzed. Overall, the work aims at the development of adapted land-use options which are climate- and biodiversity-friendly and which should be implemented in the study region.

Methods used and partnership set up

The study design covers different land-use intensities from preserved tropical seasonally dry forest to heavy grazed forest and agricultural land. For the analysis of plant biodiversity and OC sequestration within the Caatinga, 45 permanent plots were established. Furthermore, a water availability gradient was included by stratifying the area into three classes. On each plot, grazing intensity was quantified by counting and weighting animal faeces and measuring the area of livestock trampling. All perennial and herbs species found on the plots were recorded to assess species biodiversity. OC storage in above-ground biomass was assessed within the same study design. For the calculation of carbon stocks, allometric biomass equations were used (Sampaio Silva 2005, Sampaio et al. 2010). Soil samples were taken on each plot to analyze soil carbon stocks. On 44 plots within agricultural land, all herbaceous and woody species as well as their abundance was recorded, soil and aboveground carbon stocks were measured accordingly. These studies where supplemented by analyses on the soil seed bank and on root architecture.

Results

The results show a detrimental impact of heavy grazing on woody plant diversity. However, both the distance to the next water course showed a significant positive correlation with alpha-diversity measures. On agrarian land typical caatinga trees and shrubs were only found at the margin of coco and banana plantations. In parallel to woody plants, species number of herbs declined along the grazing gradient. Monthly biodiversity assessments revealed that the herb species number is highest at the end of the rainy season. In contrast, irrigation farming causes a permanent species-rich herb layer. There was a marginally significant positive correlation of species richness in the plantation margin and crop yield which highlights the relevance of ESS provided by the herb layer. This result shows that crop production and biodiversity conservation are not necessarily antagonistic but might also be mutually supportive. The analysis showed that grazing had a significant negative effect on the biomass of woody plants, herbs and bromeliads. The analysis of soil samples showed mean OC stocks of 16.8 t ha^{-1} in the study area. However, grazing led to a significant reduction of soil carbon in this part. The regeneration of the main tree species is not affected by grazing. In all grazing classes the number of young individuals was

sufficient to maintain and possibly increase the current population size. Other species, however, exhibited a striking lack of regeneration. The population of the wild fruit tree *S. tuberosa* nearly exclusively consisted of old trees and seedlings were very scarce irrespective of the land-use regime, presumably due to climatic or genetic reasons. The seedlings of *A. pyrifolium* grew better in the treatment of 9:1, caatinga soil mixed with fish tank sediment. Livestock may contribute to species diversity by seed dispersal through endozoochory. A study on viable seeds in goats faeces indicates that mainly the non-native tree species *Prosopis juliflora* is dispersed by goats. Consequently, current land use may contribute to the spread of nonnative species in the study area.

Outcomes

Based on these results, a conversion of Caatinga to high-intensity grazing is expected to cause pronounced losses of biodiversity and OC stocks. To mitigate negative consequences of climate change through a high vegetation cover, grazing should be performed at low animal loads. Reforestation measures for endangered tree species such as *S. tuberosa* should also be implemented. Conversion to agrarian land should furthermore aim at a sustainable production of permanent crops (coco, banana, fruits) which includes avoiding herbicide and preferring organic fertilizer (goat manure). Both proved neither to be related to losses in yield and food security nor to losses in OC stocks. In addition, field margins play a major role for agrarian biodiversity and should be preserved. This seems promising to increase the climate-change resilience of the study area and is part of our implementation strategy.

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EFFECT OF DROUGHTS ON THE ECOSYSTEMS IN THE CARPATHIAN REGION

SZALAI, Sandor

Szent Istvan University, Hungary

szs14@hotmail.com

Rationale

Carpathians are the second largest mountain in Europe. The mountains are rather low, and the total area of the region is about 200000 sqkm. They are characterized with high variability of the climate caused the influence of the Atlantic Ocean, Mediterranean Sea and the Eurasian continent. The region has unique ecosystems and high biodiversity. Recently, three projects were founded by the European Union to develop a basis of further research. These actions are the inputs of the Working Group on Adaptation to Climate Change of the Carpathian Convention. The members of the Convention are countries having Carpathians on their territory. The Working Group developed and accepted a Strategic Agenda to adapt to the changing environmental conditions and protect the human and natural systems from degradation processes.

Methods used and partnership set up

Three projects have been launched to investigate the Carpathians:

- Climate of the Carpathian Region (CARPATCLIM)
- Integrated assessment of vulnerability of environmental resources and ecosystem-based adaptation measures (Service contract CARPIVIA)
- In-depth assessment of vulnerability of environmental resources and ecosystem-based adaptation measures (Framework contract CarpathCC)

The CARPATCLIM project created a harmonized, freely available gridded climatological database for 1961-2010, with spatial resolution of 10*10 km, and a daily temporal resolution. The database contains more, than 50 elements, parameters, among others several drought indices as well. Therefore, drought investigations and mapping are supported by this project very well.

CARPIVIA project summarized the situation of adaptation and vulnerability of ecosystems in the region. The investigated ecosystems are the non-agricultural grasslands, forests and the wetlands. One of the output pf the project is the recognized gaps of the vulnerability researches.

CARPATHCC filled the gaps recognized by the CARPIVIA project. 6 special requests were described, except the ecosystems mentioned above, water and tourism were investigated individually.

CARPATHCC prepared a short list of the most efficient adaptation measured and the one or two most important ones have been chosen for each investigated ecosystem types.

Results

A gridded climate database of the Carpathian region has been created. The input information are 9 national database, which were harmonized and applied the same homogenisation and data quality control (MASH) and interpolation and gridding software (MISH). The calculated indices make the applied research easier. The more than 50 meteorological elements and indices in daily resolution gave a unique possibility to use the same climate data for any kind of research in the region. In the frame of CARPIVIA/CARPATHCC projects, more than 300 adaptation measures were collected and evaluated. From these, a short list of less than 20 measures was created, and 1-2 measures were tailored by each ecosystem types. Furthermore, vulnerability investigations have been conducted mainly based on experts evaluation and discussions. The vulnerability map of the Carpathians on water, forests and tourism have been produced.

The Working Group used these outputs and created a Strategic Agenda accepted by the COP4 of the Carpathian Convention. This Agenda contains overview on the climate situation of the region (past, present and future), the affected sectors, cross-cutting issues and suggested actions.

Outcomes

It is expected, that the most important, developed in detail adaptation measures will be investigated further and their evaluation will be supported. The follow-up activity of the climate will support more applied activities, involving information about soil parameters (first of all humidity) into the database.

The Strategic Agenda should be realized according to a timetable for the next period of the activity of the Convention. This co-operation makes possible even for the countries with smaller territories to estimate the natural effects on the national natural resources according to their distance of action.

The cooperation of many small countries has a real synergetic effect, because the common territory is already comparable with the dangerous characteristic of natural disasters involving transboundary catchment areas, larger meteorological events and area of extreme values.

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METROPOLITAN AREAS IN MEXICO, THEIR CURRENT LAND DEGRADATION AND FUTURE CONSIDERATION

MONTERROSO RIVAS, Alejandro Ismael (1); GOMEZ DIAZ, Jesus David (1); LECHUGA GAYOSSO, Lizeth Margarita (1); GARCIA RODRIGUEZ, Jorge Luis (2); VILLEGAS FLORES, Joel (2)

1: Departamento de Suelos, Universidad Autónoma Chapingo, Mexico; 2: Direccion de Suelos, Comision Nacional Forestal, Mexico

aimrivas@gmail.com

Metropolitan areas combine an urban agglomeration with surroundings zones not necessarily urban. In many cases, the regions around the cities are those that provide resources (food, drinking water) to the population that lives there. In order to evaluate the above consideration in Mexico, the current state in the surroundings lands of major cities in the country, we selected 12 metropolitan areas. The study considered 146 municipalities forming metropolitan areas as follow: Aguascalientes (3), Chihuahua (3), Guadalajara (8), León (2), Mexicali (1), Monterrey (13), Puebla-Tlaxcala (25), Querétaro (4), Tijuana (3), Tuxtla Gutierrez (3), Valle de Mexico (76) and Veracruz (5). Each area was intersected with the land degradation and desertification cartography developed by the National Forest Commission in Mexico (CONAFOR). Then, we remove the areas covered by each urban infrastructure (houses, streets, buildings, etc) and take into consideration only the areas that have not yet been completely urbanized. The main goal was to evaluate the current state of this not urbanized area, as providing sources of food and water resources to main cities in the country.

The main results show the following land degradation in each metropolitan area (in percent): León (89.9), Aguascalientes (89.6), Mexicali (80.3), Tuxtla Gutierrez (77.8), Tijuana (72.5), Querétaro (64.8), Guadalajara (55.2), Monterrey (53.7), Chihuahua (50.8), Valle de Mexico (45.5), Puebla-Tlaxcala (9.7) and Veracruz (0). It is important to remember that dry lands of Mexico covers 65.3% of the country and 59.2% is been effected by desertification. Also that 12 metropolitan areas cover just less than 3% of the country surface but holds 35% of the total population. The national degradation and desertification study incorporate biotic, edaphic, hydric and climate components using the most limitative criteria or factor as integration method. Focusing in edaphic variables Mexicali, Tijuana, Chihuahua and Tuxtla Gutierrez are the most affected. Focusing in hydric variables, Leon, Aguascalientes, Querétaro and Valle de Mexico are the cities with more degradation. In biotic resources degradation Tuxtla Gutierrez, Monterrey, Tijuana, Guadalajara and Queretaro are the most affected. According to the last population census by INEGI (2010) in the 12 metropolitan areas lived 39.8 million inhabitants (35% of the country) but considering the 2030 future scenario by CONAPO will live 46.5 million people (38.8%) in the same metropolitan areas. For future consideration all urban areas in the country should start taking care of natural resources (soil and water) of land around the urban areas.

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CARBON STORAGE SYSTEMS IN THE REGION OF THE MOUNTAINS, VERACRUZ, MEXICO

VALDES-VELARDE, Eduardo (1); CUEVAS-TREJO, Sarahi (1);
LOPEZ-VELASCO, Melina (1); ORDAZ-CHAPARRO, Victor Manuel (2);
AYALA-ARREOLA, Juan (1); JUAREZ-HERNANDEZ, Maria de Jesus (1);
GUTIERREZ DEL POZO, Diego (3); GALLARDO-LANCHO, Juan Fernando (4)

1: Universidad Autonoma Chapingo, Mexico; 2: Colegio de Postgraduados, Mexico; 3: Universidad Estatal Amazónica, Ecuador; 4: Consejo Superior de Investigaciones Cientificas, España

velarde@correo.chapingo.mx

The removal of emissions of greenhouse gases by biomass accumulation and / or soil in terrestrial ecosystems is a way to mitigate climate change. The coffee agroforestry systems have a high potential for carbon sequestration (C) due to the diversity of woody species used as shade. The aim of this study was to determine the C stored in aboveground biomass and soil in two coffee commercial polyculture (TT-02-PCO and PCO-ZI-03), three traditional polyculture coffee (04-PTR-TH, 05-PTR-06 and CH-PTR-ZI), a pasture land (POT-01-CH) and a mountain cloud forest (07-BMM-CH) in the region of Mountains, Veracruz. The treatment had the highest content of C in the plant component was 07-BMM-CH with 248.4 Mg • ha^{-1}, and the lowest content POT-01-CH • with 5.5 Mg ha-1.

Coffee Commercial Polycultures TT-02-PCO and PCO-ZI-03 showed the highest and lowest content of soil C and 80.9 to 165.6 Mg • ha^{-1}, respectively. Regarding the total C 07-BMM-CH had the highest content with 356.3 Mg • ha^{-1}, followed by this are presented from highest to lowest agroforestry coffee systems: 04-PTR-HT 244.7 Mg • ha^{-1} 02-PCO-TT to 207.7 Mg • ha^{-1} 05-PTR-CH with 195.4 Mg • ha^{-1} 03-PCO-ZI with 172.4 Mg • ha^{-1} 06-PTR-ZI with 166.34 Mg • ha^{-1}y last 01-POT-CH with 160.6 Mg • ha^{-1}. Of the evaluated systems is concluded that the natural forest (07-BMM-CH) was the best to store carbon.

ENVIRONMENTALLY SENSITIVE AREAS TO DESERTIFICATION IN THE WATERSHED SAN ANDRÉS AZUMIATLA, PUEBLA, MEXICO

TAMARÍZ FLORES, José Victor (1,2); CASTELÁN VEGA, Rosalía (2);
LÓPEZ TELOXA, Citlaly (2); CRUZ MONTALVO, Abel (1)

1: Benemérita Universidad Autónoma de Puebla, Mexico;
2: Posgrado en Ciencias Ambientales ICUAP

jose.tamariz@correo.buap.mx

Desertification is a type of degradation that currently threatens the sustainable food production at the global level; Mexico is one of the many countries affected by this type of degradation and the State of Puebla is no exception to this national problem. We assessed the watershed of San Andrés Azumiatla, Puebla, Mexico, which defined the environmentally sensitive areas to desertification (AASD), grouping the indicators in four qualities that define the quality of the soil, climate, vegetation and management. The results show that 89% of the area presents critical of desertification sensitivity levels, while 7% potential, and only 5% are not affected. Being overgrazing, the steep slopes, very poor natural vegetation and intensive annual crops, causes that promote the degradation of the land

Session 1.2: Environmental and ecological set up

GEOCHEMICAL AND MINERALOGICAL APPROACH TO SOIL AND WATER POLLUTION CONTROL IN MINING AND FLOODS AFFECTED AREA IN THE DRINA RIVER BASIN

GRUJIC, Gordana

Oasis Association, Serbia

gordana.grujic@eunet.rs

Introduction

Desertification and land degradation rank among the most serious threats to sustainable development on the global scale because of its influence to reduction and/or loss of the biological and large productive capacity of existing land resources as well as to migration of the population from areas affected from both droughts and floods.

In the last two decades, the area of Serbia is affected by land degradation and desertification due to the variability of the different scenarios of climate change (global / regional) referring to reasonable prediction of increased frequency of extreme climate events in the future. In the eastern Serbia a large number of drought years have been registered (the period from 1980 to 2012) due to deficit of rainfall and intense heat waves occurrences. On the other side, the frequent occurrence of flash floods due to heavy rainfall in short period of time are specific to the central, south and western part of the country.

Apart of natural causes of land degradation, industrial development brought a new set of erosion risk including mining operations, tailings of active and abandoned mines and other type of industrial landfill and municipal wastes disposal sites which can cause dissemination of toxic and harmful compounds into the soil and waterways.

The paper presents the situation of the affected area of the Drina River Basin caused by mining activities and the consequences of the floods that have an additional influence on spreading harmful and toxic elements and land degradation, along with cases of natural materials such as clay barriers and sorptive minerals that play an important role in the pollution control in the geological- geochemical environment.

Rationale

According to the latest estimates from 2009, the erosion processes of various type and intensity have engulfed almost the entire territory of Serbia. Stronger erosion (I-III categories) covered 23.81% of the total area affected by erosion, and the most vulnerable areas occupy 3.76% of the territory of Serbia (SEPA Report, 2010) including Drina River Basin in the western Serbia. Landslide risk is considered to be particularly high in western Serbia (area of Krupanj). Drina River Basin is one of the most important water resources in the Balkans, which extends in the western part of Serbia (30,5%), eastern part of B&H/Republic of Serbia (37%), south western part of Montenegro (31,5%)and Albania (1%). Average discharge rate of the Drina River at the confluence is approx 400 m3/s. Currently around 3,3 – 4 m^3/s of water is used for water supply in the Drina River Basin area, while industrial facilities use the water of about 5 m3/s from the basin for their plants.

Multi-year average precipitation is about 1,100 mm, and ranges from 700mm in the northern part of the 3000 mmm in the source area of the river Lim. The Drina River is prone to flooding from its riverbed. Particularly affected areas are middle and lower sections of the Drina River Basin (ranking as the poorest and least developed region), that have known for the appearance of huge flash floods and the high intensity of erosion process for many years. These natural phenomena caused severe economic and social problems and environmental damages. The occurrences of catastrophic floods had increased in the recent past i (2010, 2012). The latest floods in 2014 hit wider area of the Western Balkan, as never happened in the last millenium. Apart of flood disaster, the area of the Drina River is recipient of waste waters and pollution derived from several polluters including mines, power plants, industry facilities without waste water treatment plants as well as from inadequate or absence of sewerage system in the majority of municipalities along the basin on both sides of the Drina River.

Session 1.3: Food security and agriculture, including pastoralism

ASSESSMENT OF THE IMPACT OF SUSTAINABLE LAND USE PRACTICES ON FOOD SECURITY IN WEST USAMBARA MOUNTAINS, TANZANIA

TEMU, Emmanuel John; HELLA, Joseph Philip

Sokoine University of Agriculture, Tanzania

emmtemu@gmail.com

This study assessed the impact(s) of practicing sustainable land management (SLM) technology on food security in West Usambara Mountains. Primary data were collected through household questionnaires, focus group discussions, key informants interviews and personal observations while secondary data were collected from relevant local authority reports and records. A total of 160 households were interviewed. Research results suggest that, the area is still experiencing soil erosion problem by 61.9% of the respondents although at reduced scale. Multiple linear regression model to establish the contributing factors revealed that age of household head, farmland ownership and household income have significant and positive impact on improving household dietary diversity and hence improves food security while non-adopters of SLM showed declined dietary diversity. The study conclude that in order to increase food security keeping soil health in place through practicing SLM is a necessary condition.

Session 1.3: Food security and agriculture, including pastoralism

CLIMATE CHANGE AND AGRICULTURAL INSURANCE SYSTEM IN TURKEY

OZEVREN, Ayniye Sule (2); YEŞİLYURT ER, Aysel (1); ENGURULU, Bekir (2)

1: University of Pamukkale Cal Vocational High School;
2: Ministry of Food Agriculture and Livestock, Turkey

sule.ozevren@tarim.gov.tr

Turkey is the seventh biggest agricultural economy in the world and first inEuropewith its 61 billion dollars of agricultural GDP (TUIK, 2013). 22.8% of the population (76.7 million TUIK, 2013) lives in rural area which is 17.4 million people. In macroeconomic perspective, 7.4% of 820 billion dollar GDP is produced by agriculture. 6 million people which are 23.6% of total employment are employed in agriculture sector. When assessed macro indicators in agriculture, it can be seen that agriculture is an important sector for Turkey, in terms of its contribution to GDP, its employment share and its input provision to the industry.

The 5th Assessment Report (AR5) has been published by Intergovernmental Panel on Climate Change (IPCC). According to this report, sea level has risen 20 cm and average surface temperature has increased 0,9°C in the last century. The report also suggests that the number of cold days and nights has decreased while the number of warm days and nights has increased on the global scale. It says that Mediterranean area will be affected the most from climate change. It also indicates that summer precipitations will in increase in Mediterranean area which includes Turkey.

Agriculture is a sensitive and strategic sector owing to its heavy link and dependence on natural conditions. It is expected that climate change will affect weather events and frequency and severity of disasters. In that respect it is detected that there has been an increase especially in extreme weather events, hails, storms, frosts, cyclones and floods in Turkey.

Because of these disasters, some serious losses occur and make agricultural production very hard to be sustained. In that respect, as an addition to technical measures, producers suffering from disasters should be supported financially as well. From this point of view agricultural insurance is the most important tool for agricultural risk management.

Agricultural insurance has gained acceleration with Agricultural Insurance Law no.5363 inTurkey. State premium support and excess of loss reinsurance have a very important role in developing of agricultural insurance. TARSIM stands for Turkey Agricultural Insurance System and represents Agricultural Insurance Pool. It started to work in 2006 and after 8 years of implementation it is number three in European Union after Spain and France as of 2012.

TARSIM is a non-profit insurance system based on providing services to Agriculture and Livestock Sector under accuracy, transparency, accountability, sustainability and reliability principles in the scope of insurance principles and techniques. This insurance type is not compulsory, but voluntary. It is a system where only farmers who take out a policy is paid damage compensation under insurance principles and techniques in case of any loss due to a risk for which premium support is provided and which is under insurance coverage. System has been guaranteed by Agricultural Insurance Pool and sustainable production is targeted by insuring products of farmers exposed to risks.

Products, risks, regions and amount of premium support provided by the government according to scales of enterprises are determined by the Cabinet upon proposal of the Ministry of Food Agriculture and Livestock.

50% Government support has been implemented for all risks in 2014, however only for frost risk in insurance package 1/3 of risk premium is paid by farmer and 2/3 of it is paid as the government premium support due to flowering period of fruits grown on open areas.

In order to utilize from agricultural insurance premium support, agricultural insurance policy and then from loss claim when a loss is occurred, producers has to be registered under farmer registration system (CKS), veterinary information system (TURKVET), Greenhouse Cultivation Registration System (OKS), Aquaculture Registration System (SKS), Bee Keeping Registration System (AKS) and has to update this registration every year.

Audit of Agricultural Insurance Pool and operation company is realized by the Undersecretariat of Treasury in terms of insurance practices and audit of all other transactions is realized by the Ministry of Food Agriculture and Livestock under legal provisions.

Loss payments are under sole authority and responsibility of TARSIM and they are made from resources of insurance pool. Non-governmental organizations, Private and Commercial Insurance Companies and their Agencies don't have any authority or responsibility to make payments.

The most important target is to develop and extend system based on sustainability of government supported agricultural insurance practices , without adopting populist approaches and by putting controlled and accountable projects into force and by applying insurance techniques and realizing actuary studies.

Drought is the most important catastrophic risk that threats agricultural production as the result of climate change. It causes very serious problems in terms of food security as it affects large areas. Also it is the most important trigger of land degradation and desertification. It is crucial to include drought which leads to instability in producer income in agricultural insurance risks. However, both effects of climate change and difficulty in reinsurance opportunities are most important constraints in including drought in agricultural insurance risks.

Session 1.3: Food security and agriculture, including pastoralism

BEDOUIN LIVELIHOODS AND RANGELAND MANAGEMENT IN THE MIDDLE EAST; ANALYSIS OF CONSTRAINTS TO AND PRECONDITIONS FOR LOCAL OWNERSHIP IN SUSTAINABLE RANGELAND MANAGEMENT

LABAN, Peter (1); HADDAD, Fidaa (2)

1: IUCN Commission for Ecosystems Management/Thematic Group Lead Dryland Ecosystems - "In Search for Innovation" Consultancies, Palestinian Territories; 2: IUCN Regional Office for West Asia (ROWA), Jordan

plaban@palnet.com

Rationale

Herder community livelihoods, of Bedouin and others, and effective management of rangelands in the dry regions of the Middle East are under severe threat of becoming unsustainable. Where climate changes is aggravating trends, in many cases sustainability is affected by important external factors, such as urban and industrial expansion and competing other use of land and water resources, and in cases, military and security considerations of authorities. Ecosystems in these drylands are by nature already fragile and vulnerable. The local people traditionally living in these ecosystems are in all countries in the Middle East marginalized socially and politically and hence also economically. Although technical solutions for sustainable range management are available, they are often difficult to apply as the social and economic incentives to do so for local herder communities are mostly not sufficient or adequate. Until now little study is done on the knowledge needed and the constraints that are faced by herder communities.There is hence an important lack of tested development models that are applicable to enhance sustainable range management and viable livelihoods of the people that are traditionally the safeguard of the ecosystems under question. This paper will propose, on the basis of earlier social action research in other dryland situations a model for analysis of the constraints and the preconditions needed for people to take ownership of sustainable management of their rangeland resources.

Methods

Based on experience with local community management of natural forest and woodlots in the countries of the Sahel (Burkina Faso and Senegal), as well as with the tested application through social action research in countries of the Middle East (Egypt, Jordan and Palestine) this paper develops a methodology for analysis of what preconditions are needed to be fulfilled for local herder communities to engage and take ownership for sustainable range management activities. In most cases these preconditions are not fulfilled and then form almost insurmountable constraints to undertake, improve and facilitate the necessary technical and physical measures necessary to sustain the management of the rangelands that form an intrinsic part of the livelihoods of these communities.

This methodology comprises an assessment of the degree that local people can assume ownership and accountability with regard to use and management of the natural resources within their community domain (Laban, 2003). In many cases local people will not assume such accountability because they do not feel that the activity or its results are really theirs (ownership). Rather these activities are seen as provided temporarily by an outside institution (an NGO or a government agency), while they do not see the direct benefits of the activity and results do not meet their real priorities or longer term interests.

This ownership/accountability assessment will analyse the preconditions under which local people build their willingness and capacities to assume accountability for range land management. The first step is to assess how local people see their benefits (financial, influence, other) from range land management activities; second to see how confident they are of possessing the knowledge necessary to do so, strongly building on their local traditional knowledge; then how they can exercise their rights to the range land resources, and finally how empowered they are to get their benefits and rights (claim-making power). It will be through this analysis that can be understood which pre-conditions are not fulfilled and hence will stand in the way of adequate and sustainable range land management.

The assessment will identify the critical pre-conditions that are not or only partly met. When done in-depth this will allow to explore how these are affected by inequalities in benefits, rights, capacities and claim-making power between genders and among different categories of rangeland users. With the support of facilitators, herder communities should indentify options for overcoming constraints and restrictions, whether within or outside communities, on ownership and accountability for range land management interventions. The poster will document this through short case studies from Jordan and Palestine.

Results

The methodology is applied and tested in a systematic way as part of a participatory planning cycle for water resource and dryland management at community level (CARE/EMPOWERS project (2003-2007) and further used in the IUCN-ROWA REWARD programme (2007-2014). The participatory accountability assessment has resulted in important insights for planning of local level activities, in terms of priorities that need to be given either to enhancing rights, knowledge and/or benefits as well as how to empower local people to take charge of such management.

Outcomes

Following such approaches in a systematic way, delivering the above results, will have as an outcome improved ownership and accountability of local people for rangeland management, improving and strengthening livelihood strategies and inform measures to be taken for local governance and improved policies for sustainable rangeland management at the meso level such as the Middle East age-old local Al Hima local resource governance systems.

1. Diagnosis of constraints

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EFFECT OF CLIMATE CHANGE ON COCOA YIELDS AND EXPORT IN NIGERIA

OMUEMU, Efe

Institute of Public Diplomacy and Management, Nigeria

efeomuemu@yahoo.com

The production and export of Cocoa in Nigeria has been experiencing a declining trend in recent years and many factors have been identified by different researchers. One of these factors is the effect of climatic factors hence; this study examines the effect of climatic variables in cocoa yields and export in Nigeria, rainfall, temperature and precipitation were observed to have been the most important climatic factors that affect cocoa yields and export in Nigeria.

However, a trend analysis of data used, revealed that climate change had minimal effect on cocoa yields and export in Nigeria, this may be attributed to reform programs put in place by Nigeria government since 1999 to revamp coco sector with the establishment of National Cocoa Development Committee (NCDC). It was however, noted that unfavorable climatic conditions or climate change will impact negatively on cocoa yields resulting to decrease in export; if there is drought, excessive temperature, low rainfall and precipitation couple with reduction in farm land due to desertification, there will be a decline in productivity resulting to a decline in export as well. For this situation to be remedy, Nigeria's adaption and mitigation strategies and policies must be improved upon and implemented.

It was recommended that a holistic approach should be adopted by Government and all stakeholders by investing in this sector through Research and Development, proper utilization of lands in Nigeria lying fallow for cocoa production in the cocoa region or belt. Cocoa farmers should be educated on modern trends in the cultivation of this crop and value addition to their raw cocoa for more market access and competition. Measures should be put in place to address the issues of the effects climate variability on cocoa yield and the decline in its export.

Session 1.3: Food security and agriculture, including pastoralism

COMBATTING AGRICULTURAL DROUGHT BEFORE DESERTIFICATION IN TURKEY

OZEVREN, Ayniye Sule (1); ENGURULU, Bekir (2); UNAL, Mehmet (3)

1: Ministry of Food Agriculture and Livestock, Turkey; 2: Ministry of Food Agriculture and Livestock, Turkey; 3: Ministry of Food Agriculture and Livestock, Turkey

sule.ozevren@tarim.gov.tr

Agriculture is an important resource for nutrition, employment and development of countries. Studies for agricultural productivity and technology-intensive production model in Turkey have been continuing in order to achieve targets determined for agricultural production. However, besides these studies another important element that should be taken into consideration is natural disasters which caused by climate change and of which frequency and severity have been increasing. The hardest disaster to manage is drought in these natural disasters. There have been agricultural production losses as a result of disasters. Therefore, it is a risk that can make sustainability of agricultural production difficult.

It is known that climate change is a problem that can cause serious environmental and socio-economic results and ultimately effects of these results become an element that threatens life of future generations. Turkey will be affected by predicted negative aspects of global warming, especially diminishing of water resources, forest fires, drought, desertification and ecological deterioration caused by these effects and Turkey is one of the risky countries in terms of potential effects of global warming. It is known that drought which is one of the extreme incidents is generally a creeping disaster, it often continues for a very long time, it is one of the atmospheric threats of which prediction is the hardest and effects are the widest. Agricultural drought likely to happen as the result of global warming will probably effect either only one geographical region in Turkey or all regions.

Agricultural drought is described as lack of water within soil texture to meet water need of plant. Negative climate changes causing drought and increasing water demand in our country requires a planning and management considering the drought risk. Main objective in combatting agricultural drought is, during periods without drought, to ensure to take all necessary further measures with increasing awareness of public by including all shareholders in the process, by taking supply-demand management into consideration, with planning of sustainable agricultural water utilization in terms of environment and to realize an effective combat program during crises periods and to ensure keeping effects of agricultural drought at the minimum level. In our country, in order to minimize effects of agricultural drought likely to happen and to determine measures to be taken to this end, 5 year Agricultural Drought Combatting Strategy and Action Plan covering 2008-2012 period in compliance with conditions of our country under the coordination of our Ministry has been prepared and put into force. According to this plan, Agricultural Drought Management Coordination Board has been established and Monitoring, Early Warning and Estimation Committee and Risk Assessment Committee at the central level and Agricultural Drought Provincial Crisis Centers under the leadership of governors in the provinces have been established to work under the Board.

It is attempted to consider actions from a broad perspective in order to mitigate effects of drought. Agricultural Drought Combatting Strategy and Action Plan includes not only measures to be taken in years drought occurs but also measures to be taken under normal conditions. In years when drought occurs, drought action activities for dry and irrigated agricultural areas are determined as preparation for drought, drought alerts, emergency action and limitation. In order to ensure sustainability of activities under drought combatting, Action Plan has been prepared for the period between 2013 and 2017 in accordance with present conditions and combatting will continue actively.

In case of not combatting agricultural drought and not taking necessary measures in a timely manner, the problem of desertification of agricultural lands can be faced due to long drought disasters of which frequency and severity will increase as natural result of climate change.

Session 1.3: Food security and agriculture, including pastoralism

ENHANCED ADAPTATION OF WINTER PULSES TO RAIN-FED FARMING SYSTEMS IN SOUTH ASIA

SARKER, Ashutosh; AGRAWAL, Shiv Kumar; KUMAR, Jitendra; DIKSHIT, H.K.; DEY, T.K.; GHARTI, D.B.; ALI, Azgar

ICARDA, India

a.sarker@cgiar.org

Pulse crops are important for human food, animal feed and in sustainable cropping systems of south Asia. The south Asian countries comprising of Bangladesh, India, Nepal and Pakistan are major producer, consumer and importer of pulses. The region faces severe deficit of pulses, where majority of low-income people rely on pulses for their nutritional security. Productivity of pulses is very low because these crops encounter numerous biotic and abiotic stresses among which drought is most widespread. Pulses are generally grown under residual soil moisture after monsoon in south Asia, and the crops frequently suffer from terminal drought. In the context of changing climate, pulses like many other winter crops face combined effects of heat and drought, and cause substantial yield loss annually. The national programs of south Asia region have strong collaboration with the international center for agricultural research in the dry areas (icarda) in pulses improvement. Icarda in collaboration with nars partners is engaged in research to address these issues through agronomic and genetic means.

Through laboratory and field screening techniques, the center has identified appropriate germplasm from its global collection of cultivated and wild accessions from >78 countries. Targeted utilization of these materials in genetic enhancement research has resulted into construction of new genotypes with enhanced resistance to drought through various types of mechanisms, including escape, dehydration avoidance and dehydration tolerance. Several productive pulse varieties adapted to local agro-ecological conditions have been released to farmers in Bangladesh, Nepal, India and Pakistan. These varieties have early seedling vigor, fast ground coverage, early maturity, robust tap and lateral root systems, high biomass development, and have ability to adapt under mixed cropping, inter-cropping and no-till production systems. Yield stability with acceptable production potential under drought stress of these varieties and high market price has encouraged farmers to expand pulse production in the region. Icarda continues this effort in collaboration with national partners to further develop heat and drought tolerant cultivars and matching production technologies to pulses in new cropping systems niches arising in the context of climate change and farmer's and consumers' demands.

Session 1.3: Food security and agriculture, including pastoralism

DROUGHT PERCEPTION AND SUSTAINABILITY OF DAIRY FAMILY FARMING IN THE SOUTHERN RURAL REGION OF PERNAMBUCO STATE IN BRAZIL

FAGES, Marjolaine (1); LE GUEN, Roger (1); SILVA DE MELO, Airon Aparecido (2)

1: Ecole Supérieure d'Agriculture d'Angers, France; 2: Unidade Acadêmica de Garanhuns / Universidade Federal Rural de Pernambuco, CEP 55292-270, Garanhuns/PE, Brazil

m.fages@groupe-esa.net

In Pernambuco, 73% of milk production is located in the southern rural region of the state (Alves et al., 2010). Around 63% of dairy farms are small family ones which sell less than 50 liters of milk a day (Gomes, 2008). This region is semi-arid and identified in process of desertification. It is one of the poorest of Pernambuco state, since the Human Development Index of several municipalities is among the lowest of the state, covering major social and economic inequalities. Dairy farming is the primary source of income and rural employment (MDA, 2011). The exceptional drought in 2012 and 2013, associated with the loss of forage palm plantations (*Opuntia fícus-indica*) ravaged by the carmine cochineal (*Dactylopius sp.*), have strongly affected the resources, both in rural communities and the entire dairy industry. Beyond statistics, sociological knowledge about these three points are missing: (1) the farmers' experience of this crisis, (2) the collective organization of farmers and the types of support to dairy farms (water or fodder supply, milk price supports) that explain different experiences, which seem sensitive by locality (3) the ways in which farmers perceive the difficulties and constraints on their farms and their expectations of government support to rebuild the dairy sector strongly affected by this crisis.

The survey methodology (monographic type) led to the selection of four municipalities in the region to conduct group interviews which involved 276 participants (milk producers and their families) in 21 rural communities. They represented 221 family dairy farms in conventional rural communities, traditional quilombolas (communities of descendants of former slaves freed) and indigenous communities, and colonies of landless farmers. In addition, 46 advisory agents, called "professionals" who work with dairy farmers in these municipalities were interviewed individually. The purpose of these interviews was to put the answers of the farmers in context to the general background of production in the municipality visited, and to that in other parts of the region not visited where these professionals also work. The investigation phase was performed in collaboration with agricultural unions, cooperatives of farmers, rural technicians, government agencies for rural development, Dairy Technical Centre of the southern rural region of Pernambuco state and Federal Rural University of Pernambuco.

At Águas Belas, only 50% of respondents have at least one dry or milking cow on their farms, while the proportion exceeds 80% in other municipalities. Farmers say they are poorly prepared for a drought but they underline the government's inability to support their efforts to preserve their livestock. Differences between municipalities permit various hypotheses to be put forward about the level of adaptive capacity of farmers in times of crisis and their ability to recover their production: physical variables such as local weather conditions and access to water have been identified; others which we consider socio-political, such as the organization of the dairy sector, local political dynamics are also involved; finally, we also identified the weight of sociological variables such as the level of technical training and the level of collective organization of farmers (associations, cooperatives, farmers' unions).

There have been cases of individual and collective initiatives that enabled the support and sometimes the increase in milk production of family farms during the drought period. Traditional communities of quilombolas, indigenous and colonies of landless farmers appear to have been strongly affected by drought, although there are also among them cases of success and adaptation to the conditions of production in semi-arid areas.

Lack of advice is the first difficulty cited by respondents, followed by lack of water access and effective government support. Only 7% of farmers surveyed received a visit from a technician last year and 70% said they did not perceive any positive element in terms of farm support by a public or private body. Access to services (soil analysis, veterinary care, agricultural service supply agency) and inputs (feed, veterinary products) of quality and tailored to the concerns of farmers was cited by 36% of respondents as a prerequisite for fast recovery in production. Despite the hard conditions of recent years, farmers appear to be strongly tied to milk production and believe that it is possible to design more resilient production systems to climate change.

There are differences in the perception of the drought among dairy farmers, varying according to their location. Farmers and professionals in the dairy sector see this crisis not only as a test, but as an opportunity to finally mobilize state and design production systems to better suit them to the increasing variability in rainfall. Concerted public and private actions are probably possible to meet the needs of farmers. It would be urgent to put them in place in order to continue with existing social and professional dynamics and to prevent future droughts, likely in the process of desertification to which this area sensitive to climate change is exposed to.

Session 1.3: Food security and agriculture, including pastoralism

COMBINING FARMERS' PERCEPTIONS AND CROPPING SYSTEM MODELLING TO ADDRESS CLIMATE CHANGE IMPACTS: A CASE STUDY ON IRRIGATED FORAGE SYSTEMS UNDER MEDITERRANEAN CONDITIONS

NGUYEN, Thi Phuoc Lai (1,2); MULA, Laura (1,3); SEDDAIU, Giovanna (1,3); DORO, Luca (1,3); LEDDA, Luigi (1,3); PASQUI, Massimiliano (4); GUTIERREZ, Luciano (1,3); DONO, Gabriele (5); ROGGERO, Pier Paolo (1,3)

1: Nucleo Ricerca Desertificazione, University of Sassari, Italy; 2: Dipartimento di Scienze Politiche Scienze della Comunicazione e Ingegneria dell'Informazione, University of Sassari, Italy; 3: Dipartimento di Agraria, University of Sassari, Italy; 4: Istituto di Biometeorologia Consiglio Nazionale delle Ricerche (IBIMET-CNR), Roma, Italy; 5: DAFNE, Tuscia University, Viterbo, Italy

pproggero@uniss.it

Rationale

The uncertainty in future climate scenarios makes it impossible to directly use the output of a crop model as an input for developing sustainable farming practices. Farming practices are shaped by farmers' experience built from perceptions of climatic impacts on their agroecosystems. The increasing perception of changing climate triggers the farmers' concern about mitigating emissions of GHGs and adapting to the impacts (Fleming and Vanclay, 2010). However, farmers' decisions about managing their farming activities in the framework of "sustainability" are plagued with uncertainty. The scientific community is giving increasing importance to the integration of local and scientific knowledge in sustainable environmental decision-making (Nguyen *et al.,* 2013). We hypothesized that combining scientific research outputs with perceptions of local actors may support the design of desirable adaptive strategies at farm level. We focused on assessing climate change risks on cropping systems through the integration of farmers' perceptions and model simulations to develop model outputs consistent with indicators perceived as relevant by farmers. This process was designed as a critical step towards the development of effective adaptive farming strategies.

Methods used

The research is grounded on a case study in the dairy cattle district of Arborea in Sardinia (Italy), based on the silage maize - Italian ryegrass cropping system. Activities were designed in two steps:

(1) Understanding farmers' perceptions of temperature rise and its impacts through semi-structured interviews (n=5) and questionnaires (n=27). Open-ended questions were submitted on long-term changes in climate and related impacts on crop yields. The themes emerging from farmers' interviews were transformed into indicators that were used to develop a structured survey to validate perceptions on the local farmer's population.

(2) Simulating crop yields in current and near future climate scenarios using EPICv.0810 (Williams, 1990). The future crop production scenarios were developed using the calibrated output of the Regional Atmospheric Modelling System (RAMS) (Meneguzzo *et al.*, 2004) and the WXGEN weather generator (Hayhoe, 1998). Two 150 years series of crop yields and irrigation water demand were generated under present conditions (PS, based on RAMS outputs 2000-2010) vs near future conditions (FS, based on RAMS outputs 2020-2030).

The simulations were based on an input dataset from local experiments. The following indicators, identified from the farmers' interviews, were simulated: soil and crop temperature, water stress, crop yield and water demand under PS and FS. Adaptive agronomic practices were simulated under FS to mitigate expected yield drops.

Results

Interviewed farmers were male, aged 35-65 years, with lengthy experience of dairy farming and quite high level of education. All lived locally, were full-time employed in dairy cattle farming with 80% of farmland used for maize-ryegrass cropping. Most farmers perceived climate variability and its impacts in the past decades (Table 1).

Most farmers agreed on increased temperature and number of hot days in the past decades. Farmers were more uncertain about decreased groundwater supply and plant growth, while the majority believed that increased air temperature, number of hot days and soil temperature caused yield losses.

According to the downscaled calibrated RAMS, the projected minimum average temperature would increase of 1.0°C, while the maximum average temperature would increase of 1.1 °C. The crop model outputs showed that in the FS the average yearly soil temperature would rise up to 5.9%. In the FS the summer maximum temperatures would increase of 1.7°C leading to a shortening of the maize growing period (-12 days).

Impact simulation results for FS showed on average for both crops an increase in the water need due to temperature rise. Moreover, the ryegrass yield is expected to increase by 18% because of less cold stress in FS winter, while maize yield is expected to decrease by 8% because of the simulated shortertening of the growing period.

Simulating adaptive future strategies (FS_MOD) for maize by choosing a later hybrid, aiming to keep the same growth duration and yield, the model outputs indicated that the growth season length and yield under FS would be the substantially the same as PS but the irrigation water demand would increase by 6%.

Outcomes

Model results on FS were consistent with farmers' perceptions. The yield simulations showed contrasting impacts for ryegrass (increased yield) and maize (decreased yield), while a general decreasing yield trend was perceived by farmers at the cropping systems scale. Maize is far more important than ryegrass for its higher productivity and feeding value and the slight increase of ryegrass production would not compensate the yield losses forecasted for maize. Adaptive responses were then designed accordingly to enhance farmers' willingness and pro-active adaptve behaviour.

The consistency between farmers' perceptions and model outputs could enhance farmers' confidence on cropping systems simulations, thus facilitating a co-researching pathway. Understanding farmers' perceptions on the impacts on farming is useful to design effective "mediating objects" to trigger learning for developing adaptive responses to climate change between farmers and researchers.

Session 1.3: Food security and agriculture, including pastoralism

FOOD SECURITY AND SOVEREIGNTY IN DESERTIFICATION AREAS OF NORTH-WEST OF ARGENTINA

CORSO, María Laura (1); PIETRAGALLA, Vanina (1,2); POSSIDONI, Cristina Isabel (3)

1: Secretariat of Environment and Sustainable Development, Argentine Republic; 2: School of Agriculture of the University of Buenos Aires, Argentine Republic; 3: School of Bromatology of the University of Entre Ríos, Argentine Republic

pietraga@agro.uba.ar

Rationale

Health, cultural, social, economic, financial, educational, and even religious aspects are causes, on many occasions, of desertification and its impacts on each of these issues. Within previous works (LADA-FAO, 2011; Corso *et al*, 2012) the analysis of these aspects was performed using the methodology of the Sustainable Livelihoods Framework. Those studies allowed us to compare each analyzed site on the composition and balance between the resources or capital, according to the methodology mentioned: natural, human, physical, social, financial and productive. Based on the results find out on the previous works, the main objective of this work is going into detail about the analysis of the nutritional aspects of the populations affected by different degrees of desertification and its impact on food security and sovereignty. The study is focus on Cochinoca, Province of Jujuy; and in Cachi, Province of Salta. Moreover, desertification, and in many cases measures taken to prevent or mitigate this matter, modify feeding patterns from the change in access to food and / or supplies meeds for their preparation, thus impacting on ancestral customs regarding eating habits.

Methods used

Based on the recommendations of the Dietary Guidelines for Argentina Population (Lema *et al*, 2003) an evaluation matrix along with its radial graph was constructed. In which each axis one of the food groups related to the dietary guidelines recommendations is represented. This arises as an adaptation of the methodology Sustainable Livelihoods Framework (LADA-FAO, 2011).

We designed and implemented a survey from which the food frequency where the criteria for assigning the value to the matrix. The ideal situation is one that meets the requirements listed in the guide as to the daily intake of each food group. The value assigned to each group answers to the number of ingested in every weekdays (Possidoni *et al*, 2013).

The food groups are: Grains and Legumes (*group 1*); Vegetables and Fruits (*group 2*); Dairy (*group 3*); Meat and Eggs (*group 4*); Oils and Fats (*group 5*); Sugar and Sweets (*group 6*).

Each of the study sites were georeferenced, 30 surveys was made on each site and five key informant interviews were implemented.

Results

At the beginning a balance graph, which response on the recommendations of the Dietary Guidelines intakes, was constructed. The guide recommends the intake of all food groups every day, unless group 4. It can be seen (Figure 1) that, according to the meat group, the recommended value is between 4 and 7, since it is the group that is not recommended for daily consumption.

The survey to collect information was applied considering two seasons: winter and summer, as seasonality determines the availability and access to food, mainly in terms of fresh produce.

Food security at national level has three components: *adequacy, stability and access*, and are defined as follows: to ensure adequate food supplies, maintain stability and ensure access. Determining for the study area: Cachi and surrounding areas *High-sufficiency*, *stability and access media means*; and for Cochinoca, Abra Pampa: *High-sufficiency, media stability and high access*.

Considering the food frequency as a proxy of food security, it can be concluded that:

- People do not perceive their problems in terms of food;
- Characteristics of diets differ in terms of the possibility of self-production, access to markets, economics possibilities;
- It is confirmed that the meat is central to the creation of the dishes in amounts that exceed the recommendations in all groups;
- Consumption of fresh fruits and vegetables is highly related to seasonality, and in any case does not comply with the guideline recommendations;
- Cultural changes influence the diet, replacing other dishes more quickly and processing which impacts on health;
- Migratory patterns have affected the production of fresh food, increasing reliance on markets, and reducing consumption;
- Dependence of markets creates more vulnerability to access to food, even if they are available;
- Consumption of sugars and refined flour is significantly increased in populations of young people and children;
- Young people do not know or know how to prepare typical dishes of the region, and prefer less elaborate and less traditional foods.

Whereas Food Security and Sovereignty are not different but complementary concepts, especially when we refer to the indigenous peoples, where food is an essential part of culture, and taking into account the results of this study it can be concluded that current changes in the regions under study have a greater impact on the sovereignty over food safety.

Outcomes

As mentioned above, the sampling points were georeferenced, from which maps the polygon points and data relating to food frequency, adequacy, stability and access to food are constructed. This information is incorporated into the existing geographic information systems for the study region, where may be studied in an integrated manner and related data on desertification, how to be loss of vegetative cover, erosion, climate impacts, overgrazing, among others.

Session 1.3: Food security and agriculture, including pastoralism

THE IMPLICATION OF LAND USE AND CLIMATE VARIABILITY ON LIVESTOCK PRODUCTION IN NKAMBE PLATEAU OF CAMEROON: ADAPTATION STRATEGIES AND CONSTRAINTS

NFOR, Julius Tata; MARTIN, Kuete

University of Dschang, Cameroon

jtnfor2007@yahoo.com

In Sub Saharan Africa, desertification was only unique to countries found at the fringe of the Sahara desert. It was hardly to talk of droughts in the humid tropics as it is the case today in the Nkambe livestock production zone of Cameroon. The recent water shortages are therefore having a correlation with the inappropriate land use and climate variability.The Nkambe plateau located between latitude 6° 20′ and 6° 41′ North of the equator and between longitude 10°23′ and 11°25′ East of the Greenwich meridian is a component of the Savanna or Grassfields agro-ecological zone of Cameroon. This region is subjected to a mountain climate of the subequatorial type characterised by accidented relief. The annual precipitation varies between 1500-2600mm with an average of 2000mm.The region's main economic activity is agro-pastoral production and her paradox is that, found within the humid tropic, she suffers from acute water shortages most especially in the dry season.. The present study attempts an analysis of the negative impacts of land use change and climate variability on livestock production and evaluate the cost effectiveness of strategies adopted by pastoralists to adapt to droughts in the study area.

The working method used was based on documentary search, field observation, semi-structured interviews and questionnaire administered to 200 pastoralist's households and stakeholders.In addition to this, electronic search was conducted to identify published articles on land use and water resource degradation and its effects on livestock production most especially cattle rearing.Extensive practical field work was also carried out for the measurements of the volume or discharge of springs and streams for some sampled villages. Meteorological data was collected from Ndu Tea meteorogical station which permitted us to analyse the spatial and temporal variations of rainfall in the study area for the past two decades. Satellite images of the study area and geographical information system (GPS) were used to appreciate the land use change and land cover.

From our data analysis, it was established that, land use change and climate variability have had a negative impact on spring and stream discharge.In the past, it was observed that the principal water catchments of the locality of Nkambe (Chua-Chua) Ndu, Mbipgo, Ntumbaw and Ntundip registered 30m^3/hrs, 14.5m^3 /hrs, 3.2m^3/hrs, 18m^3/hrs and 1.3m^3/hrs respectively (Amawa,1999). But in 1998, the discharge of the springs and streams dropped to 5m^3/hrs, 1m^3 /hrs, 1.08m^3/hrs,1.2m^3/hrs and 0.5m^3/hrs representing a negative evolution of discharge of -25m^3/hrs, -13.5m^3/hrs, –2.12m^3/hrs, -16.8m^3/hrs, and -0.8m^3/hrs respectively. This situation is attributed to the inappropriate land use around the water sources and watersheds which are essentially dominated by *Eucalyptus* plantations. Statistics have shown that, about 845 hectares of *Eucalyptus*plantations in Nkambe plateau are found in the valleys representing 62,36% of the overall total of an estimated 1355 hectares while only 33,57% (455 hectares) and 4,05% (55 hectares) are found on the hill top and hill slopes respectively (Table .1 and Figure 2).Above all, using the Spearman's Rank Correlation Coefficient, it has been proven that although variations in rainfall has contributed very little to the reduction of stream discharge in the study area, speculation strategies and policies to check an eventual impact of the global climatic change on the evolution of rainfall in the study area and consequently drought is necessary (Tsalefac, 1999; Ngakfumbe, 1984).This is because livestock breeding which is the main economic activity in the region is exposed to droughts and pastoralists' adaptation strategies to water shortages are not always cost effective. Consequently, the steady decline in the numbers of cattle between 1985 (489.751) and 1988 (153.200) and goats 1983 (219.953), 1988 (83.000) in the North West Region as a whole with Nkambe plateau inclusive is attributed to a persistent reduction of water supply and to the likelihood that forage production is no longer sufficient to sustain the large numbers of livestock (Kaffo ,2010) .Statistics have proven that, in 1989, Ndu sub division alone had 29832 cattle, 436 grazers with cattle density of 71per sq /km. By 1999, the cattle population had dropped to 10.000, with a cattle density of only 23 per sq/km. Nevertheless, this has generated socio-cultural, psycho-social, economic and environmental problems to the community for which there is urgent need to find adequate solutions.

Our research work is imperative as we highlight the degree of social, economic and environmental vulnerabilities of pastoralists due to their exposure to droughts and inability to cope with recurrent water shortages. Our recommendations therefore will enhance sustainable livestock production in the study area which will go a long way to ensure food security, alleviate poverty and sustainable development, contributes to the emergence of Cameroon in the livestock sector by 2035 as inscriped in the Cameroon's Growth and Employment Strategy Paper and the attainment of the millennium Development Goals.

Session 1.3: Food security and agriculture, including pastoralism

PASTORALISM AND THE GREEN ECONOMY – A NATURAL NEXUS? STATUS, CHALLENGES AND POLICY IMPLICATIONS

MCGAHEY, Daniel (1); DAVIES, Jonathan (2); HAGELBERG, Niklas (3); OUEDRAOGO, Razingrim A. (2)

1: Institute of Environmental Management and Assessment; 2: International Union for Conservation of Nature; 3: United Nations Environment Programme

Razingrim.OUEDRAOGO@iucn.org

The "Green Economy" is a vision of the future wherein material wealth is not generated at the cost of increasing environmental risk, ecological scarcity or social disparity. Considerations over "green" development for the global livestock sector are at an all-time high and whilst countries grapple with what this entails, many of them possess large areas of rangelands that are managed through pastoralism and which already make a major contribution to environmental sustainability and the economy. This role is poorly understood, neglected and even eroded by misguided policies, investments and attitudes. Not only does pastoralism have a major role to play in management of natural capital and sustainable production but the aspirations of the Green Economy offer a powerful opportunity to overturn years of prejudice and misunderstanding of pastoralism.

The study is a joint UNEP-IUCN study and focuses on pastoralism's current and future potential for securing sustainable management and green economy outcomes from the world's rangelands. It synthesises existing evidences from mobile pastoralism and demonstrates the sustainability of pastoral systems. It identifies also key opportunities and challenges for promoting development in rangelands. Finally, it identifies enabling conditions required for pastoralism to deliver on its potential role in a Green Economy.

The methodology used in this study is a triangulation between existing literature review, data from case studies synthesis and a global consultation of pastoralists and experts. The case studies focus on evidence from Europe, Latin America, North America, Central, Western and Southern Asia, Australia and throughout Africa to demonstrate the system's inherent characteristics for adaptive sustainability. Regarding the global consultation of pastoralist, a global gathering of pastoralists' leaders was organized in Kenya in 2013 with the purpose of sharing experiences, discussing and consulting with pastoralists on pastoralism and the global transition to a green economy. The sessions were focused mainly on: (i) Pastoralist sustainable development goals: envisioning the future of pastoralism; (ii) The multiple values of pastoralism; (iii) Barriers and opportunities to sustainable pastoralist development (Promoting investment in pastoralism). Findings of the study are organized as following:

1- Maintenance of natural capital

- Pastoralism's role in the maintenance of natural capital
- Status and trends in rangeland natural capital

2- Resource efficiency and markets

- Pastoral intensification
- Economic & natural resource efficiency
- Market opportunities
- Innovative markets for green goods and services
- Green innovations

3- Enabling pastoralism for a Green Economy

- Strengthening basic human development
- Governance of rangeland resources
- Strengthening resilience in pastoral economies

The outcomes of the study are the recommendations to address the issues of the economic and environmental benefits of pastoralism and also the conditions for enabling Pastoralism for a Green Economy. Indeed, Pastoralism lies at the nexus of the three pillars of sustainability and provides a combination of social, environmental and economic benefits: Sustainable Land Management, Conservation of Biodiversity, Climate Change mitigation, Poverty reduction, and Economic growth. This implies, in order to strengthen pastoralism to deliver on its potential role in a Green Economy, to:

- Establish a global development framework for sustainable pastoralism;
- Disaggregate the costs-benefits of intensive and pastoral livestock sectors in green economic planning;
- Connect pastoralists to domestic and international livestock markets;
- Capitalise on the environmental benefits of pastoralism and expand green niche markets;
- Strengthen property rights and governance over rangeland resources;
- Integrate pastoralists into the development mainstream through improved human capital and knowledge

Session 1.3: Food security and agriculture, including pastoralism

SOCIO-ECONOMIC DRIVERS OF PASTORAL DROUGHT

TAHMASEBI, Asghar

Kharazmi University, Iran, Islamic Republic of

asghar@khu.ac.ir

Rationale

Drought is one of the main threats to all those forms of animal husbandry and especially to those regions where pastoral nomadism is prevalent. The natural vegetation of pastoral rangelands is very sensitive to rainfall variation, and thus the nomads are usually the first community that feels the impact of drought. In general terms, drought is a period of shortage of available water due to a deficiency of precipitation. It is mostly classified into four drought types, namely meteorological, hydrological, agricultural and socio-economic. Several drought indices, e.g. Percent of Normal, Palmer Drought Severity Index (PDSI), Standard Precipitation Index (SPI), have been developed for defining and monitoring different types of drought (Hayes 2002). So far, however, there has been little discussion about pastoral drought and its socio-economic drivers. The pastoral drought is defined as the lack of available forage due to meteorological drought because of inadequate precipitation or inappropriate seasonality, timing and intensity (FAO 2011; Jupp et al. 1998). This notion is applied to the case of the 2008-2009 drought in the territory of Shahsevan nomads in Northwest Iran to examine the function of socio-economic processes in quality drought experienced by the nomads.

Methods

The Shahsevan are the third largest pastoral group in size of human population and animal husbandry after the Bakhtiari and Qashqai tribes (Tahmasebi et al. 2013) Their summer pastures are located in the upper regions of the Sabalan Koh mountains with heights up to 4,811 meters, while their winter grazing areas are located in lowlands of Dasht-e-Moghan in Ardabil province in the southern frontiers of Azerbaijan.

A stratified sample survey of 301 households in 43 qeshlaqs was conducted and data on the impacts of drought on their pastoral production i.e. milk and livestock, animal sold and its price, change in their fodder consumption and its cost, were collected from the household heads. Furthermore, the interviewees ware asked to rank the severity of the 2009 winter drought in comparison to similar periods in 2008 and 2010 and to categorize them in five classes: severe to extreme wet, moderate to severe wet, normal, moderate to severe drought and severe to extreme drought. In addition, the Standardized Precipitation Index (SPI) was used to identify the magnitude and duration of drought in two meteorological stations, Aslandoz in winter and Ardabil in summer rangelands. Three time-interval SPIs, namely one-month, three-month, six-month and twelve-month were used for this analysis. The results then were compared with local information on the timing, duration and severity of pastoral droughts in June 2008 - May 2009.

Results

Nearly 60 percent of the 298 respondents regarded the 2009 winter drought as severe to extreme drought, 32.5 percent moderate to severe and 6.5 percent normal. Many Shahsevan furthermore regarded the 2009 drought as one of the worst droughts in the last decade. Similarly, in 2010 the March, April and May conditions were regarded as normal by 26%, moderate wet by 57% and severe wet by nearly 15% of the respondents. Comparing this results with the severity of drought identifies using SPI time-intervals (table 1), highlights the appropriateness of a six-month SPI for demonstrating pastoral drought in this region. However, the severity of drought as perceived by the Shahsevan was significantly higher than that calculated by the SPI index. On the other hand, the relationship between the increased cost of their livestock production in drought condition and the expressed drought severity were statistically insignificant at 5% level.

Further analysis of households' expenditure on supplementary fodder in drought condition indicates that, the average cost of fodder per head of adult sheep in October 2008 to May 2009 was nearly 54,000 Touman[1] as compared to 30,000 Touman in the same months of 2009-2010. However, nearly 53 percent of the increased costs were due to additional forage purchased in this period while 47 percent were caused by increasing fodder price. The barley price, for instance, reached 400,000 Touman/ton in cash and 500,000 Touman by installment in the drought period, while it was 230,000 Touman/ton before and after the drought.

Outcomes

Very little was found in the literature on analyzing pastoral drought and its socio-economic determinants. In the context of the Pastoral Drought Management program of FAO (2011), the role of meteorological drought on causing forage deficit has been emphasized. The findings of this study show that, the decline in the rangeland forage production due to meteorological drought and the simultaneous increase in fodder price play an almost equal role in increasing the livestock production costs and consequently, severity of 2008 drought experienced by the Shahsevan nomads. These evidences highlight the socioeconomic drivers of pastoral drought and suggest defining it as "lack of forage availability resulting from a combination of meteorological and socio-economic drought."

[1] 1 USD was 1100 Touman during my fieldwork in 2009-2010

Session 1.3: Food security and agriculture, including pastoralism

FACTORS INFLUENCING FARMERS ATTITUDE ON NEW IRRIGATION TECHNOLOGY DEVELOPMENT IN UPPER KARKHEH RIVER BASIN

DEHGHANISANIJ, Hossein (1); AZAMI, A. (2); ZARAFSHANI, K. (2); REZAEI, A. (3)

1: Agricultural Engineering Research Institute, Iran, Islamic Republic of; 2: Razi University, Kermanshah; 3: ICARDA-Iran Program & Head of ICARDA Office in Tehran

dehghanisanij@yahoo.com

Rationale

In West Asia and North Africa (WANA) region, water resources are generally scarce, and agriculture's share of these resources is declining due to competition from the domestic and industrial sectors. In this region, a typical Mediterranean climate prevails, with rain falling mainly during the winter (and a lesser amount during the warmer spring period). This rainy season is followed by a hot, dry summer. Rainfed crop production under this climate thus depends strongly on both the amount and distribution of rain.

The Karkheh River basin (KRB) is an important agricultural zone, located in southwest Iran within the WANA region. In the KRB, two major agricultural production systems prevail, a rainfed system and fully irrigated system. Due to the limitation in water resources and climate change farmers supported to use advance irrigation technology to better use of water and less impact of upstream to down stream. However entrance of new technology to farmers community need to be evaluated for a sustainable development in future. A study was conducted in upper part of KRB in Kermanshah provinces to integrative factors influencing farmers' attitude toward new irrigation technology development.

Material and methods:

The study was conducted in Kermanshah provinces located in upper part of Karkheh River Basin. It was based on quantitative -qualitative perspectives coalescent and descriptive –correlation and method of data collection is on-farm research field type. A sample of 274 farmers who were equipped with new irrigation technology (sprinkle irrigation systems) during the past three years participated in the study. For selection of samples, proportional stratified sampling method was used. Accordingly, farmers who were using new irrigation technology classified to 14 groups (sub-provinces), then the samples were selected randomly from each group depended to the size of the group. A questionnaire was used to collect data. The face validity of the questionnaire was tested using experts in Department of Irrigation Improvement in Water and Soil Division in Ministry of Jihade Agricultural as well as experts in Agricultural Department on Razi University. Corrections were made in the research instrument as needed. The reliability was tested using a pilot study with 50 farmers outside the population. An Alpha Coefficient of 0.75 proved to be reliable.

Results

Results showed that 18% of farmers had positive attitude toward their irrigation systems and 70% were relatively positive. Moreover, farmers' level of education, experience with the systems, cost if installation, training, changes in income, and land holdings explained 64% of variance in farmers' attitude toward irrigation systems.

Within the evaluated farmers, 77% were satisfied with their systems whereas 23% were unsatisfied. Moreover, there was same level of satisfaction between drip and sprinkler irrigated farmers. Level of satisfaction across farmers with different sprinkler systems showed that farmers using non-portable sprinkler systems were most satisfied. The qualitative results revealed some problems and issues perceived by farmers. Long process in filling application, lack of expertise among engineering firms, ineffective training classes, low quality spare parts, lack of water resources, and inefficiency in allocating resources were challenges by most farmers.

The land owners were more satisfied than landless farmers equipped with pressurized irrigation systems. Furthermore, farmers were most satisfied with: increased yield, higher quality product, less dependence on farm workers, water use efficiency, even water distribution, and increased irrigated farms. However, farmers were least satisfied with: low quality spare parts, incompetent sprinkler designers, administrative obstacles in receiving loans, and non-adaptability of systems in different climatic conditions.

The farmers requested educated designer, farmers' cooperation during the design and installation of the system, better control on quality of equipment, training of farmers for operation and maintenance could help to efficient use of system and expecting sustainability. Some farmers complain about the suitability of their irrigation systems with current cropping pattern or future plan, water availability with irrigation scheduling and system capacity, unsecured of the system, low quality of education, and quality of equipments. Since attitude is predicts behavior, the result of this study can assist policy makers for a sustainable and efficient development of new technology for irrigation development in the arid and semiarid regions.

Outcomes

- Development of manual use handbook to better management and operation
- Improvement of farmers knowledge on operation and maintenance
- Conduction of training course for farmers by irrigation system companies
- Cooperation of irrigation companies with farmers for at least one year operation
- Improvement in irrigation system design proposal
- Revision of education course for designer of advance irrigation systems
- Improvement in irrigation scheduling suggested by designer
- Control of irrigation system proposal by a specialist society.

1. Diagnosis of constraints

Session 1.4: Socio-economics

APPROPRIATION OF LAND AND GREEN GRABBING IN SUB-SAHARA AFRICA

ELEMIDE, Adebola

FEDERAL COLLEGE OF AGRICULTURE AKURE ONDO STATE NIGERIA, Nigeria

bolafebi@gmil.com

The term 'grabbing' focuses on appropriation, which has long been the subject of analysis in political economy, In many parts of the world, a new political economy of land and livelihoods is emerging, driven by 'green' market economics, and global discourses of the use and repair of ecosystems. New valuations of nature are legitimizing and incentivizing new appropriations, and multiplying them, as ecosystems become compartmentalized and commodified in an ever greater variety of ways. This appropriation of nature for green ends – 'green grabbing' – adds a new dimension to the wider discussion of 'land grabbing' and the study of agrarian change in diverse rural locations across the world. There are new actors, political-economic processes and forms of resistance, constructed through new discursive framings. While there are many echoes of past interventions in the name of the environment, green grabbing operates often virtually through novel legal and market mechanisms, suggesting new methodological and analytical challenges, as well new dilemmas for action.

This paper declares that there is a clear role for engaged researchers and activists, NGOs and even aid donors in changing the terms of debate, the biases of policy and so the dynamics of investment. Agrarian struggles, focused on land and resources, must be seen in a new light, and must engage with virtual markets, fictitious commodities and the speculative character of 'green' commodity trading. This is new territory for many, and will require alliances of communities, activists and scientists in counteracting the negative effects of green grabbing and seeking out and shaping alternative solutions, even in highly constrained settings.

The paper recommended that the emerging phenomenon of 'green grabbing' presents a fundamental and new challenge to 'peasant studies', and indeed all those concerned with the both the analysis and transformational change of rural politics and economies.

Environmental green agendas are the core drivers and goals of grabs – whether linked to biodiversity conservation, biocarbon sequestration, biofuels, ecosystem services, ecotourism.

RURAL DEVELOPMENT PROJECTIONS IN THE FOREST VILLAGES OF CENTRAL ANATOLIA DROUGHT BASIN OF TURKEY

GÖRÜCÜ, Özden

Kahramanmaras Sutcu Imam University, Turkey

ogorucu@ksu.edu.tr

The aim of this research was to evaluate the projections of rural development made Karaşar town, Saray and Köseler villages in the central Anatolia.To draw the projections for development of the basin,the study material has been obtained from related archive documents,interwievs held by managers of related governmental and non governmental institutions and also surveys by the research team was applied to local the people living in the basin.

This research was carried out by using the rapid rural appraisal technique in the basin.The frequency tables and percent distribution figures were used.According to surveys,semistructural interviews,It was determined and identified that economic resources and income generation sources were strictly limited.Local people make their livelihood from foresry and livestock,literacy rate in middle and elder age is 45%,people meet their vegetables and fruit needs from Beypazarı district.It was observed that majority of the young population had immigrated to the big cities,ezpecially to Ankara and İstanbul.

In conclusion, the applications such as the appropriate unit price fixing in the basin topography for forestry jobs and employments like afforestation,restoration,harvesting and rehabilitation actions are proposed in detail.The applications providing food safety and income generating,the transfer of fruit tree plantation areas to public,education and grazing knowledge for livestock,opening rangelands to use via sustainable rangeland management approaches and credit, loan or grant applications,using local development cooperatives more conscious and active,analysing educational problems and using natural resources according to community based management components,will make important contributions to the development of the basin takes places in the central Anatolia.

Session 1.4: Socio-economics

ASSESSMENT OF SOCIO-ECONOMIC ASPECTS OF DESERTIFICATION IN RELATION TO FARMER CHOICE PARAMETERS USING AN AGENT-BASED DECISION-MAKING SYSTEM (CASE STUDY: SEGZI PLAIN, IRAN)

AMIRASLANI, Farshad (1); ASKARI SHAHID, Marziye (1); MESGARI, Mohammad (2); ALAVIPANAH, Seyed Kazem (1)

1: University of Tehran, Iran, Islamic Republic of; 2: K. N. Toosi University of Technology, Tehran, Iran

amiraslani@ut.ac.ir

To study desertification, we need to identify risk factors as well as their interactions with each other in different time and places. In other words, reliable assessment, monitoring and displaying of desertification problems, require an integrated analysis and simulation of the real world (Gross et al. 2006). Intensive use of agricultural land is one of the major causes of desertification (Takafumi, 2012). Therefore, land use changes resulting from the interaction between social and economic systems in different scales of time and space, are complex (Lambin et al. 2003). An agent-based model can be used to analyse and simulate the decision-making process of human regarding land cover and land use changes. In the model described in this paper, the human agent (household) and environment (patch) agents are both used for the simulation. The agent-based decision-making process needs to be parameterized by decision rules. In this paper, a decision-making mechanism for farmer household agents is provided in the form of an agent-based model. It defines the conceptual aspects of land-use decision-making agents as well as their perception of the social-ecological feedback according to the co-adaptation and co-evolution of human and environment systems.

Methodology

Diverse data (including GIS and household attribute data) were used for initializing the coupled human–landscape system and farmer household decision making simulations. GIS data consists of Land use/cover (based on Landsat 8), soil physico-chemical properties (EC, SAR, pH, texture, moisture), institutional variables (i.e. ownership, village territory), and topography. Household data consist of socioeconomic attributes: labour force, educational status, income structure, and land properties. They were derived from an intensive household survey conducted in Segzi plain in Isfahan province (central Iran) during the spring 2013. In this research, the agent-based decision-making method presented by Le (2005) is adopted. For determining decision-making approach, a mechanism of livelihood group dynamics were considered as follows. At first, principal component analysis (PCA) was used to identify key factors differentiating household characteristics. These factors were then employed to classify the population into certain household groups using K-Means Cluster Analyses. The identified agent groups were interpreted and their types specified. Regression logistic multinomial model (M-logit) was employed for land-use choices modeling in each typological household agent group. The dependent variable of the model is the land-use choice of the farming households (P_{use}). The independent variables of the M-logit model include two groups of spatial variable and socioeconomic characteristics of farming households.

Results

We reduced the dimensionality of 14 potential criteria using PCA method. The six (6) principle components were extracted with total Eigenvalues greater than 1.0, explaining 77.4 % of the total variance of original independent variables. The PC1 was strongly correlated to land variables: $H_{holding}$=0. 911, $H_{cultivation}$=0. 925. The next principle components PC2, PC3, PC4, and PC5 were most weighted by percentage income from other off-farm activity factors ($H_{inother}$=0.843), household size (H_{size}=0.833), percentage income from grain ($H_{inGrain}$=0.773), percentage income from wheat ($H_{inWheat}$=0.898), respectively. Three groups were extracted from the implementation of K-means method. The group I consists of households that are rich regarding both land resources and income. The group II includes households with average livelihood standard and the group III comprises the poorest households having the lowest amount of land and income (Table 1). After determining the typological livelihood group, the variables affecting the decision-making was identified using the M-logit model. The effect coefficients were estimated with respect to the

fallow land, i.e., the base case. The chi-square test shows that the empirical M-logit model is highly significant ($p < 0.01$) in explaining land-use choice by farmers of the group.

The M-Logit analysis of land use choices for household type I indicate that P_{slope} (-) and $H_{holding/pers}$ (-) inversely are effective variables for every land use option and have statistical significance at the 0.05 and 0.1 levels, respectively. A similar M-logit regression analyses was also carried out for the group II (Table 1). With regard to the choice of grain and wheat, significantly affecting factors were H_{age}(+), H_{labor}(-), H_{depend}(+), $H_{cultivate_per}$(+), P_{SAR}(-), P_{PH}(+) and $H_{edu=0}$(-). Variables that significantly influence selecting other cultivations are H_{labor}(-), H_{depend}(+), $H_{cultivation_per}$(+), P_{EC}(-), P_{Slope}(-) and $P_{groundwater}$(-). For household type III, the results demonstrated that P_{EC} (-), P_{Slope} (+) and P_{wet} (+) were effective in each land use choice. Finally, these coefficients were used to obtain the probability of selecting each land use according to the location of the plot in the process of implementing the model as follows:

Where β_{ik} are preference coefficients,are dependent variables, i: number of land use.

Outcomes

In this paper, the preference coefficients for household decision-making are proposed by M-Logit model. These coefficients were used by an agent-based model at later stages. Dynamically, the agent-based model run calculated the probability of any land use choice, depending on livelihood groups. Accordingly, the final farmer decision is predicted based on the utility function and random proportional rule. Thus, decision-making process is based on bounded rational decision-making mechanisms.

Session 1.4: Socio-economics

COLLECTIVE ACTION FOR SUSTAINABLE LAND MANAGEMENT: THE CASE OF BOSOKHA LABOUR SHARING GROUP "MANY HANDS MAKE WORK EASIER, LIGHTER AND FASTER"

WANGDI, Tashi (1); DORJI, Karma Dema (2)

1: Agriculture Office, Punakha Dzongkhag, Bhutan; 2: National Soil Services Centre, Bhutan

kddorji@gmail.com

Bhutanese farmers have a long tradition of working together, for example, during farming, house construction, religious functions like rituals and festivals, construction and maintenance of community owned structures such as monasteries, irrigation channels, etc. Such collective actions are based on mutual trust, social norms, reciprocity and exchange, connectedness and networks through kith and kin and neighbourhood relations. Today, while the cooperative working system still exists in our society, it is increasingly becoming less prevalent in most of the rural communities. In fact, in some communities such practice has been completely disappeared. People have developed an individualistic thinking and behaviour and tend to do things more independently or as a family business with limited exchange of resources. This has become a serious problem for communities and families having fewer workforces and wishing to take up labour intensive tasks such as sustainbale land management technologies.

While there are many drives forces behind the vanishing tradition of farm labour sharing, like in any farming communities across the globe, farm labour shortage mainly due to rural to urban migration in search of easier means of income sources is the main contributing factor. Farm labour shortages have resulted in huge areas of arable land being left fallow which in turn impact the already constrained food security status of the country.

This article will share the experience of Bosokha community under Phuntsholing geog, Chhukha Dzongkhag where the community has successfully undertaken labour intensive Sustainable Land Management (SLM) interventions following "labour sharing group" that was once discontinued but revived by the SLM project (SLMP).

Session 1.4: Socio-economics

APPLYING NEXUS THINKING IN DRYLAND SOCIAL-ECOLOGICAL SYSTEMS IN MALAWI: CONSEQUENCES FOR JUSTICE AND EQUITY

QUINN, Claire Helen; STRINGER, Lindsay

University of Leeds, United Kingdom

c.h.quinn@leeds.ac.uk

Approximately one third of the global population lives in and depends on drylands for their livelihoods. Land degradation, desertification and drought represent significant challenges to the water, energy and food (WEF) security of dryland peoples. Supporting WEF security, and therefore sustainable development in drylands, requires holistic approaches (Reynolds et al, 2007). Nexus approaches have been developed to highlight relationships and interdependencies between WEF and the need for integrated management to understand the trade-offs and promote synergies (Bazilian et al., 2011). However, they have not yet been widely applied in dryland settings. They also lack explicit focus on issues of justice and equity (Pelling, 2011). Maintaining WEF security does not necessarily require an equitable or just system (Stringer et al., under review). This paper fills this knowledge gap by applying nexus thinking to Malawi's drylands to explore the distribution of equity and justice in WEF security at a household level. It identifies groups of 'winners' and 'losers' and highlights the importance of policies, institutions and knowledge in offering ways forward for more equitable and just WEF security.

In this paper we analyse data from dryland social-ecological systems in southern Malawi to identify and understand the factors that both enable and inhibit more equitable and just WEF security. The WEF nexus is examined to identify the relationships between water, energy and food, by unpacking local economic equity (distribution of costs and benefits), social justice (equity and fairness) and environmental equity (resource access and distribution).

Data for this analysis were generated from two focus groups and 32 semi-structured interviews with poor, middle and better-off households. The focus groups consisted of six village representatives, including both men and women who developed a locally appropriate wealth ranking and assigned households to wealth categories. Subsequently, interviews focused on livelihoods were carried out with household heads from across the wealth categories. These data were supplemented by secondary data from further research conducted in Malawi on cultivar selection and the subsidy scheme.

Central Malawi is semi-arid/arid and dominated by rainfed agriculture as the main source of livelihood for over 80% of the population. While maize is a key subsistence crop the climate is marginal for its production, resulting in large fluctuations in yields. Sorghum is also grown for subsistence along with cash crops including cotton and tobacco. For poorer households, temporary migration for work, both in Malawi and to neighbouring Mozambique, is a key strategy for maintaining food security. Since 1997, following significant famines in the 1990s resulting from a combination of drought and structural adjustment that resulted in declining yields and food price inflation, national seed and fertiliser subsidy programmes have been directed at poor households to boost national maize production. In this social-ecological system, evidence suggests that benefits tend to accrue to better off households who are more likely to be targeted because they are better able to make use of the inputs from the subsidy programme, and because they have the financial resources to access irrigation and energy sources (Table 1).

Poorer households are often the losers when it comes to WEF security in this social-ecological system. Poorer households are traded-off against better off households and remain reliant on rainfed agriculture with little or no inputs and few buffers against increasing climate variability. Policies (promoting the subsidy) and institutions (including cultural values and social networks) play an important role in determining these winners and losers. Although the subsidy scheme aims to improve agricultural production for poor households, the reality is that better off households are targeted as likely to make better use of inputs, and local institutions reinforce the preferential treatment of better off households. Even when poorer households do access the subsidy, it is often not the right types of seed or fertiliser, in the right amounts, for them to be able to use effectively.

Local knowledge could offer a way to identify and promote more appropriate and drought tolerant grains (such as sorghum and millet) in order to reduce the climate vulnerability of poorer households in this social-ecological system. This would allow the subsidy to particularly target poorer households so that seeds and fertiliser are more equitably distributed. By recognising and addressing these inequalities a more equitable and just social-ecological system could be promoted.

Session 1.4: Socio-economics

EVALUATION AND SELECTION OF SOCIOECONOMIC INDICATORS FOR LAND DEGRADATION MONITORING IN OMAN

AL-HATRUSHI, Salim Mubarak; AL-BULOSHI, Ali Said; ZEKRI, Salim; AL-WARDY, Malik Mohamed; CHARABI, Yassine Abdualrahman; AL-RAWAS, Ghazi Ali

Sultan Qaboos University, Oman

hatrushi@squ.edu.om

Rationale

Oman occupies the south-eastern part of the peninsula. It consists of plains, wadis, and mountains and receives less than 100 mm in annual rainfall on average, with 95% of land characterized as being either climatic desert or more than moderately affected with desertification. The problem of land degradation is most acute in Al-Batinah, Al-Hajar Mountains, Al-Sharqiyah and in Dhofar. With the climate being very unpredictable and regional models predicting higher temperatures and less rainfall (Charabi, 2009; Charabi and Al-Hatrushi,2010; Charabi and Al-Yahyai, 2013, Luminda and AL-Rawas, 2014), combating land degradation will present an even more serious and complex challenge than it already is.

In 2013, the Ministry of Environment and Climate Affairs, in collaboration with Sultan Qaboos University, started conducting a research project about mapping, monitoring, and mitigation of land degradation in the governorates of North and South AL-Sharqiya, Dohfar and Al-Jabal Al-Akhdar. This project aims to assess degraded areas and lands prone to degradation and to identify physical and socio-economic causal agents, in each region.

In order to investigate which indicators are most effective in assessing the level of land degradation risk, a consultative participatory approach with stakeholders from policy and academic sectors was followed to elaborate an effective targeted questionnaire, to track biophysical environment, economic progress, social change, and land management characteristics.

Data sets and Methodology

A socioeconomic land degradation indicators questionnaire, was prepared based on experts opinion and according to a participatory approach involving stakeholders from policy and academic sectors.

The questionnaire was developed according to the following stages:

Stage 1: Identify potential land degradation indicators

Review and evaluation of desertification indicators from previous research; provision of guidelines for identifying and cataloguing indicators; characterization of stakeholder groups and analysis of their perception of desertification; identification (in collaboration with stakeholders) research priorities and knowledge gaps in different domains of desertification; documentation and development of a database of indicators for different land use types, based on the stakeholders' inventory and field survey.

Stage 2: Evaluate and short-list proposed indicators

A comparative analysis of indicators and land management practices for different land use types; development of a methodology to use indicators to evaluate land management practices and techniques according to their effects on land degradation and their economic feasibility.

Stage 3: Improving indicators

Additional research was done in the economy of land degradation

Stage 4: Approval of the Socio-economic Indicators

All the investigators involved in the research project from Sultan Qaboos University and The Ministry of Environment and Climate Affairs, have deeply discussed, commented, reviewed and approved the questionnaire.

Results and Discussion

Causes of land degradation can be divided into proximate causes and root causes or underlying driving forces, (figure 1). The proximate causes are those factors that directly affect the land, such as agricultural activities, i.e. herdsman and farmers. Whereas indirect driving forces constitute demographic, economic, technological, policy, cultural, and climatic factors. The final version of the questionnaire consisted of 152 questions. The first round of the survey has started in august 2014, in the fragile and vulnerable ecosystems of Al-Jabal Al-Akhdar. In this remote area, farmers have very few facilities such as transpot, and their educational level is very low. A work team was formed, to help them to fill the questionnaire. This first round was very successful, the questionnaire was filled by 250 herdsman and farmers.

Conclusion

The development of this socioeconomic questionnaire is the first step towards understanding the general and root driving forces triggering land degradation process in the area under study. This will allow the formation of linkages between socioeconomic factors and land degradation to help establish socio-economic indicators for the assessment of processes related to land degradation in Oman.

DROUGHTS ARE SILENT, HEALTH IS INVISIBLE

SENA, Aderita (1); BARCELLOS, Christovam (1); FREITAS, Carlos (2); SILVA, Diego (1); CORVALAN, Carlos (3)

1: Institute of Health Communication and Information, Oswaldo Cruz Foundation, Brazil; 2: National School of Public Health, Oswaldo Cruz Foundation, Brazil; 3: Pan American Health Organization/ World Health Organization, Brazil

aderitasena@gmail.com

Rationale

Droughts are extreme climatic events of slow onset with health impacts that are poorly recognized. Its impacts on human well-being are mediated by economic decision and social policies, where poor and vulnerable populations tend to suffer the greatest consequences. Between 1969 and 2013 there were 612 droughts recorded globally, which resulted in 2.19 million deaths with 2.14 billion affected persons (EMDAT, 2014). Health risks from drought cover a range of health outcomes, from infectious diseases related to the use of unsafe water, respiratory diseases, chronic health effects such as malnutrition, and mental health disorders (Stanke et al, 2013). This study focuses on the semiarid region in Brazil, an area in the Northeast of the country, which includes 1133 municipalities and approximately 22.5 million persons (nearly 12% of the total population of Brazil). It aims to identify the specific health risks and impacts related to drought in the context of poverty eradication and the improvement in quality of life of the local communities. Climate change is expected to make current conditions worse in the next decades.

Methods used and partnership set up

Our work started with a review of the literature on drought and health, including reports in the grey literature. This process helped us to identify the key indicators needed to assess impacts and vulnerabilities. In order to determine the social and environmental vulnerabilities of the population in the semiarid region, we are collecting meteorological, social, environmental, and health indicators to construct an index, which can help local public health decision makers to implement targeted interventions in the affected populations. For each of the 1133 municipalities we obtained data on average annual precipitation, socioeconomic indicators and several health metrics (UNDP, 2014). This information will be discussed and analyzed in workshops with local stakeholders, which would include community leaders and decision-makers, among others. This will allow the identification of processes, which determine the changed incidence of diseases and other health outcomes resulting from extreme and/or prolonged drought episodes. In addition these consultations will inform on social, environmental and institutional factors which are not otherwise available in established information systems, and which would also inform on local knowledge measures to reduce health impacts.

Results

Time trends based on initial grouped analyses (national census data from 1991, 2000 and 2010) show continued improvement over time on all key socioeconomic variables in Brazil, but there are marked differences between population living in the semiarid region and the rest of the country. In every aspect, the semiarid region has less favourable social (e.g. literacy levels), economic (e.g. poverty levels) environmental (e.g. access to drinking water), and health indicators (e.g. infant mortality rates) as compared to the rest of Brazil (Sena et al, 2014). Median values for key variables, for the semiarid region and the rest of Brazil are 70.5 and 74.2 years for life expectancy; 29.9 and 11.6 % for illiteracy; 41.1 and 11.9 for percentage of poor persons; and 74.5 and 93.0% for access to drinking water (based on census data grouped by 5565 municipalities). The extent of these differences can be appreciated in the figure, which shows infant mortality rates (per thousand live births) by income levels (Brazilian Real or BRL). We can see the narrow range of lower income levels for the 1133 municipalities, versus the 4432 in the rest of the country. The median income in the municipalities of the semiarid in 2010 was just BRL 267, compared with BRL 542 in the rest of the country. Infant mortality rates were higher in the semiarid, with 25.2 per thousand, compared to 15.5 per thousand in the rest of Brazil. The combined social and environmental vulnerabilities in this region call for joint action of local decision-makers with full involvement of the affected communities.

Outcomes

This work will contribute to improving health and human well-being in local communities affected by drought. It builds on the knowledge that drought affects the availability and security of water and food principally, and other health risks related to heat, dust, hygiene, housing, income and pre-existing health conditions. It promotes awareness of these conditions to local stakeholders and raises alarm regarding environmental changes, such as the expected changes in drought conditions as a result of climate change. The project expects to build capacity at the local level and community resilience, promoting prevention (e.g. sustainable practices of water use); mitigation (e.g. reducing risks and vulnerabilities in communities; preparation (e.g. awareness creation through community leaders); alert (e.g. community issued alters and pre-planned actions); response (e.g. community participation for an integrated response), and rehabilitation (e.g. comprehensive evaluation to develop adaptation and build resilience for future events).

Water management in the Tiout Oasis in Morocco: friction between tourism development and agricultural improvements

BARBE, Audrey, Corine, Laurence (1); MAHDANE, Mhamed (2); RUF, Thierry (1)

1: Institut de Recherche pour le Développement IRD France Sud, France; 2: Université Ibn Zohr - Agadir - Maroc

audrey.barbe91@gmail.com

Working in the oases of Tiout, Morocco, was part of an international research program: "Innovating about promotion of local specific features in Mediterranean hinterlands", also called Med-Inn-Local. This program considers these hinterlands' development through the enhancement of their typical and specific features, thanks to different kind of devices, like ecotourism**.**

I based my work on different tools such as individual and collective interviews, field work but also historical and bibliographical research. The main goal consists in answering the following question: "can oases be thought as territorial innovation laboratory?"

Historical research shows that the hinterland of Tiout has been of paramount importance in the regional past, considering an economic, political and social point of view. The oasis of Tiout has been structured around a very adaptable water management system that has faced multiple factors and this past flexibility remains valid. Today this territory shows a resilient agriculture that struggles to be remunerative and that entirely depends on groundwater resources. But you also have to add property and political issues that some future work could clarify.

Moroccan tourists as well as European ones have long been attracted by this specific landscape and hydraulic heritage, but this lucrative activity tends to slow down. Besides national projects are currently promoting water saving. This context led to a study dealing with the conversion of the current gravity-fed irrigation system to drip irrigation.

Behind those local attempts to use tourism in order to make the area more attractive, you finally find a will to transform the water management system in both technical and institutional ways. But it seems that the choice made by project holders does not fit with the population perspectives, torn between development of tourism and agricultural improvements.

Session 1.5. Integrated methodology and policy making

PUBLIC PERCEPTION OF AN ECOLOGICAL REHABILITATION PROJECT IN INLAND RIVER BASINS IN NORTHERN CHINA

QI, Feng; WEI, Liu

Cold and Arid Regional Environmental Engieering Research Institute, Chinese Academy of Sciences, China, People's Republic of

qifeng@lzb.ac.cn

We investigated the effects of China's national and regional policies related to environmental protection and rehabilitation projects in inland river basins, by studying the effect of projects in the Heihe and Shiyang river basins, in northwest China. Interviews and surveys were conducted at 30 sites in the lower reaches of these two arid basins, an area that has experienced severe ecological degradation. The survey results show the ecological rehabilitation projects adversely affected the livelihoods of 70.35% of foresters, 64.89% of farmers and 62.24% of herders in the Minqing region in the lower Shiyang River Basin; also, the projects negatively affected 51.9% of residents in the Ejin Qi in the lower Heihe River Basin. This caused 16.33% of foresters, 39.90% of farmers and 45.32% of herders in the Minqing region to not support the project and 37.5% of residents in the Ejin Qi region said they will deforest and graze again after the project ends. The negative impacts of the policies connected to the projects cause these attitudes. The projects prohibit felling and grazing and require residents to give up groundwater mining; this results in a great amount of uncompensated economic loss to them.

Session 1.5. Integrated methodology and policy making

THE ENDURING DILEMMA BETWEEN MAPPING DESERTIFICATION AND ITS MITIGATION

ZDRULI, Pandi

CIHEAM Mediterranean Agronomic Institute of Bari, Italy

pandi@iamb.it

Mapping desertification has proven to be a challenging task. Difficulties derive from its ambiguous definition and the comprehensive integration of various bio-physical and socio-economic indicators that need to be considered in the assessments. In the early 90s, assessments and mapping were based primarily on expert opinions that included uncertainties and obvious shortcomings. Later on, with the development of the Remote Sensing technology and the advancement of the Geographic Information Systems, global mapping became a standard procedure. Results showed that temporal and spatial scales are crucial components of the mapping and assessment process but this makes it almost impossible to compare maps that were developed based on different methodologies. A global map could depict only trends in land degradation caused by human-induced land use changes or climatic variations but has little value at local level.

This necessitates the performance of mapping at various scales but only after a methodological approach has been developed that accounts for all the components of desertification process and allows for upscaling and downscaling from global to local level and vice versa. The scientific community "lost" considerable time trying to map desertification at various levels, no matter maps have exponential "power" especially at the eyes of the decision makers and public at large. However, no matter the scale of mapping and the indicators included in the assessments, what counts are the results on the ground. Therefore much attention should be devoted to the endorsement of sustainable land use planning and implementation of adequate land management practices as the only remedies to reverse the negative consequences of desertification, a process that for the most part of it is driven by adverse human-induced land use changes such as deforestation and destruction of vegetation cover.

Session 1.5. Integrated methodology and policy making

TEN YEARS OF LARGE-SCALE REFORESTATION IN THE OFFICE NATIONAL DU BOIS: ACHIEVEMENTS, CONSTRAINTS AND PROSPECTS FOR SUSTAINABLE FOREST MANAGEMENT AND THE REDUCTION OF POVERTY IN BENIN

DOSSA, Ogougbé Sourou Nounagnon Léonce

Office National du Bois (ONAB), Benin

leonceonab@gmail.com

Rationale

Located in West Africa, Benin does not have large areas of natural forests, as being in the "Dahomey-gap", a mixed area of dry forest and savanna that stretches along the coast , Benin, Togo and Ghana. A total of 44 forest reserves covering 1,292,543 ha or 11.5% of the country, have been identified throughout the country and classified by colonial governments in the 1940s and 1950s Having regard to the rate of decline in their coverage, estimated more later 50,000 ha between 2000 and 2010 (FAO, 2011). This situation is caused by uncontrolled wildfires, agriculture, extensive grazing of cattle, etc. To reduce the rate of forest degradation, the Office National du Bois (ONAB) undertook an extensive campaign of reforestation since 2005 This study aims to evaluate the results achieved during the 10 years of operation work of that year; with a view to build on the lessons learned from to make decisions and implement favorable to the successful management of the Office appropriate actions, forest plantations and improvement of living conditions of the populations.

Methods used and partnership set up

ONAB efforts to combat desertification and deforestation are mainly oriented towards reforestation and natural regeneration of forests under-management in the southern part of Benin. All relevant activities (manual clearing, seedling production, planting, orchard maintenance, etc.) are carried out exclusively by the local workforce, which is valued at about 800 between February and September for the campaign of 2013.

The methodology used for this evaluation of the achievements and constraints of the reforestation campaign is essentially based on the use of activity reports of technical units of ONAB performed during these ten years. This reports analysis was supported by interviews and field observations in different regions affected by the campaign. The data (qualitative and quantitative) collected was processed and analyzed by the Word and Excel. The self-assessment results were presented through the diagnostic tool SWOT (Strengths, Weaknesses, Opportunities, Threats).

Results

A total of 2924 ha of surface were planted in 2005 to 2013 in forest areas undergoing desertification or "new sites" .It is the forests classified of Dogo-Kétou Atchérigbé, Bonou Bassila and Pénéssoulou where 4871384 plants were planted. Similarly, natural regenerations were carried out in the former sectors in operation where they occur, mainly teak (Tectona grandis) and Gmelina (Gmelina arborea) on an area of 2448.53 ha. These forests classified Agrimey, Djigbé and Toffo, set up by the Government of Benin with the support of the French cooperation in the years 1945. Furthermore, an analysis in the time and space of reforested areas in these forests shows a progressive evolution and that forests of Atchérigbé and Dogo-Kétou recorded the highest proportions of land. In ancient forest areas (Agrimey, Djigbé, Toffo) and Lama, reforestation efforts are limited to an average of 105 ha/year and natural regeneration to maintain productivity are estimated at 306 ha/year.

Outcomes

In addition, the manual reforestation of one hectare (01 acres) requires the ONAB nearly 546,000 F CFA or (1200 USD). For the past three years ONAB has made from its own funds over 2500 ha of plantations, or 1.365 billion F CFA ($ 2,689,050) as gross money supply for the benefit of forestry employment.

Faced with these problems, ONAB pending the backing and support of technical and financial partners must make resolutions namely: (i) take over the plantations which have not been successful; (ii) substantially reduce the areas to be reforested each year and account renewal efforts of old plantations, (iii) continue efforts to mobilize the local labor taking into account better the concerns of local residents (reduced costs of planting, improving the quality of work and better protection against fires and illegal logging); (iv) Develop master plans, plans for participatory development or updating of zoning sorted before the start of large-scale reforestation forests.

Session 1.5. Integrated methodology and policy making

STATUS OF ECOLOGICAL, DEMOGRAPHIC AND SOCIOLOGICAL BALANCE OF THE MEDITERRANEAN DINARIC KARST AREA OF BOSNIA AND HERZEGOVINA HAVING A FUNCTION OF SUSTAINABLE DEVELOPMENT AND POVERTY REDUCTION

ČUSTOVIĆ, Hamid; LJUŠA, Melisa

Faculty of Agricultural and Food Sciences University of Sarajevo, Bosnia and Herzegovina

custovic.hamid@gmail.com

Rationale

Mediterranean Dinaric karst represents a significant natural resource that covers 30% of the territory of Bosnia and Herzegovina (BiH). The area of Mediterranean karst comprises the karstic fields and pastures, biodiversity of natural cover and many untouched "virgin" areas. In the aftermath of the past war and during the transition of BiH society, the karst area sustained various forms of destruction and degradation as well as desertification.

This area is characterized by pronounced demographic trends especially as a result of the war, depopulation caused by poverty and depletion of human resources which may be connected to the activities supporting sustainable development.

One of the priority tasks in the entire Dinaric karst area, not only in BiH but in all neighbouring countries from Italy to Bulgaria, is to find out how to i) stop and reverse the negative socio-economic and environmental trends in karstic areas, ii) introduce new integrated concepts into the activities of karst revitalization, and iii) achieve socio-economic and environmental sustainabiility of life.

Methods used and partnership set up

In this paper we used the analyses based on research of the area and field tour of the Mediterranean Dinaric karst area of BiH within the framework of DAI initiative.

The Dinaric Arc Initiative (DAI) is a broad framework of collaboration that brings together partners that are concerned with the future of the Dinaric Arc.

The Dinaric Arc Initiative is a partnership of WWF, IUCN, UNESCO-BRESCE, UNDP, UNEP, FAO, EuroNatur, SNV, REC, ECNC, and CIC (FAO, 2007).

Drought index was obtained by SPI method. To calculate SPI index, we analysed the referent sequence of data 1961-2012 for different time scales and compared them with the area of Mediterranean karst, i.e. meteorological station Mostar.

In this paper we used other papers relating to Mediterranean Dinaric Karst.

Results

The condition of ecological balance in the area of Mediterranean karst complicates the climate change phenomenon. This is best shown in the drought index analysis which indicates that the highest increase of the Index during the vegetation period ocurred in the area of Mediterranean karst, i.e. Mostar. Increase was determined for the vegetation period, seasonal period as well as at monthly level. During the vegetation period the coefficient of increase averaged between 0.08 and 0.2, and during the summertime between 0.02 and 0.20. Capriciousness of the climate and effects of drought on biodiversity of the area further complicate karstic character of the area which developed mostly shallow skeletal soils.

Pronounced depopulation of the karst area is a consequence of the extreme depopulation politic in the past as well as the fact that during the war it was mostly occupied and suffered extreme demographic changes (Marković, 2011). Analysis of data from the 1991 Census as well as preliminary data of the 2013 Census shows that the population in rural areas has been drastically reduced, e.g Glamoč municipality where the population was reduced by as much as 68% or the municipality of Bosansko Grahovo whose population was reduced by 63%. Such trends are also characteristic for other rural areas of the region.

Depopulation leads to the abandonment of traditional forms of agriculture which directly threatens the preservation of biological diversity and supports rapid succession (Marković, 2011). This area is severely affected by soil erosion and desertification (Čustović, 2007). „A strong degradation of vegetation cover results in a specific rocky landscape with oasis-like „fences" (Rogić, 1976).

"The landscapes surrounding the karst fields above 500 m altitude were traditionally linked to extensive livestock production, mainly sheep and goats, less cattle. However, due to depopulation, lack of fresh water for households and animals, lack of appropriate agricultural machinery and improvement of pastures, lack of civilization contents in these areas, the number of livestock was dramatically reduced and area almost deserted" (Čustović, 2007).

The phenomenon of poverty in this region is not just a lack of income to purchase the basket of basic goods. Poverty is a form of insecurity and exposure to uncertainty. It consistes of increasingly present phenomena of climate change, inability to access elementary needs such as adequately good drinking water and sanitary services, education and health care, employment opportunities. This is a condition where basic opportunities for a dignified life are lacking.

Outcomes

To stop further degradation of all components of the environment, i.e. soil, water, air, biodiversity, landscape, economic and historical heritage, and to reverse it into improvement it is necessary to:

- support the economic viability of traditional farming systems and products to contribute to the maintenance of landscape and biodiversity,
- foster regional management of natural and cultural resources to ensure long-term conservation of biodiversity (through important natural karst systems), and
- contribute to sustainable rural development by building a specific tourism product (brand).

BiH needs to develop the policy, legal and regulatory frameworks and other required ingredients to ensure the conservation of the karst.

Session 1.5. Integrated methodology and policy making

ISSUES RELATED TO POLICY AND MEASURES TO COMBAT DESERTIFICATION IN MONGOLIA

JAMSRAN, Tsogtbaatar (1); DOLJIN, Dash (1); NYAMTSEREN, Mandakh (1); ZAMBA, Batjargal (2)

1: The Institute of Geoecology, Mongolia; 2: Ministry of environment and green development

tsogtbaatar_jamsran@yahoo.com

Mongolia became a party of the UN Convention to Combat Desertification in 1996 and as it suggested following all its decisions. For instance, it is actively implementing its action plan to combat desertification and if necessary timely act to revise, to amend and to adopt this document in line with current socio-economic and political needs. During past years, following requirement of UNCCD Secretariat the Government of Mongolia has been reporting all its actions to fulfil the implementation of the Convention in its country and best practices achieved to reach individual goals. The year of 2014 is a year for development of fifth report to the Secretariat.

Mongolian Government made a few changes in its policy to combat desertification, which was mainly influenced by announcing a decade to combat desertification by UN and adoption of new strategy by UNCCD in 2008 for the next 18 years. On other hands, research results and scientists conclusions mainly focused on establishment of strong legal and policy background to combat desertification supporting scientific elaborations realized through coherent and leveraged policy in action.

Today, the national policy to combat desertification is follow the National Action Plan to Combat Desertification adopted by the Government in 2010 and Law on Soil Protection and Combating Desertification approved by the Parliament of Mongolia. Besides these policy and legal documents Mongolian Government tries to reflect combating desertification issues into the sectoral policies, which define policy issues, are relatively solved in this country. The combating desertification problem can only be implemented with strong, coherent and transparent policy not only in environmental but also in different sectors; however, in policy documents doesn't completely emphasize this issue.

The following issues need to be carefully analysed and implemented to ensure the national policy is in act:

Even though Mongolia has made an effort to assess the degradation/desertification over its land it is still has not established monitoring system or framework to collect data/information and generate knowledge to validate assessments' results. The establishment of national monitoring system and developing specific programme for conduct should narrow any analytical works related to assessment and mapping, thus improve combating desertification actions at all level. The current actions taken by Mongolia to combat desertification consists of a short list of actions (e.g. tree plantation, establishment of forest strips, protection of water wells) which has a little impact on the ground. The definition of process and causes in detail may benefit land users and all interested stakeholders improve land use strategy, define priority actions and promote conservation approach, which are driven from solid monitoring data and knowledge generated.

The current process of degradation/desertification of land caused not only by climate change but also by changes in land use occurred in last hundred years. The nomadic pastoralist system is now adapting to socio-economic transformation, which is resulted formation of economic centers and centralization of social relations around it. Such centralization has also been observed in distribution of livestock, so we can assume that there are lands where human-driven degradation may exist. The researches dedicated to assess magnitude of human impact on land, therefore, has to be a priority field, especially evaluation of economic loss due to land degradation. On other hand, it will be feasible to conduct specific research programmes which will determine impact of ecosystem service deterioration on economy. Such approach will benefit policy and decision makers establish economic instruments that could coordinate and synchronize land use types and their intensity.

Eventough we employing limited types of combat desertification actions (e.g. tree plantation, well restoration etc.) at the global level there many different promising technologies adapted to specific environment are developed. It is, therefore, necessary to pay attention on experimental technology researches which will mainly focused on adoption of appropriate land use technology to avoid any risk of degradation. The practical side of such measures would be increased incentives for land users, economic benefits to save resources, and capacity building at all level. It will also increase awareness towards best practices which are suitable and can replace old not environmentally friendly actions.

All environmental issues need to be communicating to general public, their awareness and knowledge considered as an essential power. Giving proper information and allowing land users apply knowledge in their land use practice could be a good strategy to increase awareness. Besides it organizing different informal trainings, connecting people through workshops and establishing campaigns to promote combating desertification activities are essential.

Finally, desertification and land degradation engage all the natural processes and affect many ecosystem services, it is recommended to follow ecosystem-based approach, and act consistently, coherently and interrelate all possible forces.

Session 1.5. Integrated methodology and policy making

VULNERABLITY AND ADAPTIVE CAPACITY OF AGROFORESTRY BASED AGROECOSYSTEMS: IDENTIFICATION OF CONSTRAINTS, BARRIER ANALYSIS AND SUGGESTED POLICY OPTIONS

SAXENA, Vivek

Forest Department, Government of Haryana,India, India

viveksax1@gmail.com

Agroforestry based agro ecosystems have incremental mitigation potential through carbon sequestration in trees associated with the crops through appropriate conservation agriculture practices. Agroforestry has potential of not only ensuring sustainable land management and improvement of soil and biomass carbon stocks and consequential improved agroecosystems for combating Desertification, Land degradation and drought (DLDD), but also ensures sustainable livelihoods through improved income from harvesting of associated tree species. Agroforestry has importance as a carbon sequestration strategy because of carbon storage potential in its multiple plant species and soil as well as its applicability in agricultural lands and in reforestation (Montagnini et al. 2004)**.** At a global scale, it has been estimated that agroforestry systems could be implemented on 585 x 10^6 hectares of technically suitable land, and these systems could store 12 to 228 Mg C ha^{-1} under the prevalent climatic and edaphic conditions (Dixon, 1995)**.**Agroforestry will play a major role in the two key dimensions of climate change: mitigation of greenhouse gas emissions and adaptation to changing environmental conditions. Farmers will need to adapt to more extreme drought and flooding events, as well as the elevation in temperatures that are predicted to occur in coming decades. The poorest rural populations in the regions with least responsibility for causing climate change are nevertheless likely to be most negatively affected. Agroforestry needs to play in role in increasing the resilience of small holder farmers to climate change and other stresses. The barriers related to agroforestry as mitigation cum adaptation option need to be identified and addressed in the policy options.

The adoption of agroforestry is influenced by climatic, policy factors and other factors like rainfall, household and land holding size, farm characteristics, marketing facilities, availability of high yielding clonal seedlings, etc. Adoption of agroforestry has potential of generating significant environmental services, such as mitigation benefits, watershed protection, biodiversity conservation. Soil fertility benefits from agroforestry are key to sustainable land use. Sustainable land use management practices such as agroforestry need to be integrated in agro extension and dissemination services and farmers/tree growers awareness programmes.

Northern Plains, one of the 14 physiograhic zones defined by Forest Survey of India with an area of 295780 sq km (9 % of TGA). Northern Plains have net sown area of 71.45 % of TGA. (SFR, FSI, 2011) A low intensity survey, based on questionnaire from the owners of selected sample plots for which field data was collected from the selected sample plots of study area in Northern Plains of India was carried out. Analysis for adoption of agroforestry and key barriers was carried out. About 89% were in favour of adoption of agroforestry as mitigation cum adaptation option. 55% have preference for Poplar based agroforestry due to relatively shorter rotation period, better returns and lesser impact on associated crop yield. 33% have preference for Eucalyptus, where as 12% have no specific preference, however willing to have either eucalyptus or poplar species in combination with crops, due to advantage of additional income and improvement in soil organic content, compared to agricultural crops without trees. Poplar based block plantation is the most preferred option, followed by Eucalyptus linear plantation, Eucalyptus block plantation and Poplar linear plantation models. The model wise preference analysis is shown in Figure 1. The barrier analysis for identified barriers, as per questionnaire related to availability of good quality high productivity seedlings at affordable price, marketing constraints , price support or adequate price , transit permit/transportation and disposal of agroforestry produce was also carried out. The barrier analysis reflects, price support or adequate price is the most significant barrier, followed by marketing constraints, transit permit/transportation, and availability of good quality high productivity seedlings at affordable price and disposal of agroforestry produce. The analysis of adequacy of government policies and support for adoption of agroforestry reflects that 27.3% are

satisfied with the present government policies and support, whereas 54.7% emphasize that present support mechanism and policies are not adequate for adoption of agroforestry. About 18% have no comments on the issue of adequacy of present policy and support mechanism.

The study concludes that mitigation and adaptation potential of selected agroforestry models of Eucalyptus and Poplar exists in Northern Plains. The large population of Northern Plains depends on climate sensitive sectors like agriculture and forestry for their livelihoods. People in rural India depend on climate sensitive sectors for their livelihood and are at maximum risk from climate change. Rural areas are highly vulnerable to climate change, since people there depend heavily on natural resources. here is need to strengthen the capacities of vulnerable rural communities to live with climate variability and change, that need facilitating mutually reinforcing policy regime towards adoption of agroforestry practices in the region for the relevant stakeholders, i.e., Government departments, local communities, industries, research institutions, etc.

Session 1.5. Integrated methodology and policy making

MODELLING THE CAUSALITY OF LAND DEGRADATION WITH BAYESIAN NETWORKS LINKING DRIVERS AND PRESSURES TO STATE INDICATORS UNDER THE DPSIR APPROACH

PONCE-HERNANDEZ, Raul; AHMED, Oumer; DIXON, Rebecca

Applied Geomatics, Remote Sensing and Land Resources Laboratory, Environmental and Resource Science Program and Departmentof Geography, Trent University, Peterborough, Ontario, Canada

rponce@trentu.ca

Rationale

The determination of the likely causes (drivers and pressures: -DP) of the actual physical states (S) of land degradation at local scale, is fundamental for identification of impacts (I) and the design of appropriate responses (R) to reverse the degradation process. Linking indicators of Drivers and Pressures to State indicators on their presumed cause-effect relationship is an essential component of the DPSIR approach to the design of appropriate responses and remedial actions. This paper introduces Bayesian Networks (BN) of probability to the development of a model of causality following the DPSIR approach to establish the likely causes of land degradation at local scales. The approach integrates a set of bio-physical variables of the state of land degradation to socio-economic data gathered through interviews at local scale in North Central Mexico for model development and testing. The BN model is described and its usefulness for causal discovery evaluated.

Methods

This study integrates the biological, physical, social and economic factors of land degradation in "El Alegre" watershed, San Luis Potosi, Mexico, and links various land degradation types with their likely causes. A Bayesian network model was constructed and tested using prescribed DPSIR indicators of land degradation (Ponce-Hernandez and Koohakan, 2010) using data obtained from measurements recorded in field forms and questionnaires applied to farmers and herders and local experts and officials. These data were used as input to the model developed using the Netica™ software. The BN model was developed by linking indicators of Drivers and Pressures to State indicators based on their presumed cause-effect relationships, which were derived from expert knowledge and available data sources in the study area. The definition of the probabilistic links or the cause-effect relationships was achieved based on empirical data from Dixon (2003), and local expert consultation. Values were assigned to each degradation indicator based on all combinations of the status of each of its identified causes. The final built model enables the visualization of the causality, intensity, and areal extent of each indicator within the model and to identify the most probable causes (drivers and pressures) of the state Indicators from the sensitivity analysis of the model, determining the most influencing causes for each indicator of the state of degradation. The predicted causal relationships were validated independently through a confusion matrix and Cohen's Kappa technique using local farmers' perceptions of the causes for a given type of degradation, collected from interviews in the field through questionnaires.

Results

The resulting DPS-BN model in "El Alegre" watershed is shown, together with the mapped states of degradation and its ad-hoc designed legend in Figure 1. The complete model consists of 38 nodes representing Driving forces, Pressure and State indicators of land degradation, 92 links between the indicators and 3465 conditional probabilities. The model communicates substantive assumptions about the relationships between the degradation indicators. The model found that most of the state indicators of degradation in the area are in their worst case scenario (i.e. high degradation intensity) and under the effects of diverse degradation types and states which resulted from strong driving forces and pressures on the land. The results from the sensitivity analysis offer a ranking of the most probable causes of a given state. Driving forces, Pressures with the greatest influence on degradation on a quantitative basis can be identified. In turn, degradation indicators can be prioritized for remediation or prevention in the study area, and for investment of research effort and policies design towards the prevention of these causes,

according to their influence. In the study area, the largest intensive cause of degradation is exhibited by *"Recess of Land cover"* indicator, accounting for 95% of the study area. As the results, the Sensitivity to findings analysis shows the top three ranked causes of *"Recess of Land cover"*, *"Rangeland Biomass Scarcity"*, *"Livestock Population"* and *"Decrease in Livestock Feed in Rangelands"* respectively, while "*Crusting and Sealing"* and *"Soil Erosion by Water"* show the least impacts**.** *"Surpassed Animal Carrying Capacity"* of the rangelands is the most dominant cause ranked 1^{st} – 4^{th} for having the greatest influence on the 5 state indicators out of the 11.This indicator is identified as the 1^{st} responsible cause, contributing the highest to *"Soil Erosion by Water (rills)"*, *"Soil Erosion by Water (Gullies)*" and *"Crusting and Sealing"*, and it is ranked 3rd, and 4th in its influence for causing *"Soil Erosion by Wind"*, and *"Recess of Land Cover"***.**

Outcomes

The Bayesian Network linking Driving Forces to Pressures and States of degradation (DPS-BN) in "El Alegre" watershed represents a useful paradigm and demonstrate that these type of models can be a valuable tool for potential use by physical and social scientists in the field in order to identify the underlain causes (drivers and pressures) of specific states of degradation and accordingly set priorities for research and policy drafting for remedial action.

Session 1.5. Integrated methodology and policy making

DEFORESTATION, VULNERABILITY AND ADAPTATION STRATEGIES OF RURAL FARMERS: THE CASE OF CENTRAL RIFT VALLEY REGION OF ETHIOPIA

GEBEYEHU, Dembel Bonta

Educational Organization, Ethiopia

bontadembel2@gmail.com

In the study area, the impacts of deforestation on environmental degradation and livelihood of farmers manifest in different faces. They are more vulnerable as they depend on rain fed agriculture and immediate natural forests. On the other hand, after planting seedling, waste management system of the plastic cover is poorly practiced and administered in the country in general and in the study area in particular

These and other problems beg the attention to conduct a research to assess the causes of deforestation, environmental degradation and socio-economic vulnerabilities and adaptation strategies of rural farmers in a comprehensive manner that could suffice to inform any intervention schemes or to contribute to the existing knowledge on these issues.

The methodology for this research is qualitative approach. It is based on intensive field work data collected through different data collection techniques namely open-ended interviews, focus group discussion, key-informant interview and non-participant observation. The combination of these qualitative data collection tools in separate method can end up blurring into one another in research practice.

A study area and key informants were selected purposefully. Other respondents were selected by using random sampling technique. Primary and secondary data were utilized in the study.

The collected data was duly transcribed which was latter categorized into different labels based on pre determined themes to make further analysis and interpretations. Finally, the prior categories were disintegrated into phenomenon and conditions for the purpose of depicting their connections.

The major causes of deforestation were expansion of agricultural land, for fire wood and charcoal as source of income, poor administration and population growth. In addition to the above causes, lack of modern agricultural technology, environmental degradation, low perception about forests and lack of conservation methods.

The farmers are vulnerable to soil erosion and soil infertility which in turn resulted low agricultural production; loss of grazing land and decline of livestock production; climate change i.e. a change in traditionally known seasons of crop sow and harvest and the farmers are facing an unpredictable weather and climatic conditions to perform subsistence agricultural production/farming/ activities; deterioration of long time established social capital which was essential during adversity; and forced migration.

The farmers use different adaptation strategies include migration, different natural conservation methods in the area closure, diversification of income sources, and safety-net program; for building huts and fence they use *Kuyisa* soil block; to cope up the decrease in livestock grasslands, the farmers use "*Godantu*". For most of studied farmers' temporary and permanent urban employment is used.

Restoration and regeneration of natural resources have been implemented in the study area. There is area closure of 13,000 hectares and different conservation measures have been implemented by local farmers' participation. Due to these practices the volume of surface water run-off has decreased, soil erosion has been decreased and protected, natural woodlands started to regenerate. These also brought farmers' attitudinal change towards the benefits of area closure and its outcome.

There is also large scale reaforestation program but it failed to achieve better. The basic reason were after planting seedlings there is no enough protection and majority of plants do not easily adapt the local environment. In addition, after planting seedlings there is no mechanism for the plastic waste disposal and management as well as recycling and reusing system.

The study also found out certain organizational challenges between Environmental Protection Office and Natural Resource Office. Both institutions are working under separate offices. The first office is under Land Ownership and Environmental Protection Office and the second office is under Agricultural and Natural Resource Office, this posed a challenge for both offices to coordinate and implement their programmes and resources.

Reaforestation program should look seedlings easily adapt to local environment. During dry seasons seedlings should be adequately watered. Either by providing manageable number of seedlings for individuals or installing water pipeline that should be connected with the main container found in the study area that provides safe water for Batu/Zeway town.

Different seedling plastic cover waste collection methods should be devised. It is possible through: creating awareness about the negative impacts of plastic for the farmers, during the distribution of seedlings assigning responsible officials to coordinate peoples to collect the plastic after planting seedlings, organizing low income peoples or micro and small enterprises to reuse and generate income from the collected plastic.

Creating alternative income sources and employment opportunities to the farmer's. Educating sons and daughters would be better solution for the sustainability of their livelihoods.

Alternative ways of livestock production should be sought. Either new type of hybrid livestock or modern livestock fodder supply methods should be employed.

Environmental protection office and natural resource office are operating separately. This situation created a hurdle to have a record of better success story. Thus, the coordination efforts, activities and logistics among these organizations are recommended.

Session 1.5. Integrated methodology and policy making

RESIIENCE, INEQUALITY AND ECOLOGICAL SOIL CLASSIFICATION AS DIAGNOSTIC TOOLS

HARTMANN, Ingrid

UNDP New York and Zambia, Germany

ingridethio@yahoo.com

The diagnosis of causes of land degradation conceptualizes also the type of responses.

The hypothesis of this contribution is, that besides the drivers, which are commonly mentioned in the land degradation neutrality papers, as there are population growth, poverty, climate change etc. Other parameters are to be considered, whose importance is acknowledged, which, however, are not yet put in practice for diagnosis and responses for land degradationa neutrality.

These are resilience, inequality and ecological soil classification into the diagnosis systems for land neutrality.

Resilience: It is suggested to break down resilience in its various components as they are described in the Holling loop (Holling 1990) - growth, conservation, release, reorganization, and to translate them into practically applicable parameters which constitute adaptive capacities, as there are adaptive learning, diversification of livelihoods and ecosystems, sustainable technologies and innovations and self-regulation. It is assumed that these components are lost when land degradation is taking place, and that their restoration can also be used to restore land resilience. For further diagnosis also the resilience index framed by FAO is tested. This will be underpinned by examples from practical resilience projects of UN organizations and NGOs.

Closely related to the resilience element of self-regulation of socio-ecological systems are inequality factors. While land degradation neutrality papers highlight the relations between poverty and desertification and land degradation, it is argued in this paper, that poverty is related to poor land condition, but that land degradation and desertification are more related to inequality. This argument is based on the theories of environmental justice and underpinned by regression analysies of certain parameters of injustice with land degradation, as there are Gini coefficients of land and income distribution, inequalities of purchasing power and power of decision making etc..

Finally, the paper argues, that the enhanced focus on the use of vegetation parameters or agricultural productivity is inaccurate, as land is defined as composed of vegetation and soils, and various soil types in different conditions could produce similar vegetation types and productivities, as and might stil vary in the quantity and quality of ecosystem services they provide. It is suggested, to revitalize ecological soil classification as a diagnosis instrument for land degradation. It is argued, if the relevant data for ecological soil classification would be obtained from field mapping or infrared metods, the measurement would be as cost and time efficient as vegetation or even ecosystem service measurements, however, be close to the object in question. This will be demonstrated on the basis of selected soil data and their interpretation for comparison various conditions of degradation. .

Abstracts of contributions presented in session 2: RESPONSES

How can adaptive capacities be developed or maximized in the short-, medium- and long-term? What are the major contributions from traditional and local practices and scientific research? How are they related to specific settings? How can they be generalized so that they can be adapted and applied to broader settings? What are the obstacles to their more widespread use?

The fight against desertification, land degradation and drought is based on different domains of action aimed at improving living standards, reducing environmental degradation, stabilizing the balance between use and renewal of natural resources, and re-establishing viable community and political frameworks for managing natural resources including agricultural land. Such actions may take the following forms:

- Corrective methods, such as land rehabilitation and ecosystem restoration, which aim to halt and reverse degradation.Components of these methods include conservation of water and soils, protection or introduction of vegetation, water harvesting and management of droughts, ecological engineering, etc.;
- Improved management of ecosystems and in particular agroecosystems. These may include agroecology, agroforestry, conservation agriculture, sustainable agricultural practices for use in dry zones, etc.;
- Development of models for integrated management systems for shared natural resources. These would address such issues as access to information, negotiation of access and user rights between local and national organizations, exchange of data, conflict management, etc.;
- Implementation of favourable institutional and policy settings that promote sustainable practices that achieve livelihood goals. These can include access to market for products from dry zones, diversification of the economy, payment for environmental services, land ownership rights, access to credits, training for farmers, insurance systems, public-private-partnerships etc.

For all these actions, a "standard" or academic model often cannot be applied effectively in the field or be used to outscale practices from one region to another. Combining scientific research with traditional and local knowledge should be encouraged through participatory research to facilitate and enhance adoption of innovations so that they are well adapted to different social, economic, political and ecological contexts. Towards this end, focus should be placed on family farming systems and achievement of a better understanding of socio-ecological dynamics at micro- and landscape levels.

GENETIC ANALYSIS FOR WATER USE EFFICIENCY TRAITS AND YIELD UNDER DROUGHT STRESS CONDITIONS IN GROUNDNUT

JOHN, Kommalapati (1); RAGHAVA REDDY, Poli (2); RAJA REDDY, K. (2)

1: Regional Agricultural Research Station, Tirupati, Andhra Pradesh, India; 2: Acharya N.G. Ranga Agricultural University, Andhra Pradesh, India

johnlekhana@rediffmail.com

ABSTRACT

Groundnut is an important oilseed crop grown in India and is largely cultivated in dry lands. Drought is the most important factor limiting the yield potential of the rain fed crop. The present study is aimed at evaluating the genetic parameters for water use efficiency traits and yield in identification of drought tolerant groundnut genotypes with high yield potential. The results clearly showed that among the parents, TPT-4 recorded the highest kernel and pod yields and the genotype K-1375 showed best performance with respect to specific leaf area and water use efficiency. Among the F_1 crosses, TPT-4 x TIR-25 had showed highest pod and kernel yields and the other F_1, JL-220 x ICGV-99029 were identified as best cross for water use efficiency and harvest index. The heritability in broad sense ranged from 17.60% (specific leaf area) to 91.71% (days to maturity). High heritability and moderate GAM observed for days to 50% flowering. Moderate heritability and high GAM was showed for water use efficiency and dry haulms yield per plant, whereas moderate heritability and moderate GAM was recorded for harvest index and kernel yield per plant and low heritability and moderate GAM for stomatal conductance indicating the importance of additive gene effects, selection for such characters may be rewarding.

OVERCOMING CLIMATE CHANGE EFFECT TO INCREASE PRODUCTION OF QUALITY WHEAT SEED THROUGH PUBLIC-PRIVATE PARTNERSHIP FOR COMBATING LAND DEGRADATION IN POTOHAR-PAKISTAN

RAJA, Muhammad Omer (1); MUHAMMAD, Tariq (2); MUHAMMAD, Ashraf Mian (2); IFTIKHAR, Abbass (3); OBAID, Ur Rehman (4)

1: Forestry, Wildlife & Fisheries Department, Lahore, Pakistan; 2: Barani Agriculture Research Institute, Chakwal, Pakistan; 3: Ministry of Climate Change, Islamabad, Pakistan; 4: Zamindara Seed Corporation, Okara, Pakistan

omerraja07@gmail.com

Rationale

One of the major reasons for low yield of wheat in dryland areas of Pakistan is use of old and traditional varieties of seed by the farmers that results in decreased production and eventually farmers loose profit. Consequently, substantial rainfed area remains devoid of agriculture crops that result in exposure of soil to erosion and leads to soil degradation and desertification. If productivity from available land could be enhanced through provision of quality seed the process of land degradation will retard. Large scale production of quality seed of wheat is comparatively less cost effective for private seed companies in rainfed areas due to inconsistent climatic conditions. An innovative mechanism was explored for providing seed of improved varieties to farmers in the rainfed areas through Public – Private Partnership (PPP). A comparison between the farmer's own seed and certified seed was made to ascertain magnitude of effect on crop yield. The impact on crop yield due to sustained supply of water resource to the certified seed was measured to study the effect of semi-arid conditions on productive potential of the crop.

Methods used

The study was conducted in the rainfed District of Chakwal and canal irrigated District of Okara in Punjab province of Pakistan. The first part of the study related to the PPP mechanism for seed production in District Okara and the second part assessed the crop yield due to introduction of certified seed in District Chakwal.

Public-Private Partnership in Seed Production

A total of 25 private seed companies were pre-qualified to invite bids for the production of certified seed and a PPP arrangement was concluded between the Government of Punjab (GoPb), Pakistan and the company that tendered highest share in seed production. A total of 3,750 kg of basic seed of improved wheat variety of 'Chakwal-50' was provided to the ZSC. The seed was provided to contract growers in Okara District by the ZSC for raising certified seed over an area of 75 acres under irrigated conditions.The ZSC procured 90,000 kg of quality seed from the growers and carried out the process of seed grading, cleaning, storage, fumigation and packing before supplying to farmers in District Chakwal through seed dealers.

Comparison of crop yield

The certified wheat seed prepared by ZSC (T1) and that preserved by farmers of Chakwal-50 wheat variety (T2) were sown at six sites to compare the yield from the two treatments under rainfed conditions. The results of different crop variables measured during the trial were bulked up to each location and treatment for the principal component analysis (PCA) and analysis of variance.

RESULTS

Public-Private Partnership in Seed Production

The PPP arrangement was cost effective since all parties had suitable human resource and infrastructure to achieve the desired outputs. Although the seed company was slightly reluctant to cultivate rainfed variety of wheat under the impression that the crop yield will be quite less, however, due to higher resilience of the rainfed variety the crop yield was quite high. Due to timely availability of irrigation water for the wheat crop the growth of plants raised from basic seed in District Okara was satisfactory as depicted in the reports of FSC&RD. A total of 136,639 kg seed was procured from the growers by the ZSC and 90,000 kg quality seed was produced.

Comparison of crop yield

The crop yield obtained from the certified seed was significantly higher than the seed used by the farmer from its own source. The increase in crop yield due to use of quality seed was 46%. The difference in crop yield was highly significant between the six sites for both certified and farmer seed. The overall interaction between the sites and seed quality was also highly significant. The yield obtained from the certified seed with application of irrigation through tube well was significantly higher than that under rainfed condition at one site. The increase in crop yield on overcoming the water limitation was 41%.

Outcome

The PPP arrangement was successful in arranging certified seed for cultivating about 2,000 acres. The role of FSC&RD to regulate the sale of quality seed will have to be enhanced beyond certification process to encourage authentic seed companies to expand their business, especially in rainfed areas. In future seed companies may be encouraged to specialize in producing seed of rainfed crops to avoid unhealthy competition with such companies that rely only on wheat seed production. Furthermore, farmers have a choice to double their yield by using quality seed and increase production by almost three folds on overcoming the climate change effect caused by unsustainable supply of water resource.

Acknowledgement

The study was completed with the financial assistance provided by United Nations Development Program-Global Environment Facility funded SLMP and ZSC and technical/administrative support by the Government of Punjab, Pakistan.

LEAF TRAIT VARIATIONS AND MORPHOLOGICAL DIFFERENCES FROM CORK OAK POPULATIONS ALONG TEMPERATURE AND PRECIPITATION GRADIENT IN NORTHERN TUNISIA

ENNAJAH, Amel (1); MOUILLOT, Florent (2); SALMA, Say Kachout (1); GARCHI, Salah (1); LAAMOURI, Abd Elwehed (1); MARIEM, Aloui (1)

1: INRGREF institute, Tunisia; 2: Centre d'Ecologie Fonctionnelle et Evolutive CNRS – 1919, route de Mende. 34293 Montpellier cedex. France.

aennajah@yahoo.fr

Summary

We tested the hypothesis that contrasting climate and elevations affect the growth and productivity of more than 50 cork oak populations in the Kroumirie (Mediterranean forest in the north west of Tunisia) (Hammill et al., 2013). Study increases the terminal branches, nodes marked by annual leaf production, leaf number, life leaves, number ofbranches, their length, diameter and biomas sinformthe annual productivity of trees and this by turning up the last 4 or 5years. Similarly, the study of dendrometric parameters and foliar structural parameters like the Leaf mass per area (LMA) are parameters the variability of which informs about the architectural plasticity (Mediavella et al., 2001). We observed a significant difference in LMA, tree height and circumferences according to altitude and climate. Highest LMA values were obtained in the less favourable sites. For terminal branches, only the biomass of four consecutive years reveals significant differences between populations in response to climate and altitudinal gradient.The results indicate changes in the annual growth and productivity of these populations under near future drier and warmer conditions. They also point to alterations in their competitive abilities, which could lead to changes in the composition of this ecosystem in the long term.

EFFECT OF INTEGRATED WATER AND NUTRIENTS MANAGEMENT ON RUNOFF AND CROP PERFORMANCE IN CONSTRAINED INDIGENOUS SOIL AND WATER CONSERVATION SYSTEMS OF NORTHWESTERN BÉNIN

MOUTOUAMA, Fidèle Tchossi; AKPONIKPE, Pierre Irénikaché; SOKPON, Nestor

Université de Parakou (BENIN), Benin

fidelemoutouama@gmail.com

Rationale

In Benin, the commune of Boukoumbé is considered one of the most food insecure and vulnerable to climate change. The annual rainfall is around 1000mm and the majority of the population lives with less than $2 a day. It lies on 1036Km² of which only 33% is arable. The extensive agriculture faces a lot of constraints: the high population growth rate coupled with the hilly topography put an enormous pressure on land resources; the uneven relief causes erosion and continuous soil fertility loss; and the low purchase capacity of farmers does not allow them to buy mineral fertilizers. In such an environment, farmers have developed indigenous soil and water conservation (SWC) techniques across time such as "honey comb" and tie ridging. Soil management practices can potentially affect the process of evapotranspiration by modifying the available energy and water in the soil profile, or the exchange rate between soil and atmosphere (Jerry and al., 2000). Combined with efficient nutrients management, SWC techniques could improve water and fertilizer use efficiency and consequently crop yield. We assessed the combined effect of indigenous soils and water conservation techniques and nutrients management through micro-dose technique on runoff and sorghum performance.

Method used

The experiment was conducted in 2012, at two sites: a hillside and a plain, following a split-plot design with three SWC (whole-plot level) and four nutrients management treatments (sub-plot level). On the hillside, the SWC techniques were: 1) rectangular honey comb 2) circular honey comb and 3) stone rows. This factor on the plains included: 1) Perpendicular ploughing 2) Tied-ridging Option1, and 3) Tied-ridging Option2. The differences between the hillside and the plain SWC treatments were because of the topography.

The micro-dose is a strategic application of fertilizer, which combine small amounts of mineral fertilizer, organic matters and good cropping techniques to improve crop production. Nutrients management in our experiment included four levels of mineral fertilizer applied in the same way on the two sites:

Recommended dose: 5.52g/hole of NPK 25 Days After Sowing (DAS) and 1.2g urea /hole 45DAS

Micro-dose option1: 4g/hole of NPK at sowing and 1.2g/hole of urea 45DAS ;

Micro-dose option2: 2g/hole of NPK at sowing and 1.2g/hole of urea 45DAS ;

Control: no fertilizer.

Crop performance variables (yield, leaf area index and water use efficiency [WUE]) were analyzed through an ANOVA. For runoff water and sediments, we used a linear mixed effect model due normality and homogeneity of variance issues.

Results

The most effective treatments were perpendicular ploughing combined with either micro-dose1 or recommended dose on the plain, and rectangular honey comb combined with micro-dose1 on the hillside. On the plain, perpendicular ploughing and tie-ridging option1 reduced runoff water and sediments. On the hillside, rectangular and circular honey comb combined with micro-doses reduced runoff sediments. Plots with recommended fertilizer dose increased sorghum yield three fold compared to the unfertilized plots while Micro-dose1 doubled the yield. Fertilizer application at the recommended dose and micro-doses improved WUE for sorghum grain and total dry matter (TDM) compared to control plots, either with or without perpendicular ploughing.

Outcomes

Poverty, environmental degradation, and low agricultural productivity are interlinked and potential causes of food insecurity (Bationo and al., 1998). Increasing the efficiency of external inputs and making them an attractive option for African farmers can be achieved by increasing either nutrient availability or water availability (Breman, and Debrah, 2003) or both. Boukoumbé is a typical case where both land and water are marginal and where farmers have limited access to production inputs. In such a constrained environment, an integrated water and nutrient management approach has a potentially high benefit on crop production. Even if application of fertilizer at recommended dose increased the yield three fold, micro-dose1 increased it two fold and reduced the amount of fertilizer needed by the farmer, thus the financial investment. Secondly, with indigenous SWC techniques, erosion effects are reduced and nutrients and water are stopped and used more efficiently by the crop. Finally, the combination of the previous aspects improved WUE.

These findings are relevant for other cereal crops, particularly under harsh conditions, and areas where farmers have limited access to land and fertilizers.

Still, there are potential areas of improvements, such as fine tuning the amount of fertilizer used for the micro-dose and the utilization of organic fertilizer to insure long term improvements in soil quality.

THE DIVERSIFICATION OF THE AGRICULTURAL CROPS FOR IMPROVED NUTRITIVE BASE OF LIVESTOCK ON SALINE SOILS IN TAJIKISTAN FARMS

AHMADOV, Hukmatullo Mahmudovich (1); TODERICH, Kristina Nikolaevna (2)

1: Tajik Soil Sciences Institute, Tajikistan; 2: IGBA-CAC, Uzbekistan

ahmadov@yandex.ru

Rationale

Tajikistan is embarking on developing a self-reliant agriculture for food security and improved livelihoods. A multitude of newly independent, often poorly trained farmers has emerged. Rural poverty is high. In this context, farmers need urgent assistance in becoming acquainted with new technologies. Ideally, such innovative technologies on land and water use-efficiency through cultivation of salt/and drought tolerant non-traditional or underutilized local crops help farmers to obtain immediate short-term benefits and improve their living standards with a longer-term perspective of improving the quality of natural resource base. Although the challenge is further complicated by adversities stemming from climate change, rainfall scarcity and variability, which require irrigation agriculture to be applied, the low financial resilience of the farmers in the region and a weak extension system, had impact on rural poverties, health and environment.

Methods

Saline soils are widespread in the irrigated areas of the Northern and Southern Tajikistan.Formerly more of these lands used for agriculture. In the 90 because of the civil war, lack off unding and equipment, etc. these lands were out of crop rotation. Salt-affected soil formed.

In consideration of importance of the problem IGBA with national institutions for several years in Tajikistan in some farms abandoned and saline soils, research conducts in two areas: first - development of technology for the production of seeds of promising accessions of sorghum and millet indifferent saline soils and climatic conditions, second - study of the influence of different doses of mineral fertilizers on the growth, development and productivity of promising accessions of sorghum and pearl millet in saline soils. Soil-salt characteristics of the plots and vegetation indices plants have studied in detail.

The research conducted territory of Southern and Northern Tajikistan in the field, experimental, expeditionary and laboratory conditions.

Results

Field observations measured showed considerable variability for some quantitative traits, which allowed to identify ICSV 93046, ICSV 1411, ICSV 112 (SP 4495), S-35 and ICSV 25280 (SP 4487-3) asthe mosttop-yielding populations/lines of sorghumfor forageproduction in the south part of Tajikistan. These sorghum lines showed good performance under hot summer season, survival of adult plants, plant height and vegetative cover (plant density) to that of local Gissar variety.

Improved Pearl MilletlinesMC94C2 IP19586 and less HHBCV Tall IP and IP 13150 among tested varieties were performed well and for short summer period given high green biomass (of about 53,6 t/ha). These improved lines could be also characterized as early-blossoming and early-maturing varieties.The above mentioned varieties were also characterized by having the highest yield of fresh biomass.

In Northern Tajikistan first screening of pearl millet and sorghum at on-farm level was conducted in the second decade of July after harvesting of winter wheat.

Field observations measured showed considerable variability for some quantitative traits for both crops. A single cutting of above-ground biomass at the10 cmheight was done for fast-growing forageICSV-93046, ICSR-93034 sorghum and IP-19586, IP-13150 lines. Re-growth of the shoots after cutting was going slowly. Plants harvested only once on 05.10.11 produced about 5 times more forage than local varieties that indicated on perceptivity of cultivation of these two forage crops in the Northern Tajikistan –as an additional source of forage for livestock. The top-yielding ICSV 93046, ICSV 1411, ICSV 112 (SP 4495), S-35 and ICSV 25280 (SP 4487-3) sorghum cultivars for forage

production in the southern Tajikistan were identified (Figure).

Improved Pearl Milletlines MC94C2 IP 19586 and less HHBCV Tall IP and IP 13150 among tested varieties were performed well and for short summer period given high green biomass (of about 73.01 t/ha).

For sorghum ICSV 93046, ICSV 1411, ICSV 112 (SP 4495), S-35 and ICSV 25280 (SP 4487-3) were recognized to be promising as a second crop by producing about 105,04t/ha

Percentage of seed germination (as ranges 69-90%) and survival of seedlings/adult plants (67-86%) was significantly higher for HHVBC tall and IP19586. when compared with local variety.

Outcomes and Recommendation

Varieties and lines of sorghum ICSR 93034, ICSV 93046, Uzbekistan -18,Glaze and Peark Millet: 1P 19586, 1P13150, HHVBC TaLL., Hashaki, are turned out to be more adapted to saline soilsand climatic conditions of Northern Tajikistan.

The top-yielding ICSV 93046, ICSV 1411, ICSV 112 (SP 4495), S-35 and ICSV 25280 (SP 4487-3) sorghum cultivars for forage production in the Southern Tajikistan were identified. They showed good performance under hot summer season. Improvedlines of Pearl MilletMC94C2 IP 19586 and less HHBCV Tall IP and IP 13150 among tested varieties were performed well and for short summer period given high green biomass (of about 73.01 t/ha). For sorghum ICSV 93046, ICSV 1411, ICSV 112 (SP 4495), S-35 and ICSV 25280 (SP 4487-3) were recognized to be promising as a second crop by producing about 105.04 t/ha.

SUSTAINABILITY THROUGH PROTECTION AND PROPAGATION OF INDIGENOUS LIVESTOCK BREEDS- CHOLISTANI BREED OF CATTLE AS MODEL FROM CHOLISTAN DESERT, PAKISTAN

FAROOQ, Umer

University College of Veterinary & Animal Sciences, The Islamia University of Bahawalpur, Pakistan

umer.farooq@iub.edu.pk

Rationale

The 15 recognized indigenous breeds of cattle constitute 43% of the total livestock population in Pakistan and belong to Zebu cattle. These precious breeds are currently under threat and might disappear even before proper documentation until and unless streamlined efforts are diverted towards them. This horrific state is due to many factors such as epidemic diseases, urbanization, indiscriminate crossing with native stock, misdirected cross breeding with exotic stock/semen, inclined livestock systems from extensive to intensive, lack of valuation of local breeds, decreasing natural resources, environmental degradation and global warming. Hefty work has been documented on many aspects of Sahiwal and Red Sindhi breeds of cattle in their respective local climates which have rightly gained them an international fame as being the vital tropical milk breeds of Pakistan. However, many other indigenous livestock breeds such as Cholistani cattle being reared under pastoral systems of Cholistan desert are yet unexplored. Specifically, the aim is to introduce this formerly neglected breed of cattle (Farooq *et al.,* 2010). This breed is a new entrant in Livestock Census of Pakistan, 2006 to stay as a breed. It is a brown/black speckled breed with stout body and black switch tail (Fig 1) and is a major factor in socio-economic aspects of Cholistani nomads.

Methodology

The said work will present a detail account of research work conducted in the last five years by the author, on reproductive traits of Cholistani breeding bulls being harbored at Semen Production Unit (SPU), Karaniwala, Bahawalpur (Cholistan), Pakistan. Keeping in view the prevailing climatic conditions of the Cholistan desert, four seasons of 3 months duration each were defined as i) cool dry winter (November, December, January) ii) temperate spring (February, March, April) iii) hot dry summer (May, June, July) and iv) hot wet summer (August, September, October) (Farooq *et al.,* 2012). Various testicular (length, width, scrotal circumference, paired testicular volume), seminal (fresh and post thaw semen), libido-related, fertility related, haematochemical and endocrinological attributes were studied in various seasons of the year.

Results

Results of the continued study has revealed that this breed has an innate ability to maintain most of its reproductive and physiological traits to near constant during all seasons without compromising on their performance (Farooq *et al.,* 2013; Mehmood *et al.,* 2014). This is indicative of their thermo-tolerance and adaptation to harsh climatic conditions of the desert.

Outcomes

Our group was the first to introduce Cholistani breed of cattle from Pakistan in 2010. We are of the strong opinion that poverty alleviation and sustainability in livestock/agriculture lays within the protection/propagation of indigenous livestock breeds. Since our study, various academic institutes have diverted their research works on this breed and work is under way. However, a directional approach by the stakeholders, researchers, academicians, governmental/non-governmental organizations need to collaborate for protection and propagation of this neglected breed of cattle. It will pave a smoother way towards poverty alleviation of rural/suburban areas and a successful sustainable agriculture in low input production systems such as Cholistan desert, Pakistan.

USE OF MUTUALISTIC SYMBIONTS AS A STRATEGY FOR REHABILITATION OF TEPETATES

SANTIAGO MARTÍNEZ, María Guadalupe (1); HERNÁNDEZ CUEVAS, Laura (1); GALINDO FLORES, Gema (1); NAVA GUTIERREZ, Yolanda (1); GUERRA DE LA CRUZ, Vidal (2)

1: Autonomous University of Tlaxcala; 2: National Institute of Forestry Agriculture and Livestock Research-Tlaxcala

gsmico@hotmail.com

Soil loss is one of the most critical problems in the Mexican territory. In central Mexico, where soils of volcano origin predominate, natural and anthropogenic erosive process has lead to the exposure of the hard horizons from soil, locally known as tepetates. The extreme hardness of tepetates limits gas exchange and water infiltration, which in addition to the low fertility make them not suitable for the establishment and persistence of plants (Gama-Castro, et. al., 2007). The use of mutualistic symbionts as N-fixing rizobacteria and mycorrhiza fungi that help plants for nutrient and water uptake can be a promising strategy for rehabilitation of critical environments like the tepetates (Garcia-Cruz, et. al., 2007). Under such a premise, we established mycorrhized and rizobacteria colonized-trees and shrubs in two areas with tepetates, with the aim to evaluate their survival and growth and asses their role as "resource islands" in the process of tepetates restoration in the long term (Bethlenfalvay, et.al., 2008).

In a greenhouse we produced seedlings from seeds of five plant species: *Amelanchier denticulata* and *Eysendhartia polystachya* were inoculated with arbuscular mycorrhiza fungi (AMF) (*Acaulospora laevis, A. morrowiae* and *Claroideoglomus claroideum*), *Phaseolus coccineus* was inoculated with N-fixing bacteria (NFSB) (*Rhizobium tropici*); *Pinus cembroides* and *Comarostaphylis discolor* were inoculated with ectomycorrhiza fungi (EMF) (*Inocybe dulcamara, Suillus glandulosipes* and *S. tomentosus*). Half of the plants of all species were not inoculated. All seedlings were planted in two areas with tepetates in Vista Hermosa ranch, municipality of Altzayanca and Ejido San Jose, municipality of Atlangatepec, Tlaxcala, Mexico. In each area we set 40 plots of 16 m^2 to randomly assign five replicates of eight treatments: S0V0M0, S0V0M1, S0V1M0, S0V1M1, S1V0M0, S1V0M1, S1V1M0, S1V1M1 (S0: without sediment; S1: with sediment; V0: without green manure; V1: with green manure; M0: no inoculation; M1: with inoculation). We determined pH, EC, organic matter, P contents and most probable number of infective propagules (MPN) of AMF and NFSB before planting in each plot as well as the end of the experiment. We evaluated plant survival, diameter, height growth and mycorrhization percentage and MPN of AMF and NFSB in soils. Survival was analyzed through X^2-test, while growth variables were analyzed by tree-factors ANOVA and Tukey mean comparisons.

Plants of *Comarostaphylis polifolia* showed 100% mortality after planting. Survival and height of *Pinus cembroides* in Altzayanca showed non-significant differences between treatments, higher diameters were observed in treatments with sediment; in Atlangatepec survival was greater in treatments without sediments; while height and diameter were low in all treatments. *Amelanchier denticulata* in Altzayanca showed low survival on inoculated plants and zero in non-inoculated plants, while height and diameter were variable between treatments. In Atlangatepec higher survival was observed in treatments without sediment, only inoculated plants increased height and diameter. *Eysendhartia polystachya* in Altzayanca showed the higher survival for inoculated plants and little growth in all treatments. In Atlangatepec higher survival was observed in inoculated plants added with green manure, growth varied in all treatments. In Altzayanca, *Phaseolus coccineus* showed higher survival in with sediments plots, although differences between treatments were non-significant, in Atlangatepec, survival varied and the species showed very limited growth. AMF mycorrhization in Altzayanca was high in *A. denticulata* and *E. polystachya*, in *Ph. coccineus* varied; EMF in *P. cembroides* was also high. In Atlangatepec, mycorrhízal colonization was high in all species. In both locations, MPN of propagules of AMF and NFSB were very low at the beginning; but increased considerably in the end of the experiment, for instance, in Altzayanca MPN of infective propagules of AMF increased in treatments without sediments, and in with sediment plots. The MPN of NFSB increased in treatments without sediments and with-sediment plots. A different trend was observed in with-

sediment plots and green manure in Atlangatepec, where AMF propagules decreased. In general, treatments with inoculated plants showed more propagules of NFSB and AMF. By the end of the experiment non-inoculated plants also showed mycorrhization in both locations.

Amelanchier denticulata, Eysendhartia polystachya, Phaseolus coccineus and *Pinus cembroides* are native plants with good potential for tepetates rehabilitation, which improves with mycorrhization. Infective propagules of AMF and NFSB, key biological groups in soils, increase by the addition of green manure, sediment accumulation and mycorrhization of plants. It can be said that plant mycorrhization for tepetates rehabilitation provides important advantages, particularly in survival. Native propagules in tepetates interact with introduced propagules from plants, functioning as "resource islands". In summary, results from this study, despite the short term assessment, showed that induction of ecological rehabilitation process is possible in highly degraded environments like in tepetates, as stated by García-Cruz *et al.* (2007). Nonetheless, such induction does not guarantees the success of rehabilitation, if it is not considered as a long term practice, in which all the process have to be maintained to prevent the reverse by disturbances, especially the anthropogenic factors.

PRODUCTION POTENTIAL OF RAINFED GROUNDNUT/PIGEONPEA INTERCROPPING SYSTEM AS INFLUENCED BY CLIMATE RESILIENT FARM POND TECHNOLOGY IN SEMI- ARID TROPICS

TIMMAVAJJULA, Giridhara Krishna; GUDUPALLI, Krishna Reddy; PULI, Maheshwara Reddy; ACHUKATLA, Muneendra Babu

REGIONAL AGRICULTURAL RESEARCH STATION, TIRUPATI, ANGRAU, India

tgiridharakrishna@gmail.com

Abstract

Increasing food production to cater the needs of burgeoning human population has become a global challenge. The scope to increase productivity in drylands needs exploitation through different means as horizontal expansion is the prime limiting factor. Groundnut crop is cultivated as a sole crop under rainfed conditions in semi arid alfisols and does not provide the scope for utilization of natural resources throughout the year (Singh et al., 1980). Erratic rainfall coupled with drought often recording low yields. However, the high yield potential of rainfed groundnut with supplemental irrigations at sensitive stages was realized in eastern mandals of Chittoor and parts of Nellore District of Andhra Pradesh (India) with an average productivity of 1500 kg ha^{-1} as compared to the average productivity of 800 kg ha^{-1} under rainfed situation. It was reported (Yellamabda Reddy T and Sankara Reddy 1992) that groundnut responds well to 10 mm of irrigation through sprinkler in alfisols during pod development stage and supplemental irrigation of 10 mm depth increased the pod yield of rainfed groundnut at Ananthapur (2002) over control by 21.7 %. Experiments conducted all over the country revealed with one supplemental irrigation at pegging stage results in marked increase (50-60%) in pod yield of rainfed groundnut over check (no irrigation).

Stabilization of low productivity of rainfed groundnut and providing crop insurance are the need of the hour.Therefore, a series of experiments were conducted with an objective to study the effect of supplemental irrigation on crop performance in terms of yield and economics at Regional Agricultural Research Station, Tirupati of Acharya N. G. Ranga Agricultural University from 2009 to 2014 with groundnut + red gram (7:1) intercropping system using surface runoff water collected during intense rainy days in a farm pond.

Methods Used and Partnership Set Up

To study the effect of supplemental irrigation for *Kharif* groundnut through sprinkler at moisture sensitive stages during dry spell and to assess the economics of groundnut / pigeonpea (7:1) intercropping system with supplemental irrigation pumped from the farm pond.Four treatments *viz.*,T_1 – Groundnut + pigeonpea(7:1) (control – Rainfed),T_2 – Groundnut + pigeonpea(7:1) 10 mm of irrigation water given at each irrigation at flowering / pegging when there is a dry spell of more than 10 days, T_3 - Groundnut + pigeonpea (7:1) 10 mm of irrigation water given at each irrigation at flowering and pod formation stages, T_4 – Groundnut + pigeonpea(7:1) at 10 mm of irrigation water given at each irrigation at flowering, pod formation and at maturity; were laid out (Plot size: 1000 m^2 (50 m x 20m) for each treatment) and replicated four times with a spacing of 30 cm x 10 cm. The experiment was designed in randomized block design and the varieties under study were Narayani (*Arachis hypogaea* L) and TRG-38 (*Pigeonpea*). The applied doses of Nitrogen,Phosphorous and Potassium were 20,40,50Kg ha^{-1} respectively.

Institutional Support

Central Research Institute for Dryland Agriculture, HYDERABAD

Results

During *Kharif*, 2009 one supplemental irrigation applied through sprinkler, could significantly influence the yields of groundnut and pigeonpea and recorded the highest net returns of Rs.21,180 ha^{-1} whereas the treatment without supplemental irrigation gave the lowest net returns of Rs.8,710 ha^{-1}. During 2011-12, supplemental irrigation given once with collected rain water in the farm pond. The net returns were influenced by supplemental irrigation. The highest net returns are due to irrigation which increased from Rs.27,645 to Rs.31,180 ha^{-1} as compared to control

(Rs.12,275/- ha^{-1}). In *Kharif*, 2012-13, supplemental irrigations were given to the treatments T_2 and T_3. As there was no dry spell at maturity phase irrigation was not given to groundnut in T_4.The results revealed that highest net returns of Rs.46,750/- were realized from groundnut + pigeonpea in 7:1 system in T_4 followed by T_3 treatment (Rs.45,060/-). The control treatment (T_1) gave the lowest net returns of Rs.17, 200/-ha^{-1}. This clearly envisaged that providing supplemental irrigation even at moisture sensitive stages(three) suffice to realize highest net income under Semi Arid Tropics.

Outcome

Results are encouraging the farmers to grow groundnut with pigeonpea (7:1) intercropping system irrigated with surface runoff water collected in farm ponds in Semi Arid Tropics. The positive results are due to supplemental irrigation applied during moisture sensitive stages and there by realizing stabilized yields. Moreover, system as a whole can able to sustain profitability of rainfed farmers as well it could avert the loss of huge quantities of top fertile soil during the intense rains.

Acknowledgement

The support received from the Associate Director of Research, Regional Agricultural Research Station,ANGRAU, Tirupati,Hyderabad (India) is acknowledged.

ARBUSCULAR MYCORRHIZA: AN ESSENTIAL COMPONENT FOR THE ESTABLISHMENT OF WILD PLANTS ON "TEPETATES"

NAVA GUTIÉRREZ, Yolanda (1); SANTIAGO MARTINEZ, Maria Guadalupe (1); HERNÁNDEZ CUEVAS, Laura (1); GALINDO FLORES, Gema (1); MARTÍNEZ Y PÉREZ, J Luis (2); GUERRA DE LA CRUZ, Vidal (3)

1: Laboratory of Mycorrhiza, Research Center in Biological Science, Autonomous University of Tlaxcala, Mexico; 2: Laboratory of Biodiversity, Research Center in Biological Science, Autonomous Univertity of Tlaxcala, Mexico; 3: National Institute of Forestry Agriculture and Livestock Research-Tlaxcala

ixtulco@hotmail.com

Rationale

Areas with exposed "*tepetates*" has been studied since several years, mainly to estimate the loss of soil organic layer (Gama-Castro, et.al., 2007) or to incorporate them to agricultural uses (Alvarez, et al., 1992). However, in most of these studies, knowledge on the establishment of natural flora in these areas has not been considered, neither the mutualistic associations of plants and microorganisms, like Arbuscular mycorrhiza fungi, that favor their survival. Generated information could be important in selecting plant species with greater potential for rehabilitation of highly disturbed areas, either for restoration purposes or for their human uses. The objective of this study were, to identify plant species growing on *tepetates*, to asses the effect of physical structures for soil retention, placed along the slopes during the rainy season, on the natural establishment of plants and to determine their mycorrhizal status.

Methods

In two locations of the state of Tlaxcala, Mexico, namely Vista Hermosa ranch, municipality of Altzayanca and Ejido San Jose, municipality of Atlanagtepec, with 20.37% and 15.73% of slopes respectively, we established 40 experimental squared plots of 16 m^2 dimension. On the lower part of each plot we set stone or board aligned barriers to promote terrace formation preventing soil runoff and in this way creating microenvironments with translocated soil. During 2007 and 2008 rainy seasons we collected samples of plant species inside and outside of the plots to integrate a floristic inventory; these plants were taxonomically classified trough monographic keys. To determine mycorrhizal colonization we randomly sampled the radical system of five individual plants of each species, which were processed through standard techniques for arbuscular mycorrhiza, and estimating the percentage of mycorrhizal colonization by viewing structures of the association (McGonigle et. al., 1990). Comparisons for plant species and percentage of colonization were performed between locations and plots with and without physical barriers.

Results

For both locations we registered a total of 44 botanical families, 106 genus and 140 plant species. Best represented families were Poaceae with 18 species, five of which were shared by the two locations and Asteraceae with 10 species, two of which were found in both locations. 55 taxa were found only in Atlanagatepc and 29 only in Altzayanca, and 14 were species shared by the two locations. Most of the species were herbs, which predominantly associate with arbuscular mycorrhiza fungi. In Atlangatepec, 80% of the species had mycorrhizal colonization, with 27% showing from 80 to 100 % colonization.

In Altzayanca 86% of the species showed arbuscular mycorrhiza, however, only 10% showed a very high level of colonization. Physical barriers had a positive effect on the establishment of plant species since we identified 61 taxa in these plots; in contrast in plots with no barriers we found 50 species. The same trend occurred in mycorrhizal colonization; plants in plots with barriers showed on average 75% colonization, while in no barriers plots colonization averaged 40%. *Tepetates* are very poor in fertility, P content in Atlanagetpec was 1.9 mg/kg, and in Altzayanca it was 2.23 mg/kg, which suggests the need of plant species to form arbuscular mycorrhiza.

Perennial plants that showed 60% or more colonization, *Cheilantes lendigera, Brickellia veronicifolia, Haplopappus venetus, Mimosa biuncifera* and *Plantago nivea*, have a high ecological potential, since they can function as nurse plants to favor the establishment and development of micorryzal association in other herbs through the hyphae net that forms in the soil matrix connecting two or more plants and sharing the mycorrhizal fungi community.

Outcomes

This study concurred with the conclusions of Valle and Bocio (1996) on the importance of the knowledge of plant communities to determine the species with potential for rehabilitation of degraded areas, allowing the implementation of strategies for this purpose. Building physical barriers is a practice that promotes soil retention, improving conditions for the establishment of plant species. Dominance of families like Poaceae and Asteraceae is important since some the species are considered as early sucesional in disturbed areas. Micorryzal fungi play an important role in the establishment and survival of plant communities favoring the increase in number species. Some of the species found in this study showing high percentages of colonization might be considered for massive production in order to utilize them in rehabilitation of degraded soil programs. Soil fertility is considered as an important factor for the establishment of arbuscular mycorrhiza association, therefore nutrient deficiency, particularly P, promotes high percentage of plant colonization as a strategy to uptake the few available nutrients.

PROMOTION OF PARTICIPATORY GROUNDNUT BASED CROPPING SYSTEMS IN SEMI-ARID TROPICS TO COMBAT CLIMATE CHANGE AND IMPROVE PRODUCTIVITY FOR SUSTAINABLE LIVELIHOODS

LEVAKA, Surya narayana reddy; S, Rajendra Nath; KUNUTHUR, Srinivasa Reddy

Grameena Vikas Samithi, Tirupati, India

grameena@yahoo.co.in

Rationale

Groundnut is the major rainfed crop in our operational area i.e., Chandragiri and Pulicherla blocks of Chittoor District, Rayalaseema, Andhra Pradesh. Season rainfall of 380.4 mm in this region is sparse, ill distributed and erratic, with recurrence of droughts. With the result, the rainfed crops have been failing over several decades, driving farmers to desperately explore and exploit ground water by digging deep bore wells whose failure rate is very high as the water table falls steep down. Traditionally, millets had been cultivated in these tough and rough weather conditions which provided at least minimum food security among the vulnerable farming community, but a major shift towards groundnut cultivation over a few decades, has proved un-economical. Hence, farmers are in constant search for improved technologies and drought resistant varieties. Available groundnut seeds are spurious in quality and yields are reducing gradually and most of them have lost their identity. Strategically, to enable these farmers to switch over to Low External Input and Sustainable Agriculture ways of farming, and to empower them in alternative farming practices, Farmer Field School (FFS) a discovery learning method was introduced.

Methodology: Farmer Field Schools are the schools for the farmers organised outside the classrooms and on farms. They operate adopting principles of the non-formal education. Most of the sessions/contents are based on adult learning processes. Aim of FFS Sessions: Generation of awareness among the farmers by 'Learning by Doing' method.

Partnerships set-up

Agriculture Man Ecology (AME); Village council, Watershed committee, Self-help groups (SHGs), Regional Agricultural Research Station (RARS), Tirupati, Department of Agriculture.

Results:

Soil and moisture conservation achieved by laying of bunds, sowing across the slope, conservation furrows and inter-cultivation. Particularly, conservation furrow enabled farmers to understand its uses especially in the form of increase in the soil moisture, duration of its availability, arrest of soil erosion and mitigation of soil degradation i.e., a sign of Land Degradation Neutrality (LDN).

Farmers learnt that increasing number of inter-cultural operations in Experimental Plot not only helped in proper weeding, but also increased soil moisture content. Benefit of the conservation furrows was even more evident when it was compared with the growth of the red gram crop to 150 cm near the conservation furrow as compared with that of the farmers practice (120 cm). Due to this impact other FFS farmers showed keen interest to adopt sustainable agriculture techniques in their plots.

Groundnut cultivation aided in enhancement of soil fertility due to presence of nitrogen fixing *rhizobium* in the root nodules. Besides application of good quality Farm Yard Manure (revitalisation of traditional knowledge)@four tones/acre, enriched FYM and bio-fertilizers in FFS plots rendered the crops drought tolerant and they looked healthier than the crops grown with the farmers practice. [One acre is equivalent to 0.40 hectare]

Adoption of good practices like quality seed, optimum seed rate @50kg/acre, optimum plant density (33 plants/sq.m), red gram as intercrop at 7:1 ratio, trap and border crops, and practice of carrying seed germination test has resulted in good plant population. Change in inter cropping system from 15:1 row to 7:1 row, and also introduction of trap and border crops helped to increase productivity in the form of additional bio-mass per unit area cultivated.

Due to inter cropping, more predator population (Lady bird beetle, spider) was observed. Prior to FFS, farmers were of the opinion that they can't go for intercropping especially in groundnut. Border crop like bajra served as barrier to Thrips movement from the neighboring plot which comes under sustainable agriculture practices. Castor as trap crop attracted *Spodoptera* caterpillar for egg laying and cowpea crop served as a source of food for the predators.

Outcomes

Results clearly indicated that farmers can cultivate groundnut based cropping systems in drylands with following natural and monetary benefits. Results are in congruence with that of the study conducted by Eric Carl berg et., al (2012) in Ghana.

Benefit of Conservation Furrows was evident with redgram crop which grew up to 150 cm near the dead furrows as compared to 120 cm growth in the farmer practice plot. This impact awakened farmers to adopt such Sustainable Agriculture practices.

Group farmers were able to make a decision on the groundnut variety suitable to their area. FFS farmers have stopped using old varieties (TMV2, JL24) and sown VRI-2 & Narayani varieties in the Kharif crop season-2007. VRI-2 & Narayani cultivars identified for promoting seed bank.

FFS approach has resulted in the crop maximisation and in the development of livelihoods (Ali and Haider, 2012). Group farmers reaped additional net returns of US $24.00/acre due to increase in yields by 94 kg/acre in groundnut in first year of transition itself from existing practices to LEISA technologies. Increased income paved way for reduction of poverty, and an improvement in sustainability as well.

Acknowledgements

We acknowledge with thanks all the stakeholders.

ENHANCING LAND REHABILITATION, ECOSYSTEM RESTORATION AND CLIMATE CHANGE RESILIENCE IN THE DEGRADED LAND AREAS THROUGH SALINE AGRICULTURE

SAQIB, Muhammad (1); AKHTAR, Javaid (1); ABBAS, Ghulam (2); WAHAB, Hafiz Abdul (1); MURTAZA, Ghulam (1)

1: University of Agriculture Faisalabad, Pakistan; 2: Dept. of Environmental Sciences, COMSATS Inst. of Information Technology, Vehari, Pakistan

drhmsab@yahoo.com

Rationale

Land degradation is a major threat to food security and climate change resilience of rural communities around the world. Salinity, sodicity, low fertility and drought are among the major causes of land degradation. Saline agriculture technology proposes an integrated utilization of genetic resources (plants and animals) and improved agricultural practices for profitable use of these degraded lands and poor quality water on a sustained basis (Saqib et al., 2013). Soil and water problems of the degraded areas vary hence require site specific solutions depending on the needs of the local communities and their ability to adapt particular solutions. These solutions include the use of stress tolerant crop genotypes, grasses and tree species in combination with different organic/inorganic amendments. The slightly degraded areas may be used for crops and the moderatley to severely degraded areas may be utilized for grasses and trees. It is hypothesized that the land degradation can be reversed and a win-win situation (i.e. land use, climate change resilience and income) can be developed in the degraded land areas by using an integrated system including crops, grasses, trees and organic/inorganic amendments. This also leads to the environmental conservation through carbon sequestration (Lal, 2001).

Methods used and partnership set up

This paper presents the results of a number of studies including controlled condition studies, demonstration studies and farmer/community participatory studies. These studies are a regular feature of our research work. The seeds of a number of crop genotypes and, grass and tree species are collected from different national and international institutes. The collected genetic material is screened for its tolerance to different stresses under controlled and field conditions. The selected crop genotypes and plant species are grown on poor degraded lands as a demonstration to the farmers/communities of such lands and for the capacity building of students/extension workers. The farmers/community members and students/extension workers are invited to the site on different times of the establishment of demonstration sites. The interested farmers and community members are involved in farmer/community participatory activities where the selected genetic material is provided to them and they use it on their degraded lands under the supervision and guidance of the technical experts. These farmers/community members become agents of change and thus the technology is scaled up to a large area. This integrated saline agriculture system is evaluated by carrying out production cost and profit analysis.

Results

The results of these experiments show a significant genetic variation among the genotypes of different crops and among the grass and tree species from different sources (Qadir et al., 2008; Saqib et al., 2013). It has also been observed that application of different essential nutrients at higher rates can improve plant performance under degraded land conditions. The crop growth and yield in wheat, maize and sunflower was improved with the application of Si, K+ and Ca2+. In moderately to highly degraded lands it has been observed that raising grasses and trees is more successful. In a field demonstration of salt tolerant tree and forage species at the Proka Farm (Farm having poor degraded lands), University of Agriculture Faisalabad, Pakistan, it has been observed that with the use of better management practices the stress tolerant grass and tree species can be established on such lands. It has been observed that plants like Acacia, Albizzia lebbeck, Sesbania sesban, Leucaena leucocephala, Zizyphus mauritiana and Atriplex spp. grew very well due to their more stress tolerance potential, so these species can be grown on highly degraded lands. Among various grasses Sorghum Sudanese, Leptochloa fusca and Chloris gayana

grew very well under degraded land conditions. After a period of three years it has also been observed that the root growth of these plants also improved the soil conditions through the process of phytoremediation. The introduction of the selected crop genotypes and plant species to the farmers through farmer/community participatory activities has also shown very encouraging results.

Outcomes

- It has been observed that degraded land areas can be rehabilitated using site specific measures including the use of stress tolerant crop genotypes, stress tolerant grass and tree species, and the use of different organic/inorganic amendments and management practices.
- The plantation and land cover leads to the improvement in the soil physical and chemical characteristics through the process of root induced phytoremediation and soil stabilization.
- The community participation and involvement is essential for the success of these projects and interventions.

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RISKS AND OPPORTUNITIES OF EUCALYPTUS PLANTING (CASE STUDY IN THE FRAMEWORK OF THE GIZ-GERMAN-MADAGASCAN ENVIRONMENTAL PROGRAM)

PRILL, Laura Antonia (1); PLUGGE, Daniel (2); KÖHL, Michael (2)

1: University of Hamburg, Germany; 2: Institute for World Forestry, Hamburg/Germany

laura.prill@studium.uni-hamburg.de

Forest plantations on prior degraded land have globally been declared as an option to address the world's increasing demand for renewable (energy) resources. One of the most widely planted fast-growing species in this context is Eucalyptus, currently covering approximately 20 million hectares worldwide. This area is expected to increase due to population growth and urbanization trends.

Growing biomass for rural (energy) purposes in highly productive planted forests can contribute to the preservation of natural forests, its biodiversity, to the mitigation of climate change and may – if appropriately planned and managed – provide other services such as the rehabilitation of degraded land and biodiversity (Bauhus *et al.* 2010; Tyynelä 2001). For this purpose, some 7.000ha of former degraded savannah have been afforested with Eucalyptus to supply the Antsiranana region in North-Madagascar with sustainable wood energy (charcoal). For further information on the community-based afforestation project see GREEN-Mad (2007) and Miranda *et al.* (2010). Despite the manifold opportunities, cultivating Eucalyptus has often been associated with environmental and ecological impacts that negatively affect environmental sustainability of afforestation projects. The present study therefore aims to analyse ecological risks and opportunities of planting Eucalyptus.

The study was carried out, financed and facilitated in the frame of the "German Madagascan Environmental Program" (PGM-E) of the "Gesellschaft für Internationale Zusammenarbeit" (GIZ) and the GIZ Sector Project to Combat Desertification in cooperation with the University of Hamburg. The conduction of the field work in 2014 was realized with the help of ECO Consult.

For reaching the overall aim of the study, impacts on floristic biodiversity and soil properties of 21 different-aged and -managed Eucalyptus camaldulensis plantations in the North of Madagascar were analysed. Special regard was given to the temporal and spatial scale of these impacts. Within 0,1ha-sample units (transects) that were implemented on the transition from a plantation to its adjacent savannah, number, species and position of woody shrubs and trees were recorded. A biomass inventory of Eucalyptus trees and woody plants exceeding a height of 1,30m was performed in four 5mx10m-subplots that were located within each transect. Non-woody ground vegetation was determined and counted using 1mx1m-subplots. Soil samples were taken for later laboratory analysis. A total of five control-transects that were located in the savannah ecosystem served as reference sites for floristic diversity and soil characteristics. Additionally several interviews with plantation owners and non-owners were realized to verify further impacts of the monocultures on environmental aspects such as faunal diversity, erosion and ground water.

Floristic diversity of the plantations was assessed by calculating the parameters species richness, plant frequency and the Shannon Index of woody plants and ground vegetation. Plantation results were compared to those of the adjacent savannah. Parameters and indices were analysed with respect to the plantation age, population density and the applied management (exploitation intensity, current age). Table 1 summarizes these stand characteristics.

Woody undergrowth diversity of Eucalyptus stands and savannah ecosystems showed differences in terms of species richness and plant frequency (number of woody species/plants), with higher species richness and lower plant frequency tendencies on unplanted savannah sites. Diversity measured by the Shannon Index was higher in the savannah neighbouring the plantations than in the monocultures itself. About half of the woody species found in the savannah (including control sites) were also present in the single-tree stands, among them the most frequent savannah species. Regarding spatial effects, the number of woody species showed

an increase towards the savannah ecosystem. Nevertheless, differences between the investigated villages were apparent for some of the parameters.

Soil samples were analysed for their pH-value, nitrogen and carbon content, carbon-to-nitrogen ratio and their cation-exchange capacity. Soil properties varied among the three villages. Further research including the comparison of savannah and plantation soils is still in progress.

Although to a smaller extent than the savannah sites, the Eucalyptus plantations in the North of Madagascar showed the ability of providing habitat for indigenous woody species. The results are discussed in consideration of the globally increasing wood demand and an associated loss of forest area and biodiversity. Further, the increasing area of planted eucalypts - which intensifies the need for management systems that enhance the provision of ecological services (Brockerhoff *et al.* 2012) - is considered. The results allow the formulation of recommendations for policy makers and practitioners to assure the environmental sustainability of afforestation activities with Eucalyptus in the future.

DROUGHT VIS-A-VIS NATURAL RESOURCE MANAGEMENT-A MEANS FOR ATTAINING SUSTAINABILITY AND LIVELIHOOD SECURITY OF FARMING COMMUNITY

PAMULA, Venkata sathya gopal; KANDURI, Shireesha

Acharya N G Ranga Agricultural University, S V Agricultural College, India

satyagopal15@gmail.com

India is a country of varied heritage with agriculture as the major source of livelihood. Indian agriculture is very indigenous and traditional in nature. More than 70% of the people are involved in agriculture and allied areas either directly or indirectly for their livelihood. Out of total cultivable area in India, 68% (130.48 million hectares) is under rainfed condition and this area is regularly prone to drought leading to failure of the crop. (Indian Agricultural Statistics, 2010). The timely onset and well distribution of monsoon rain decides the area coverage of rainfed crops. Any deviation in onset of monsoon rain results in significant change in area covered by different crops. Drought during crop season will have significant influence on growth and development of crops which leads to reduction in yield. Hence, drought became the most important limiting factor in Indian agriculture accounting for declining livelihood security of the farmer.

Though rainfall is the primary factor that controls the generation and maintenance of drought conditions, the severity of the drought can also be aggravated by other climatic factors such as high temperature, high wind and low humidity etc. (Wilhite and Glantz, 1985). On the other side, the human involvement in form of nutrient mining, combustion of fossil fuels, Intensive land use, intensive agriculture, converting agricultural lands to commercial lands due to urbanization, establishing infrastructural facilities such as cement roads and huge constructions in rural areas are the serious issues affecting the dryland agriculture. The solely money driven agriculture has resulted changes in the cultural ethos of the community and irreversible damage to the time tested sustainable agricultural practices (National Research Council1989).

In this context, a strategic approach by means of Natural Resource Management (NRM) will help in maintaining ecological balance ultimately leading to sustainability and livelihood security of the farmer. Two specific challenges of the overall deterioration of the natural resource base of Indian agriculture were sustainable natural resource management (NRM) of rainfed areas to enhance capacities and stabilizing the production systems of rainfed agriculture. (Working Group Report of XII Five Year Plan November 15th 2011)

Even though the word 'Natural Resource Management' looks simple, its application is very complicated and involves different modes and dimensions, which needs to be applied to realize the fruits of the concept. Different components of NRM and their contributions were focused in the paper.

Controlling soil erosion, replenishing the soil with high biomass and creation of congenial microenvironment invariably improves the soil resilience. Micro climate can be made congenial by adopting agro-forestry and afforestation measures. Higher land productivity can be obtained by crop diversification including alternate land uses. Cropping intensity can be tailored according to the rainfall trends. The soil and water conservation measures improve the water use efficiency as well as soil fertility. Enhancing vegetative cover on the agricultural lands will act as a catalyst for proper onset of monsoons. Integrating animal husbandry such as dairy, poultry, piggery, sheep rearing, goatery etc.., will help in enriching the soil organic matter and efficient byproduct utilization.

Adopting appropriate cropping systems will enrich the soil fertility and allows for effective nutrient and water management. Judicious use of chemical fertilizers and pesticides will reduce the soil, water and air pollution which is the major threat for causing drought. Checking the exhaustive land mining will enhance the quality of soil and plant ecosystem. Efficient utilization of irrigation water will give scope for increasing the extent of area under cultivation. Monitoring the crop-climate association is the best tool for extracting desirable outcomes even under adverse climatic conditions. Finally, the farm diversification is an important risk distribution measure which gives scope for multifaceted agro enterprises besides maintaining crop ecosystem.

To convert the concept into concrete, the role of extension personnel, farmers, researchers as well as policy makers must be substantial. Hence the roles and responsibilities of the stakeholders were also depicted in the form of a model. It includes the capacity building activities, awareness campaigns, strengthening infrastructure facilities, refining the soil water conservation mechanism, strengthening the farmers associations, amplification of research-extension-farmer linkages, youth and women involvement, employing trained resource person for technology transfer etc. to meet the demand of NRM in rainfed areas.

DIRECT SEED METHOD OF RICE CULTIVATION USING DRUMSEEDER - A SUSTAINABLE TECHNOLOGY FOR SEMI ARID TROPICS

REDDY POLU, Bala Hussain (1); SAKAMURI, Sreenivasulu (2)

1: Acharya N G Ranga Agricultural University, India; 2: Rashtriya Seva Samithi, Tirupati, India

pbhreddy@gmail.com

Rationale

In global scenario, Rice is the most common staple food for about three billion people and receives an estimated 24-30 percent of the world's developed freshwater resources (Satyanarayana et al. 2007; Sudeep 2010). The world's population is increasing and there has been more concerns towards food security but is challenged by increasing food demand with declining water availability (Farooq et al., 2009). To meet the demand of growing population, rice production needs to be multiplied to a great extent. About 13 million ha of Asia's irrigated wet-season rice and two million ha of irrigated dry-season rice may experience physical water scarcity, and about 22 million ha of irrigated dry season rice may suffer economic water scarcity by 2025 (Tuong and Bouman, 2003).

Increased inputs cost, labour scarcity and water scarcity can be minimized, and to provide an alternative option to traditional rice cultivation method, Krishi Vigyan Kendra (KVK- Agriculture Knowledge Centre), Chittoor has introduced direct seeding method using a 8-row drumseeder for the first time in 2006 in Chittoor district, Andhra Pradesh, India. This led to considerable reduction in exploitation of water resources, human labour and ultimately cultivation costs without impact on productivity.

Methodology

The success of the assessment trial on drum-seeder technology in 2006 encouraged KVK to popularize it through training farmers (village, mandal and district levels) and extension staff; conducting *front line demonstrations* in farmer's fields; organizing field days and exposure visits; developing publications and DVDs on the technology and using mass media and purchasing more drum seeders for conducting demonstrations.

Partnership set up

KVK partnered with a number of other agencies in promoting this technology. Technical bulletins, pamphlets, Digital Video etc were prepared in vernacular (Telugu) language for supplementing the capacity building programmes to farmers and extension functionaries. Partners involved in the programme were *National Bank for Agriculture and Rural Development (NABARD),* India, *Agricultural Technology Management Agency (ATMA),* Chittoor, Andhra Pradesh, India, *Agriculture Department, Non Governmental Organizations etc.*

With the financial support of ATMA and NABARD about 200 drum-seeders and 200 modified conoweeders were procured and placed at Agricultural Offices as well as the contact farmers and innovative farmers. Agricultural department supplied drumseeders and conoweeders to farmers on 50% subsidy basis.

Results

Operationally, the direct seeding with drumseeder method differs from traditional transplanting method in nursery raising, seed rate, transplanting, weeding and irrigation operations. The rest of the things like fertilization, plant protection, harvesting, threshing and bagging remain same in both cases. RASS-KVK has conducted as many as 300 front line demonstrations in the farmers' fields to show the performance and convince the farmers about the technology. The impact of direct seeding at farm level was measured with indicators like cost of operations, yield parameters and economics of Paddy.

The cost of operations in direct seeding method was very low i.e., 4775 INR/ha when compared to that of transplanting method (13625 INR/ha). Hence it can be concluded that direct seeding method is profitable to the farmers even if they get normal regular yields.

On an average, the grain yield obtained in direct seeding method (6820 kg/ha) was 10% more than traditional method (6188 kg/ha). This is due to maintenance of 20 cms space between rows, more aeration and healthy growth of roots due to running of conoweeder, more productive tillers per hill due to intermittent wetting & drying of the field in initial stages etc. Net returns in direct seeding method was 53230 INR/ha while in traditional method it was 36396 INR/ha. Benefit Cost ratio in case of direct seeding method is 2.86 whereas in traditional method it is 1.96.

Outcomes

Studies indicated that emission of Green House Gases like Methane, Nitrous oxide and Carbon dioxide from direct seeded method was less compared to that from traditional rice cultivation method. Irrigation water savings ranging from 12-35% in direct seeded method provides opportunities for minimizing water scarcity threat. The cost of cultivation was reduced very much in drum-seeder method compared to traditional method of rice cultivation and hence direct seeding method using drum-seeder is profitable for farmers even if they harvest the same normal/ regular yields they are getting. Growing acceptance of drum-seeder version especially from small and marginal farming sector was observed due to factors like low seed rate, low irrigation water requirement, skipping of nursery and transplanting operations and subsequently reduction in drudgery, early crop maturity by 7-10 days and higher productivity in drum-seeder method. The technical feasibility and economic viability of the technology for all types of farmers, coupled with incentive schemes of the Agricultural Department, have helped support mushrooming use of the technology in Andhra Pradesh state of India. This is evident from rise in area under drum-seeder method in Chittoor district from 0.2 ha in 2006 to 4800 ha in 2013.

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INTRODUCTION OF RESPROUTER SPECIES TO INCREASE RESILIENCE OF MEDITERRANEAN ECOSYSTEMS TO COPE WILDFIRES

GRANADOS, María Elena (1); VILAGROSA, Alberto (2); CHIRINO, Esteban (2); VALLEJO, Victoriano Ramón (2)

1: Instituto de Investigaciones Sobre los Recursos Naturales. Universidad Michoacana de San Nicolás de Hidalgo, Mexico; 2: CEAM Valencia

grgarcia@umich.mx

Rationale

Predictions on climate in the Mediterranean basin indicate an increase in air temperature and a reduction in summer rainfall (IPCC 2012). These conditions may favor an increase in water stress for seedling survival and risk of new wildfires, affecting all ecosystem levels (Pausas and Paula 2012). In the Mediterranean region several reforestation programs were carried out in degraded areas in which different species of pine were planted to increase forest productivity as a way to control forest hydrological processes (Esteve *et al.* 1990) and to restore vegetation cover (Ortuño 1990). Currently, new goals emerge in restoration for improving diversity, resistance and resilience of old pine forests through the introduction of key resprouter species. Resprouter species promotes ecosystem resilience by means of quick recovery of above ground parts after fires, retarding soil erosion (Vallejo *et al.* 2012). Therefore, use of resprouter species with high fire resilience would improve ecosystem functionality and resilience against degradation processes. We studied the survival, growth and efficiency of photosystem II in six Mediterranean resprouting species introduced under different density of Aleppo pine, (*Pinus halepensis* Mill.) which resulted in different conditions for installation of new species and promoted different performance in introduced species.

Methods

Experimental sites are located in old Aleppo pine reforestations at La Hunde (39º 09' N, 1º 23' W; Valencia, SE Spain) on Dry Mesomediterranean climate. Average annual rainfall is 480 mm, with a maximum precipitation in autumn and spring and average annual of temperature of 14ºC with maximum values in summer and low in winter (Perez-Cueva 1994), at 600 masl. The soils are loams, calcareous bed-rock, shallow and stoniness between 27 y 49%.

Three experimental treatments based on pine density: high density (HD), medium density (MD) and low density (LD) were installed in nine experimental plots, replicated in three different sites: El Aljibe, El Lobo and El Mojón. Fifteen seedlings of *Arbutus unedo* L., *Rhamnus alaternus* L., *Quercus ilex* L., *Quercus fagínea* L., *Fraxinus ornus* L., and *Acer granatense* Boiss., were planted in each experimental plot in February of 2011.

Photosynthetic Photon Flux Density (PPFD) was measured in days completely cloudless, in May, July and November of 2011 and March of 2012 in each experimental treatment respect to full sunlight area. Daily rainfall and daily air temperature were registered from the weather station of nursery La Hunde. Soil moisture was monthly monitored by TDR probes from 0 to 40 cm in 2011 and 2012. Survival and relative growth rate (RGR) of stem height and the basal diameter were monitored in spring and autumn of 2011, 2012 and 2013. Six plants of each species and treatment were randomly chosen for maximum photochemical efficiency of photosystem II (Fv/Fm), measured at predawn and midday in leafs previously darkness for 30 minutes, in spring and autumn at 2012.

Results

An increase of pines density produced a decreasing of the PPFD during the whole year. HD treatment produced a decreasing on PPFD of 80% respect to full sunlight; while MD and LD treatments showed a decreasing of 56% and 25% respectively. Rainfall during 2011 was 578.5 mm, while from January to November in 2012 was 470 mm. Average annual of temperature was 13.9°C in 2011 and 13.10°C in 2012. GLM repeated measure for soil moisture from 0 to 40 cm, showed differences over time ($G\text{-}G' < 0.001$), but not showed interactions time-treatment ($G\text{-}G' = 0.292$).

Mean seedling survival on whole experiment was around 78%. Pine density produced differences in seedling survival (*Kaplar-Meier Log Rank 13.230; p=0.00*). RGR in height was higher in HD and MD than in LD. RGR in diameter showed significant differences, the highest values were for LD and the lowest values for HD plots. Maximum photochemical efficiency of PSII (Fv/Fm) showed significant differences among treatments with the highest values for HD plots. These differences among treatment were higher at midday (Table 1).

Outcomes

Seedlings under low radiation levels performed better in terms of survival than seedlings in the treatments receiving more sunlight. Decrease in survival was recorded after summer periods pointing out that summer drought is the main limiting condition for plant survival. However, seedling survival was high, with averaged values about 95%, 81% and 77% for the first, second and third year after outplanting, respectively. High RGR in height for HD and MD plots could be related to the fact that plants under low light conditions have to promote mechanisms like stem elongation, allowing reaching enough quantity of light to maximize carbon balance (Valladares and Pearcy 1997). Additionally HD plots produced a higher photo protection and consequently lower PSII damages, as can be inferred from the values of Fv/Fm dynamics along the year, which remains to be investigated. Preliminary results pointed out that photoprotection during summer promoted by high density plots could be beneficial for seedling survival in drought prone Mediterranean ecosystems.

HOW DO FARMERS PERCEIVE BENEFITS OF PARTICIPATORY TREE DOMESTICATION OF PRUNUS AFRICANA IN THE WESTERN HIGHLANDS OF CAMEROON?

CHIATOH, Maryben Kuo (1); GYAU, Amos (2); ASAAH, Ebenezar (3)

1: World Agroforestry Centre, West and Central Africa Regional Office, Yaounde, Cameroon; 2: World Agroforestry Centre, Global Headquarters, UN Avenue, Nairobi, Kenya; 3: World Agroforestry Center, Country Office, Freetown, Sierra Leone

marybenk@yahoo.com

Prunus africana (Hook.f.) Kalman (Rosaceae) (henceforth called *Prunus*) is a montane hardwood medicinal tree species of tropical Africa and makes up one of the important tree species on which poor households in Cameroon rely for its products. *Prunus* is under pressure from overutilization especially through unsustainable commercial harvesting of bark. Consequently, the European Union banned importation of *Prunus* from Cameroon. More so, *Prunus* is characterized by irregular fructification and the seeds have a short life span. Reforestation based solely on natural regeneration and seed propagation alone would hardly give satisfactory results. Therefore research and development organizations have initiated participatory tree domestication projects as a means to encourage farmers to plant *Prunus*. This paper assesses farmer perceptions of the benefits associated with the domestication of *Prunus*. Results from interviewing 154 farmers show that the main benefits associated with *Prunus* domestication include; increase in the sources of planting materials, increase in the number of trees on farm, reduction in harvesting time, improvement in income levels, better communication with others and the learning of new ideas. We conclude by saying that the economic benefits from *Prunus* can be improved through better pricing policy and certification.

PUBLIC MANAGEMENT OF ECOSYSTEM SERVICES ESS FOR PRODUCTIVITY INCREASE IN SMALLHOLDER FARMING THROUGH BIODIVERSITY: ON ESS VALUATION, PES AND GOVERNANCE

NUPPENAU, Ernst-August

Justus-Liebig-University, Germany

ernst-august.nuppenau@agrar.uni-giessen.de

Rationale

A typical problem of making eco-system service ESS appreciable by local land users and optimizing them along nature conservation is that common pool resource and property right problems emerge. In this regards payment for eco-system services PES (Wünscher et al. 2007) has gained interests and we need rules for public management (habitats, buffer strips, etc.). However, simple PES are usually not capable to come up with detailed valuation of services, habitats, species and actions to be taken. Managers of ecosystems need more detailed information on priority settings. To solve this problem we suggest a simulation approach including payments in which ES management is about planning and offering habitats; but also valuation. Planning is conducted by ecologists who possess knowledge of pertinent functional relationships between species prevalence and ESS, though also have interests: here conservation.

Methods

This piece of research is an attempt to combine several methods for a unified ESS provision in a landscape used by smallholders who are facing land scarcity. It links provision and use of ESS, based on biodiversity BD, in a PES concept which is a regulation in land use. Regulations are part of landscape governance which is explicitly conducted in terms of habitat planning. The conceptual framework used is a cultural landscape of multi-functionality in which certain measures are taken by government to create conditions that are favorable for a specific BD (precisely: habitats for preferred species such as birds or insects, example offering pollination and predations). In principle, some farmers are paid for actively taking measures (change farming) here for the sake of creating a favorable landscape (offering habitats), which supports higher BD. Money for this is collected from other farmers who benefit from ESS mostly and from external sources. Ecological experts play a role as facilitators of exchange and are conservation custodians. They bring in their information on interaction between habitats and species as ecological knowledge (ECK) aiming at a specific species. However, species have to be put into balance (equilibrium) with farmers (WTA) and public interest (WTP). Then, "ecological technology" must be flexible and evaluated on the basis of substitution.

The suggested method is programming spatial combinations of land use and habitats as outlined in Figure 1 (following Wossink et al. 1998). Ecologists facilitate (govern) the exchange of services and detect prices for "management by objectives", i.e. through generalized shadow price analysis (using flexible functions: Paris, Howitt 2001). We discuss a framing of ecosystem services (ESS and BD) as a farm supply given nature-related compensation assuring participation (in simulations), even of land scarce smallholders.

Results

The paper offers a technical (mathematical) approach specifying value functions for each participant in PES on the basis of shadow prices. Shadow prices can be retrievable if an optimization is combined with certain constraints. This optimization uses advance techniques of quadratic expressions of farmers', ecologists' and public interest functions (Paris, Howitt, 2001). For instance, ecologists as landscape managers use their knowledge on likely species appearance as preferred vector.

The PES outlined will enable the management to generate revenues with some farmers and the public as it offers higher productivity and more food. Revenues then can be spent with others farmers having the main burden of ESS provision. From a management perspective of the ES the interaction with farmers is, in fact, a call for participatory habitat design, first; but, second, it is the factual provision of ESS.

For simplification: we receive a linear dependency between public willingness to pay (WTP) and farmers/producers' willingness to accept (WTA), respectively. This means a public value for ES (species vector) is dependent on willingness to accept habitats as compensation; this result implies, to a certain extent, that a balanced species vector is found in equilibrium related to ecologists' preferences for conservation. This enables us to equate the "supply side" of ESS by some farmers with the "demand" side of other farmers and ecologists using the corresponding functions. The final solution is an optimal valuation of ESS.

Outcomes

This paper provides a novel approach on how to obtain values (marginal values; price, etc.) for ESS which are based on habitat provision and corresponding biodiversity BD in rural areas. We show how to calculate compensation payments for BD provision as a strategy for productivity increase for the poor, land scarce farmers. As an underlying concept we suggest a landscape modulation for PES which is directed towards field sizes, buffer strips and intensity of farming. Ecologists plan and manage exchange of money and assure equilibrium, influenced by their own preferences and knowledge on how to achieve a certain envisaged species compositions (BD). They govern not neutrally. Farmers and citizens are passive as providers of changes in the landscape and money, respectively.

Enhancing livestock market access for sustainable rangeland management and improved livelihoods in Kenya

KIHIU, Evelyne Nyathira (1); AMUAKWA-MENSAH, Franklin (2); MIRZABAEV, Alisher (1)

1: Zentrum für Entwicklungsforschung (ZEF), Germany; 2: Department of Economics, Swedish University of Agricultural Sciences

evekihiu@uni-bonn.de

Productivity of rangelands in Kenya is limited with increasing crop farming especially in the more fertile range areas. Encroachment of crop farming on rangelands occurs as producers' seek higher financial gains for sustaining livelihoods. We hypothesize that the condition of livestock markets, especially the producers prices received in such markets are a major risk rangelands face. To analyze the effect of livestock market conditions on rangeland management, we draw on household survey, crop, livestock and economic modeling tools. We develop a stochastic dynamic programming model for livestock systems in Kenya with stochastic forage production to analyze the effect of improving livestock market access on rangeland management. A positive mathematical programming (PMP) model is used to assess rangeland allocation decisions under improved market access conditions. We find that traders' rent seeking behavior and high transport costs act as disincentives to livestock producers' participation in markets, rangeland use decisions and productivity of rangelands. The study concludes that re-apportioning value-added in livestock marketing chains and reduced transport costs are important complements to efforts of manage rangelands sustainably and improve livelihoods.

STRATEGIES OF FARMERS TO RAINFALL VARIATIONS IN THE MUNICIPALITY OF ZÈ IN BENIN

ADJAHOSSOU, Vidédji Naéssé; ADJAHOSSOU, Sêdami Baï; DOVONOU, Flavien Edia; ADJAHOSSOU, Firmin Dossou

Université d'Abomey-Calavi, Benin

vidnae@yahoo.fr

Current climate changes in several parts of the world are real obstacles to the development of agricultural activities. This change is characterized by irregularity and bad distribution of rainfall along the year. Sometimes rainfall occurs in abundance during a short period when crops don't need a lot of water. These difficulties are greater for farmers in developing countries as those in South-Benin practicing for the most part, highly dependent on rainfall agriculture.

Zè municipality is located in Atlantique department . It is the largest one and represents 19.88% of the territory. It is situated between 6° 32 and 6° 87 N latitude and between 2°13 and 2° 26 E longitude. The relief is part of the vast plateau of Allada which slopes gently toward the coast, overlooking the north of the Lama depression. The height difference is approximately 160 m between the depressions and the highest point. Then the Southern portion of the municipality (92.9 km^2) drains into the Atlantic ocean through the lagoon fringe on the coast.

The climate is sub-equatorial and is characterized by rainfall amounts higher or lower, a relatively small annual thermal amplitude (less than 5 ° C) and the succession of four distinct seasons: a long rainy season from mid - March to mid – July; a short dry season from mid - July to August; a small rainy season from September to November and a long dry season from December to mid – March. The frequencies of rainfall and water levels are experiencing more and more disturbances in recent years. The hydrographic system is not dense. Only the northern part of the municipality is watered by the tributaries of the river Oueme mainly Sô river.

The soil level, just over 62% of the territory of the municipality of Zè consists of lateritic soils and their natural fertility are not suitable for agriculture. Hydromorphic soils, that is to say waterlogged temporarily or permanently, cover about 37% of the territory. These soils are found mainly along So river.

Documentary research, observation and investigation in a real area have permitted to collect the necessary data during this research. The surveys were conducted with 202 farmers living and operating in the Municipality of Zè. It appears from the use of the data collected that people (more than 84% rural) of the Zè municipality develop strategies to cope with climate change. In general, the agricultural calendar is modified to comply with new rainfall rates.

The combination of cultures and multiple or replanting seedlings are practiced in place to reduce the impact of rainfall variations on Agriculture in Zè.

Changing the cropping calendar

Crop calendar takes account of the seasonal precipitation. Land preparation takes place in the late dry seasons. From the first rains, the farmers start planting. To the rainy season, sowing takes place from mid-March to mid-April and early rainy season, from mid-August to mid-September for maize. Currently, with late rains, sowing takes place later. Generally, farmers expect three to four rains before planting when they consider soil humidity is sufficient to favor seed germination and seedling emergence. But some farmers take the risk of planting after heavy rain and other precipitation when not following the operation, they resume planting.

Increase in the area allocated to the pineapple

In localities of great pineapple productions like municipality of Zè young farmers interested in increasingly pineapple production at the expense of maize production. Pineapple, CAM plant (Crassulacean acid metabolism), tolerates, breaking to sudden stops rain (Degras, 1986). This is not the case of maize which performance may drop drastically when drought occurs in the critical period of 15 days to 20 days during which occurs grain filling (Vieira da Silva, 1984). There is therefore, according to farmers, less likely to produce pineapples to produce maize.

Combination of crops

The combination of cultures is to produce two or more crops simultaneously in the same field (Steiner, 1985). It contributes to reduce natural risks that could affect crop yields including breaks rain. Trenbath, (1993) showed that species that grows in association with other cultures is less attacked by pests that in mono culture and improves productivity per unit area (Adjahossou, 2005 and Adjahossou, 2012). According to some farmers, the association of cultures would better conserve soil humidity. This could be explained by the limitation of evapotranspiration due to the microclimate created by the combination of two or more cultures. In the study area, commonly associated crops are maize-cassava, maize-cowpea and corn-pineapple.

Few farmers do irrigation to reduce water stress. They represent about 6 % of the population and use water from river. But they don't arrive to water large area. It should be noted that these strategies have many limitations and need to be improved significantly.

FOOD SECURITY AND THE ENVIRONMENT

ADEDUGBE, Adebola Adebiyi

FARM I DEAS NIGERIA, Nigeria

bolaa2001@yahoo.com

Africa's vulnerability to climate change impacts have been underscored by the severe droughts experienced recently in the Sahel in 2012 and the Horn in 2011. All these bring into focus the serious impacts of climate change in the continent and highlighting the urgent need for adaptation as a priority in providing sustainable solutions to reduce the vulnerability of Africa's one billion citizens. Approaches with the potential for informing and guiding policy and practices are imperative. One of these approaches is Ecosystem-based Approach (EbA), which provides flexible, cost effective, and broadly applicable alternatives for building robust food systems on less inputs and reducing the impacts of climate change. Practices such as agro-forestry, buffer strips, on-site water conservation, use of native species, etc., have demonstrated that ecological based approaches can provide just one right framework for catalyzing transformative change on a larger scale. Adapting ecological based approaches could help build efficient food systems and resilient livelihoods, and ultimately achieve global food security in a changing climate. This paper provides a short description of the potential influence of climate change, variability on food systems and local adaptation strategies.

RESTORATION OF DEGRADED PEATLANDS AS A TOOL FOR SUSTAINABLE LAND USE AND CLIMATE CHANGE MITIGATING: THE BEST PRACTICES FROM BELARUS

YATSUKHNO, Valentin (1); ZHARKINA, Natalia (2)

1: Belarusian State University, Belarus; 2: Ministry of Natural Resources and Environment Protection of the Republic of Belarus

yatsukhno@bsu.by

In temperate and boreal zones peatlands play the key role for accumulation of surface and groundwater of their own basin and catchment areas, preservation biological diversity, climate change mitigating. At present peatlands are still important recreational, hunting and natural conservation areas as well as agricultural activity and cultural heritage [1].

About 14,2% of the territory of the Republic of Belarus is covered by peatlands (comparation in the world - 3,4%). In the course of the large - scale drainage of peatlands and active peat extraction, especially in the soviet period, total areas of natural mires was decreased by more than half. According to official data, about 432,5 thous. ha of Belarusian peatlands are degraded, including 209,5 thous. ha - depleted peatlands and 223,0 thous. ha - inefficiently use of agricultural lands. Peatlands, once degraded, contributes to progressive loss of productivity and declining harvests, disruption to the carbon cycle, shrinking habitats for globally important species, increased risk of fire overall, for peatlands in the Chernobyl zone, has implications for the spread of radioactive contamination. Emissions of into the atmosphere caused by mineralization and peat fires reach 8,0 mln. tons per year. After drainage of peatlands in southern part of Belarus the amount of precipitation decreases on 10-31 mm. During vegetation period the quantity and duration of droughts are increased above two times. [2]

The overall goal of peatlands restoration is to enable the natural functions and structures of peatland ecosystems to become re-wetting in areas where they have been affected by human activity. The restoration of degraded peatlands is based on stabilization of the hydrological regime by even raising of the groundwater up to the soil surface level. For this purpose a number of water flow regulating devices are constructed, i.e. different types of dikes, sluices, dams [3]. Dams need to be built at shorter intervals where terrain slopes more or the peatlands are very wet. They should be sited to take advantage of natural rises and depressions in microtopography. In some cases when restoring steeply sloping peatland sites it is necessary to bild dams reinforced with wooden supporting devicies or geotextiles.

As result of re-wetting of 17 degraded peatlands with total area about 40,000 ha reduce of from the restored wetlands consist 311,000 tons per year. Balance sink from the atmosphere into restorated mire ecosystems for samples of bog type peat is 876-2276 kg/ha (1380 kg/ha in average), for a fen one - 571-979 kg/ha (694 kg/ha in average). In the whole restoration of peatlands has a synergistic effect, to address the problem of land degradation, climate change and biodiversity conservation. This is facilitates revave of habitats favorable for typical wetland vegetation and animal life. The results of flora and fauna monitoring at the project sites show that wetland vegetation has been restored at 70-90% and ornithological fauna at 20-48% for 5 years.

Ecology-based approach to peatland restoration helps to re-establish and reinforce the ecosystem services provided by peatlands [4]. So, long-term results of restoration of peatlands - benefits for local population: more possibilities for hunting, fishing, gathering berries and mushrooms. Returning of wetland ecosystems to their state raises tourism capacity of these areas and promote to creation of ecological paths.

TECHNICAL, ENVIRONMENTAL AND ECONOMICAL REVIEW OF ICARDA TARGETED TECHNOLOGY PACKAGES FOR ADOPTION IN THE PRESENT ARABIAN PENINSULA FARMING SYSTEMS: THE CASE OF UAE

NEJATIAN, Arash; BELGACEM, Azaiez Ouled

ICARDA, Arabian Peninsula Regional Program (APRP)

a.nejatian@cgiar.org

Rationale

After date palm, the main agricultural farming system in the Arabian Peninsula (AP) region includes open field forage and vegetable production under protected agriculture. Although in many cases agricultural activities in such environment have not any economical justification, traditionally and strategically the existing the farming systems are very important. Thousands of people livelihoods are depending on agriculture. On the other hand, non-conventional water resources are either expensive or required some health or environmental consideration. Therefore, there is a need for more advance production systems to improve existing farming practices. ICARDA introduced/developed number of technologies to the region which aiming to increase the productivity per unit of water for vegetable crops as well as irrigated indigenous grass species. For a successful technology transfer, this is very important that the technology not only be fitted with the local conditions but also must be sensitive to the existing farming systems and indigenous technologies (OTA 1984).This study aims to measure the technical, environmental and economical privilege of ICARDA's technology packages over conventional production system within the present farming systems.

Methods

Based on the NARS request, ICARDA has started a program for the region called Arabian Peninsula Regional Program (APRP) since 1988. The achievements of APRP are demonstrated by the six useful technology packages (ICARDA 2008) from which 4 are directly connected to the growers and their farming systems.Based on agro-ecological similarity study, UAE can be deliberated as a representative sample for 2/3 of the AP (Nejatian 2013). Therefore, UAE was selected for this study. Data on yield and cost of the production for soilless culture and IPPM are based on the interviews with growers in different agro-ecological zones of UAE. The information about cost of production and materials are based on actual data collected from different experiments as well as interviews with end users and suppliers. The information regarding forage species (Buffel grass and spineless cactus) yield and water productivity are based on ICARDA published data and joint research activities in UAE.

Results

Buffel grass as Irrigated ingenious forage species:

It saves about 50% of irrigation water compared to Rhodes grass, the wide adopted species in the past. Significantly reduces cost of production due to using less water. About 1,275US$ will be saved for production of each metric ton of DM compared to Rhodes grass.Buffel grass can beeasilyfit to the UAE farming system to replace theexoticRhodes grass. Government is supporting Buffel grass expansion.

Spineless cactus as fodder crop

Spineless cactus is one of the most adapted plants to arid and desert environments. It is a good source of energy for livestock with relatively low price and cost of production. Spineless cactus is as multipurpose species which may improve rural income. Under harsh environment of UAE and AP in general, about 38 accessions were introduced and showed very high performance of adaptation both in term of pads and fruit production at very low level of irrigation.

Integrated Production and Protection Management (IPPM)

It reduces pesticide residue. As a result of applying the IPPM techniques, number of pesticide sprays is reduced from 15 - 19 to only 2 - 3 sprays in the region which significantly reduced cost of production in addition to the positive impact on environment safety. Moreover, it has led to higher yield and efficient water productivity compared to control greenhouses (GH). IPPM hasIncreased pilot growers income by about 1000US$/Gh/year due to higher yield and less cost of plant protection.As GH and vegetable production are from main part of UAE farming systems and IPPM developed based on locally available materials it can be easily adopted within the present farming system.

Soilless production system

Hydroponics uses less water. For cucumber in UAE water productivity increased by more than 50% as well as less land erosion and soil salinity and no agro-chemical for soil sterilization and soil borne pathogens. Hydroponics increases growers income by 10US$/$m^2$GH/year in UAE. The capital costs could be recovered in 2nd season. Soilless high income is encouraging growers to adopt this system. In UAE, a large number of leisure farms have changed their functionality to more economic activities after adopting soilless production systems. In addition, the government and policy makers are supporting this technique.

Outcome

Overall, after number of interviews with ICARDA pilot growers and production records, it can be stated that ICARDA targeted technologies in the region, not only have technical advantage over existing production system (higher yield), and more environment friendly (less water and Hazardous Agro-Chemical); but also are match with the present farming system. These technologies can be successfully used in different regions with similar agro-ecological characterization. However, based on the interviews with the growers and farmers, there are some constrains for wider adoption. The most important one is reported as lack on know-how and technical back stopping.

FIGHT AGAINST DEFORESTATION AND DESERTIFICATION THROUGH THE OCCUPATION OF THE HOLES RELATED TO LOGGING BY THE RESPONSIBLE FOREST AGRO PRACTICE IN THE PEA-187 IN CENTRAL AFRICAN REPUBLIC

POPOCKO, Boniface

Institute of Central African agricultural research, Central African Republic

popocko@yahoo.fr

In its national policy, the Central African Govemment is engaged in the sustainable management of natural resources including forest through the forest planning process in the context of the development of the forest management Plan this process includes a socio-economic study.

Socio economic study of the PEA 187 near the capital Bangui let understand that farming practices are the main causes of deforestation (seven PARPAF. 2009). Thus, to reduce the anthropogenic pressure reflections have been conducted, where the idea for this project.

The objective of this project is from "to contribute to the sustainable management of forests; the reduction of carbon dioxide emissions due to deforestation and degradation of natural resources and the improvement of the living conditions of populations beneficiaries in Central African Republic" through to inform him and the awareness of the populations of the damaging effects of deforestation finally involve them in the implementation of the project, building the capacity of the communities benefit in techniques and methods of agroforestry to diversify agricultural productionincrease household income and improve their living conditions.

Indeed, the RCA is a country locked with little infrastructure and a non-existent industry, its population is predominantly rural. Agriculture contributes 55% of GDP, its yields are low. All of the strategic axes developed by the Government relies on the development of the territory and rural populations, this in the context of the poverty reduction such as combating and adapting to climate change.

The Document strategic Reduction of poverty (PRSP 2008-2010) focuses on several sectors in its 3 pillar among them the forest sector. The project will be part of the logic of development sought by the Government through the sectors identified as key.

The national plan of adaptation to climate change of the Ministry of water and forests in 2008 places strong emphasis on the sound management of forest resources as a means to limit forest degradation.

Multiple recurring anthropogenic actions disrupt the plant formations in the villages Salanga and Ndangala causing a reduction in socio-economic and cultural values. These actions include among others the resurging annual destruction of forests due to *slash and burn shifting cultivation, fuelwood, cutting coal production and artisanal lumber* for the supply of the city of Bangui. The farmer provides a lot of efforts for the transport of products agricultural both new fields are becoming increasingly distant villages, from the choice of agricultural land on the areas of virgin forest. This effort reduced the ability of the peasant to give the best performance of his work, accordingly making its living conditions still difficult. This project which fits in transverse field allows recipients to properly manage their forest heritage and improve their living conditions.

SUCCESSFUL AGROFORESTRY SYSTEMS IN THE ARID AND SEMI-ARID REGIONS OF LATIN AMERICA

REDDIAR, Krishnamurthy Laksmi; RAJAGOPAL, Indumathi

Universidad Autonoma Chapingo, Mexico

uach1854@gmail.com

Abstract

Changes in land uses are important agents of environmental change and degradation in the semi-arid tropics. The climate variability accelerates the problem of land degradation and desertification (IPCC, 2001; UNCCD 2007). Agroforestry provides a unique opportunity to reconcile the objectives of mitigation and adaptation while sustaining productivity of crops and livestock in arid and semi-arid regions. The objective of the present research was to identify and to evaluate the successful agroforestry systems and the key agroforestry species being managed as well as socio-economic constraints for adoption of these systems in the semiarid and arid regions of Latin America. The study area was divided into the following regions based on climatic conditions: 1) Dry sub-humid region of the Pacific in Central America (Costa Rica, Salvador, Guatemala, Nicaragua) and the Chaco (Paraguay); 2) Warm semi-arid region (Loja, Ecuador); 3) Temperate arid region (Zacatecas-Mexico; Piura-Peru; Mendonza-Argentenia); 4) Cold arid region (Potosi and Cochabamba in Bolivia); and 5) Warm arid region (Falcon-Venezuela). A diagnosis and design methodology developed with the WAFLA Consortium was applied to 3 - 6 farms in each partners' site of work to make an inventory of the agroforestry practices and to collect socio-economic variables of these practices.

The agroforestry practices were defined as: 1) Successful agroforestry systems (which is widespread in the region and being managed by many farmers in the area for a long period); and 2) Agroforestry prototype (a practice that has been validated and is in the process of adoption by farmers). After the analysis of the data on farm inventory, a semi-structured interview was made with farmers (15 to 30 farmers) to evaluate their perceptions on the successful agroforestry practices and / or the agroforestry prototypes.

In the dry sub-humid region in Central America, Quesungual (Salvador) or Kuxur Rum (Guatemala) is one of the successful agroforestry systems. This system consists of the integration of a diversity of multi-purpose trees with subsistence crops (beans, corn, and sorghum) and some cash crops (water melon). In Costa Rica, fodder banks of Cratylia argentea with scattered trees on pastures is the main silvopastoral system practiced. In Paraguay, silvopastoral practice with Prosopis spp. as the dominant tree species has been the most successful agroforestry practice, and recently many farmers have been establishing agroforestry prototype of Leucaena spp. fodder bank. T

he results of many studies in the semi-arid region showed that animal production was increased in silvopastoral systems with Prosopis spp. and Leucaena spp., and trees in the silvopastoral systems play an important role in improving forage productivity and mitigating heat stress of animals (Evans P, Rombold J. 1984). In the warm semi-arid region of Ecuador, the main agroforestry practice is that of annual crops (corn, beans etc.) associated with scattered woody species including high value timber species (Swietenia spp. and Cedrela spp.). In the temperate arid region the following was observed: in Zacatecas (Mexico) scattered multi-purpose trees with crops and fruits including peach; in Jocoli, Mendonza, communal land used by farmers with the main agroforestry practice being trees in association with cash crops (onion and melon) with fruit crops including peach, almonds and olives; in Belisario of Peru, silvopastoral practice with Prosopis spp. and goats are very common and good animal productivity has been reported with this practice. In the cold arid region of Bolivia, agroforestry practice consists of barley and potatoes with woody species serving as live barriers to control erosion. In the warm arid region of Falcon, Venezuela, silvopastoral practice consists of Prosopis spp. with goats, and includes the cultivation of Agave cocuy and Aloe vera (Palomares M, Merino V, Ramírez, Y 2006).

In general farmers perceptions of these agroforestry systems, was that they contribute to economic and ecological sustainability. Many farmers felt that trees contribute to improvising soil fertility and resilience to climate change.

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MITIGATION AND ADAPTATION POTENTIAL OF AGROFORESTRY BASED CONSERVATION AGRIGULTURE PRACTICES FOR COMBATING DLDD, POVERTY REDUCTION AND SUSTAINABLE LIVELIHOODS:A CASE STUDY FROM NORTHERN PLAINS OF INDIA

SAXENA, Vivek

Forest Department, Government of Haryana,India, India

viveksax1@gmail.com

Agroforestry based agro ecosystems have incremental mitigation potential through carbon sequestration in trees associated with the crops through appropriate conservation agriculture practices. Agroforestry has potential of not only ensuring sustainable land management and improvement of soil and biomass carbon stocks and consequential improved agroecosystems for combating Desertification, Land degradation and drought (DLDD), but also ensures sustainable livelihoods through improved income from harvesting of associated tree species. Agroforestry has importance as a carbon sequestration strategy because of carbon storage potential in its multiple plant species and soil as well as its applicability in agricultural lands and in reforestation (Montagnini et al. 2004). At a global scale, it has been estimated that agroforestry systems could be implemented on 585 x 10^6 hectares of technically suitable land, and these systems could store 12 to 228 Mg C ha^{-1} under the prevalent climatic and edaphic conditions (Dixon,1995).

Northern Plains, one of the 14 physiograhic zones defined by Forest Survey of India with an area of 295780 sq km (9 % of TGA). Northern Plains have net sown area of 71.45 % of TGA. (SFR, FSI, 2011) (Figure 1) Short rotation tree species of Eucalyptus species (*Eucalyptus tereticornis*) and Populus species (*Populus deltoides)* in combination with agriculture crops has been adopted in the region. The main agroforestry models, adopted in the region and associated with Eucalyptus and Poplar are; (i) Eucalyptus under linear plantations; (ii) Poplar under linear plantations; (iii) Eucalyptus under block plantations; and (iv) Poplar under block plantations. The present study was conducted for assessing mitigation potential in Northern Plains of India and for each such combination, i.e., 8, 4 replications, data was collected and analysed from selected villages .Mitigation potential for various models also has been estimated. Eucalyptus linear plantations at half rotation, i.e., 4 years has mitigation potential of 0.03428 tonnes per tree whereas at rotation age, i.e., 8 years has mitigation potential of 0.1065 tonnes per tree. Mitigation potential under Eucalyptus block plantations at half rotation and full rotation has been estimated as 0.03700 and 0.1095 tonnes per tree.

Poplar linear plantations at half rotation (3 years) have mitigation potential of 0.02108 tonnes per tree whereas at full rotation (6 years), it is estimated as 0.0682. Mitigation potential for Poplar based block plantations at half rotation and full rotation has been estimated as 0.02188 and 0.07169 tonnes per tree, respectively. The present mitigation potential of agroforestry in Northern Plains is 1.019 million tonnes (3.74 million tonnes CO_2 equivalent) having Carbon Market value of USD 26.18 million. Mitigation potential per hectare of Eucalyptus based agroforestry systems is 71.52% more compared to Poplar based agroforestry systems. However, adaptation to Eucalyptus and Poplar based agoforestry also depends on impact on crop yield, pricing mechanism, availability of market and wood based industries, etc. The decision is not presently based on Carbon Market. Incremental Mitigation Potential through adoption of appropriate Eucalyptus and Poplar based agroforestry exists and potential under different scenarios (1 %,2.5 %,5 %,7.5 % and 10 % of net sown area) have been estimated. Carbon benefits of Eucalyptus based agroforestry systems are relatively better than Poplar based agroforestry systems. However, the economic returns per quintal at the present market price for Poplar (INR 1100 per quintal; USD 22) is more than for Eucalyptus (Rs 800 per quintal. USD 16). Moreover, effect on crop yield for Poplar based agroforestry systems is less compared to Eucalyptus species as Poplar species remain leafless during winter season.

The study concludes that mitigation and adaptation potential of selected agroforestry models of Eucalyptus and Poplar exists in Northern Plains and increase in area under agroforestry also provides an opportunity for accessing Carbon Markets, with enhanced net income to the farmers in addition to the attainment of national and global environmental objectives of mitigation and adaptation , development and strengthening of adaptive capacity of vulnerable communities, meeting operational and strategic objectives of the UNCCD strategy(2008-2018) and contribution towards aspirational goal of land degradation neutrality, stipulated in the Rio+20 document, "The Future We Want " in spatial as well as temporal terms. However, the proportion or level upto which agroforestry can be adopted as per the various hypothetical scenarios in the region depends on generation of better returns, adequate pricing, market availability, policy reforms and, mitigation benefits without compromising the food security. The key barriers for enhancing area under agroforestry include lack of incentives to farmers, inadequate availability of quality and higher productivity scientific research based clonal seedlings at affordable price, absence of assured market, weak market linkages etc.

Appropriate policy measures for attainment of mitigation and adaptation potential under agroforestry include incorporating agroforestry as an inherent component of poverty reduction strategy under sustainable land management and agroforestry based conservation agriculture practices, appropriate price support mechanism for farm grown wood, strengthening of market linkages, availability of adequate finance, etc.

MEETING THE DEMAND OF LOCAL POPULATIONS THROUGH PURPOSEFUL SUSTAINABLE DRY FOREST MANAGEMENT - UNDERSTANDING GROWTH PATTERNS OF HEAVILY USED TREE SPECIES

PLUGGE, Daniel (1); KÜBLER, Daniel (1); RATOVONAMANA, Yedidia (2)

1: University of Hamburg, Germany; 2: University of Antananarivo, Madagascar

daniel.plugge@uni-hamburg.de

Rationale

Dry forests account for nearly 40% of tropical forest areas (Brown *et al.*, 1980). Approximately 1 billion rural poor are living in dry lands (Dobie, 2001), and consequently dry forests play a major role in sustaining their livelihood, mainly as a source of timber and fuel wood as well as for livestock grazing (Stringer *et al.*, 2012). At the same time dry forest ecosystems are more vulnerable to anthropogenic impact than wet forests, as they generally show a lower resilience (Murphy and Lugo, 1986). This situation is likely to be exacerbated by climate change. Therefore, sustainable forest management (SFM) in dry areas is of extreme importance but faces high challenges due to water or nutrient restricted growth and yield potentials. In areas where precipitation is the limiting factor the development of forests and individual trees depends highly on the amount and frequency of rainfall. To be able to implement a purposeful SFM under these circumstances calls for understanding the growth patterns of species, especially those with high relevance for the local populations.

Partnership

To better understand the growth patterns of tree species in a dry forest area in south-western Madagascar the Universities of Hamburg and Antananarivo set up a partnership together with the local population of the Mahafaly Plateau study area. This partnership is part of the SuLaMa (Sustainable Land Management in south-western Madagascar) project.

Methods

Analyses of two comprehensive forest inventories conducted in 2008 (Plugge et al. 2010) and 2011 (repeated 11/2014) revealed that most tree species did not show significant growth. This makes the development of a SFM scheme challenging. To answer this challenge species of high relevance for the local population were identified. Three of these species were selected, representing a trend from high to low wood densities, i.e. *Cedrelopsis grevei*, *Euphorbia fiherenensis* and *Delonix adansonioides*. Trees of these species were equipped with dendrometers, recording their circumference (at 1.30m) as well as the air temperature at an hourly interval. Trees of different circumferences were selected (large, medium, small). Furthermore, we installed a pluviometer on site. The devices were mounted during the dry season (November 2013). This setup enables the analysis of diurnal, intra-seasonal and intra-annual tree growth under changing environmental conditions. Furthermore, differences between the growth rates and climate sensitivity of different wood densities and intra-species diameter ranges can be deduced and knowledge on the biomass development is gained.

Results[1]

The results obtained show the very high dependence of the tree growth on the rainfall pattern. There is an immediate reaction to the rainfall event in January (see Figure 1). As expected the species react differently to the rainfall event. However, the reaction does not follow the gradient of wood densities. This points at different growth strategies of the tree species which are aligned to their physiology. *Delonix adansonioides* has the lowest wood density due to very large vessel sizes which allow for storing water and thus for continuous growth. Furthermore, there is a pronounced intra-species growth pattern, i.e. different magnitudes of diameter growth following the gradient from small to large diameters. Above this, for *Euphorbia fiherenensis* the diameter increase merely makes up for the diameter decrease before the rainfall. Given the long dry period in this region this may become valid for other species, too. It is likely that in a year with low rainfall the diameter development of trees can be negative. This has a pronounced influence on the setup of a SFM scheme for the local population.

Outcome

The outcomes are threefold:

1) Knowledge about growth patterns of species with high relevance for the local population will help to identify forestry measures to ensure the constant supply of goods from these. 2) SFM schemes rely on accurate inventory data on forest development. Our results show that the inter-annual variability in tree diameters is higher than the actual tree growth. SFM schemes carefully need to consider this to avoid overexploitation. Increased variability of rainfall intensities and timing due to climate change exacerbates this problem.

3) Given that 40% of the tropical forest areas are dry forests the consequences of our research are of major relevance to the current estimates of carbon storage and sequestration in these areas, which are important for climate change mitigation strategies (e.g. REDD+).

Our results show that much more research on this topic is needed to allow SFM scheme for dry forest ecosystems and to properly include these areas in REDD+ to allow for coupled benefits for the local populations.

[1] Please note that the results discussed here are relying on data for the period from November 2013 to February 2014. For the presentation at the conference we will include data until the beginning of 2015.

BUILDING RESILIENCE OF RURAL POORS IN THE SAHEL: CLIMATE SMART AGRICULTURE TECHNIQUES AND POOR HOUSEHOLD FOOD SECURITY

SUBSOL, Sébastien; BILGO, Ablassé

AGRHYMET Regional Center, Niger

s.subsol@agrhymet.ne

Rationale

The repetition of food security crisis in the Sahel in the last ten years has lead to growing concern for increasing resilience to climate shocks at household level. Our research is aiming at crossing data from household socio-economic profiles and data on cereal yields permitted by the adoption of climate smart agriculture (CSA) techniques. These profiles have been developed since seven years in a total of 50 homogeneous socio-economic areas in sahelian countries. They describe four groups of households: very poor, poor, medium and rich. The analysis will indicate if appropriate choices of CSA techniques can improve their food security. These results could be used to give strong incentives to integrate CSA techniques in food insecurity response plans.

Methods used and partnership set up

Rural households socio-economic profiles have been developed in several zones of Senegal, Mauritania, Mali, Burkina Faso, Niger, Chad and the northern part of Nigeria. These profiles have been developed by Save the Children, a NGO involved in food security issues in West Africa. These profiles are currently used to assess acute food insecurity but can be useful for medium term analysis as they have a five years' validity.

Two lists of data are crossed. The household profile provides data on the number of family members, size of the fields, food security shocks and main adaptation strategies. Bibliography on CSA techniques gives information on the potential of these techniques in terms of cereal yield increase.The cross analysis of these data indicates the level of food security reached by the different groups on the basis of an average need of 200 kg of cereals per capita per year in the Sahel, given by national cereal balance sheets.

The analysis focuses on the most vulnerable two groups, the poor and very poor. Their percentage in the population is above 60 %. Agrhymet Regional Center is exchanging with NGOs and the World Food Program about these simulations in order to improve their operations on the field.

Results

In many cases, introducing CSA techniques could enable very poor and poor households to shift from a structural food insecure status to a situation with cereal surpluses. In case of drought, yields from fields restored with climate smart agriculture techniques are higher.

The analysis of the potential impact of these techniques on the poor and very poor households of 9 socio-economic areas in Burkina Faso and 16 areas in Niger indicates that it is valuable to disseminate them in 20 cases out of 25. The only cases where they will not improve significantly the level of food security are located in the most northern part of Burkina and southern zones of Maradi and Zinder regions in Niger. The limitative factor is always the limited size of cropland. The land tenure dynamics in these areas have led to the formation of micro-farms unable to feed the families.

But introducing CSA techniques into smallholder farms requires some conditions. First of all, the extension system has to focus on CSA in these areas. This system can consist in a mix of public services and support coming from NGOs and farmers organizations. Secondly, a lot of these techniques require the avaibility of manure. Poor and very poor household need support to develop the breeding of animals, even if it is at small scale. They may also need some support to purchase transport means, like donkeys and carts. Some farmer organizations in West Africa begin to help their members to have access to such equipment.

Important results have been yet achieved in Burkina Faso and Niger with two techniques, zai and farmer managed natural regeneration. Smallholders have adopted them massively in the northern part of Burkina Faso and the regions of Maradi, Tahoua and Zinder in Niger. Results are significant mainly in Burkina Faso, which faced only one real food crisis during the ten previous years. In Niger, farmer managed natural regeneration of Faidherbia albida trees contributed to the mitigation of climate shocks but has limited results for very poor households because of limited cropland owned by this group.

Outcomes

Rural poor household resilience in semi-arid areas could be drastically enhanced via the diffusion of CSA techniques. The type of technique has to fit with the food needs of the household, taking into account accurate socio-economic figures given by household economy analysis profiles. The inclusion of these techniques in the response plans to food crisis can be improved, aiming at avoiding cash for work actions without any outcome. In Niger, the World Food Program begins to take into account a more adapted set of techniques in its new programs. It will help to propose techniques that are more adapted compared to the usual half-moons and "banquettes" giving poor additional production in some parts of the country.

LIVELIHOODS OF THE RANGELANDS, PARTICIPATORY APPROACHES TO LIVESTOCK PRODUCTION IN THE WESTBANK'S MOST UNPRODUCTIVE AGROECOSYSTEMS

DODGE, Kristofer

ICARDA, Jordan, Hashemite Kingdom of

k.dodge@cgiar.org

Rationale

Rangelands of the Middle East and North Africa are some of the least productive agricultural systems in the world. They are extremely vulnerable to climate variability that includes extended periods of drought, more intense rainfall events that increase erosion, and land tenure policies discourage investment (Saleh H.Al-Seekh, 2009). Despite harsh growing conditions and rugged climates the rangelands are repositories for the regions livestock and a culture of people who have produced them for thousands of years. Farmers of the rangelands in the West Bank have the added complication of occupation that makes decision making to support a livelihood even more obscure. This paper will explore the socio political realities rural life in the West Bank and how explore a case study that gives promise of improved livelihoods.

Methods Used and Partnership Setup

This paper will describe the production systems of two benchmark sites where the ICARDA implemented Water and Livelihoods Initiative is leading participatory research to minimize impact of livestock breeding in rangelands as well as create rural economic opportunity. The techniques include the collection and storage of rainwater into the soil profile ready for transpiration to support animal grazing needs.

The town of Al-Dahriyyain the southern part of the West Bank and Tammun in the north are characterized by highly variable rainfall, but averages less than 250mm annually. Typical farmer practices allow overgrazing, leaving no residues and therefore creating areas vulnerable to erosion during the summer and beginning of the rainy season. Palestinian rangelands are uniquely vulnerable due to occupation because the rancher must purchase feed from Israel once the range can no longer sustain their herds. This supply chain is not always reliable nor economically viable and is at the mercy of an often heated political barrier justifying farmers to build needed resilience through local procurement.

The WLI has established a community development program that is a culmination of three years of research (Dodge, 2013) to scale out supplemental feed blocks to ranchers using silage from co-products of nearby agricultural systems. Silage blocs are pressed from the waste materials of local greenhouses, date palm plantations, and field crop residues that can be utilized as feed and alleviate both the pressure for the farmer to overgraze as well as purchase exclusively through Israel at inflated prices.

In the West Bank the WLI partners with the National Agricultural Research Committee, Applied Research Institution- Jerusalem and four women's organizations engaged in participatory research to understand community's willingness to adopt silage block technologies in rangeland communities. Preliminary data generated from surveys suggests favorable adoption rates. Once collected, these data will be a good tool to understand the challenges to scaling the technology widely in the West Bank (Allen, 2014).

Results

While the survey to generate data for communities in the West Bank willingness to adopt the technology are ongoing the research teams have preliminary results from the benchmark sites in Al Dahriyya and Tammun.

These silage blocks are fed to livestock long into the dry season and partners are documenting the following outputs:

- Relief from pressure on the range as ranchers have available feed in stored silage blocks.
- Reduces annual costs of purchasing feed from the outside.
- Increases quantity and quality of milk. (Farmer practices allow for a two-month peak of milk production (April-May), which follows the peak nutrition cycle of the range).
- Provides livelihood opportunities for women's cooperatives in non-conventional cheese making (where women in typical farmer practices would spend more time grazing livestock).

Outcomes

The technology has been developed and WLI research partners are currently conducting surveys on the willingness to adopt these technology. With these data the WLI will design a project targeting the identified challenges toward adoption. Expected outcomes are that communities will rapidly adopt silage block technology after introduced by understanding the potential to alleviate pressure on rangelands and also to generate incomes from livestock projects using the technology in the dry season. Decreasing the burden on the range will let the benefits of water harvesting combat desertification.

Acknowledgements

I would like to thank Dr. Nasser Shaoli and his staff at the National Agriculture Research Center for their work collecting social data in partnership with four communities in Tammun and Al Dahriyya.

IMPROVING THE EFFICIENCY OF NUTRIENT CYCLING IN AGRICULLTURAL-LIVESTOCK PRODUCTION SYSTEMS THROUGH PROPER MANAGEMENT OF NUTRIENTS IN ANIMAL MANURE

GOMEZ-ROSALES, Sergio; ANGELES, Maria de Lourdes

Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias, Mexico

gomez.sergio@inifap.gob.mx

Rationale

In agricultural and livestock production systems the use of inappropriate management practices have led to the erosion and deterioration of agricultural soils. On one side, the excessive use of chemical fertilizers, herbicides and pesticides have led to the reduction of yields in areas that were highly producing before ((FAO, 2006). By contrast, in subsistence farming systems low rates or no chemical fertilizers are applied to crops with the resulting impairment of soils across the years leading to low fertility, low organic matter content, nitrogen and minerals necessary for the growth of the plants (ADNP, 2014). In livestock production, overgrazing of natural and artificial pastures has led to soil erosion. Paradoxically, in nutrient balance studies carried out in central México it has been shown that the nutrient output in animal manure can meet about 50% of the nutrient required for crops per year in zones of intensive agriculture (Gómez et al., 2008). This is because animals normally excrete between 80-60% of the nutrients consumed. Without proper management of the manure, between 50-80% of the carbon and nitrogen (C&N) is usually lost to the environment via volatilization. However, through the proper and holistic management of animal wastes, between 80-90% of the C&N can be recycled to croplands preventing their deterioration and reducing the demand for chemical fertilizers (Gómez et al., 2013a; Gómez et al., 2013b).

Methods

Under experimental conditions animal excreta have been subject to a series of treatments to capture as much as C&N in the form of organic fertilizers. The first step is the collection of fresh manure from pens to be subjected to anaerobic fermentation to preserve the fresh material due to reduced pH and simultaneously kill pathogenic microorganisms, or biogas production. The second step is to add to the fermented manure and residue a source of activated carbon to reduce emissions of C&N. The activated carbon has been obtained by the anaerobic heating of animal manure. The third step is to apply a pasteurization process to the fermented excreta by heating at 60 ° C for a period of two hours (simulating the active phase of composting). During pasteurization pathogenic bacteria are destroyed and this pre-conditions the manure to a follow-up process of maturation. The fourth step is the maturation of manure after pasteurization, covering the manure with insulating material to minimize the gas emissions. The fifth step involves the application of organic fertilizer on farmlands, which contains between 500-600 g of organic matter/kg of and 15 g N/kg. Complementary of chemical sources of nitrogen and phosphorus are used.

A simulation of nitrogen utilization in familiar units of milk production systems was also carried out, starting with the entry of N in the form of animal feed up to the recycling of N in farmland.

Results

Silage of manure: a retention of 94% of C&N of the original content in fresh manure before being subjected to the fermentation process has been achieved.

Activated carbon: In anaerobically fermented manure added with activated carbon 100% retention of the original C&N was observed.

Pasteurization and maturation: In swine, poultry, sheep, dairy and beef cattle manure an average of 60-75% of the original C&N was retained after a maturation period of 60-75 days.

Use of organic fertilizers in croplands: In a study under greenhouse conditions that was established two years ago, and which is still in process, the forage production was improved between 8-30% in soils amended with organic fertilizers compared to soils without addition of any type of fertilizers and to soils added with chemical fertilizers. Chemical analysis of soil fertilized with manure indicated improvements in the content of organic matter, nitrogen, phosphorus, manganese, potassium and zinc relative to soils without and with chemical fertilizer.

In a simulation exercise on nitrogen use in family systems of milk production it was found that with the use of untreated manure about 70% of N is lost via volatilization; with the remaining N, 2.5 ha/year of corn forage can be fertilized; the efficiency of the N recovered as forage relative to the forage consumed by the animals was 16%. In the simulation of N cycling, with manure subjected to different treatments, only 20% of N was lost by volatilization; about 7.5 ha/year can be fertilized with the remaining N; the efficiency of the N recovered as forage relative to the forage consumed by the animals was 40%.

Ouputs

With the implementation of an holistic management of animal manure we have observed reductions in the emissions of gases into the environment, increments in the area of agricultural fertilized lands, gains in the nutrient content of soils, raises in the forage yields per year and greater efficiency of N recycling, and hence, of other nutrients needed to maintain high soil fertility and to maintain high yield of crops, and a long-lasting residual effect of organic fertilizers on the fertility of soils.

AWARENESS OF CLIMATE CHANGE AS A FACTOR OF ADAPTATION IN THE AGRICULTURAL SECTOR

DONO, Gabriele (1); CORTIGNANI, Raffaele (1); DORO, Luca (2); PASQUI, Massimiliano (3); ROGGERO, Pier Paolo (2)

1: Dipartimento di scienze e tecnologie per l'Agricoltura, le Foreste, la Natura e l'Energia, Università della Tuscia, Viterbo, Italy; 2: Dipartimento di Agraria, Università degli Studi di Sassari, Nucleo di Ricerca sulla Desertificazione; 3: CNR - Istituto di Biometeorologia

dono@unitus.it

The paper describes results obtained under two research projects, Agroscenari (www.Agroscenari.it) and MACSUR (www.MACSUR.eu), investigating the problems of adaptation to climate change of Italian and European agriculture. This study was developed by specifying a choice process that explicitly considers that farmers base their planning activity on an awareness of the inherent variability in the climatic conditions of their territories. Here we assume that this awareness depends on the experience gained over the years and that it generates expectations from which farmers plan their economic activities.

The expectations on climatic variables, and the consequent conditions for crop, are represented with probability distribution functions (*PDF*) that are estimated under hypotheses of climate stability, cognition of a shift of the probability distributions achieved by observing the current weather conditions, full knowledge of the probability distributions of climate. The choices due to those expectations are simulated with a model of Discrete Stochastic Programming (DSP) representing the choices of farmers under climate variability conditions. DSP reproduces a choice process that considers the probability to take wrong management decisions (short-term), and the possibility to correct them before arriving at the final productive result. Using DSP involves reducing the range of the *PDFs* in states of nature with representative values and associated probabilities.

Other studies used the DSP to assess the impact of climate change, identified by its effects of change in the *PDF* of events (Dono et al, 2013). In these cases, the assumption was that farmers recognize the change and assign the weather events they expect in the future to a different *PDF*. Here the choices are simulated under the hypothesis that farmers have not perceived there is a climate change in progress, and generated the use of resources observed in 2010 under the assumption of climate stability, with productive conditions of 2000. In particular, farmers might have not recognized that observed data from the early 2000s indicate a gradual shift of the *PDF* file of agro-climatic events. Simulations are performed to estimate the revenue lost measured by comparing the DSP results under the hypothesis (a) "2000 climate", with the results generated by evaluating these shifts (b) "2010 climate", or even knowing full well the *PDFs* of climate (c) "actual 2010 climate".

The analysis focuses on climate variables relevant to farm management in a Mediterranean area consisting of a coastal zone provided of irrigation water, and a neighboring hilly zone with no irrigation infrastructure and based on extensive farming and pastoralism. In the irrigated zone the focus is to influence of summer temperatures on irrigation needs and the production of spring-summer crops: much attention is paid to forage crops given the importance of cow's milk to the local economy. Conversely, pastoralism is much important in the not irrigated zone, and the focus goes to climate variables influencing production of autumnal and winter grasslands and pastures. Eight farm types represent the agriculture in the area provided of irrigation water, five types represent agriculture in the rain-fed area (Dono et al, 2014).

The climate analysis is carried out with data of a local meteorological station, which reproduce the conditions observed by the farmers, and with data generated by a climate model that reproduces the actual climate conditions. The influence of climate variability on agricultural production is estimated with the EPIC agronomic model, whose results are used to estimate the probability distribution (*PDF*) of the agricultural variables with maximum likelihood methods. The *PDF* constitute the expectation in a regional model of DSP used to estimate the productive and economic impacts of the various climate scenarios on the entire area and the single farm types that comprise it.

The results suggest that it may be interesting to better investigate the impact of the underway climate changes: those changes may already be significant for agricultural activities, especially in marginal areas with poor water resource. Failure to understand these changes can lead farmers to planning errors (table 1). On one hand farmers may by prevented from taking advantage of opportunities for improvement of income, which also exist. On the other hand, farmers may be induced to misconceptions about the way to defend from the negative effects of climate change. For example, farmers may be induced to believe that negative results are the outcome of occasional adversities, while are instead the result of a programming based on an inadequate framework of the climate conditions. Other simulations show that substantial increases in income could be gained if farms abandon the expectations of stable climate and adapt to the changing climate variability (table 2). This suggests that, in order to better adapt to the change of climate variability that is in progress, one of the most important and effective measures can be to support farmers in better assess the new and changing climate framework in which they operate.

RETHINKING FORMAL AGROFORESTRY PRACTICES FOR SAVANNA ECOSYSTEM MANAGEMENT TO REDUCE DESERTIFICATION IN NORTHERN GHANA

KRANJAC-BERISAVLJEVIC, Gordana

University for Development Studies, Ghana

novagordanak@gmail.com

Rationale

Even though agroforestry, considered as farming with trees is an essential part of traditional farming settings in Ghana, formal systems which involves clearing and utilizing tracts of agriculture land purposely for trees is quite recent. Since the promulgation of the National Agroforestry Policy in the mid-1980s, various initiatives between government, donor agencies and research agencies have been developed with the aim of addressing deforestation, land degradation and improving agriculture productivity among farmers (Djarbeng & Ameyaw, 2002). However, most of the agroforestry initiatives have often involved the clearing of large tracts of land for cultivation of agroforestry specie trees, a practice, which significantly impacts existing ecosystems and livelihood activities.

In this study, we evaluate community-based agroforestry projects in purposely-selected rural communities in the Northern and Upper West regions of Ghana. The study tries to establish if the primary goal of agroforestry schemes is the economic benefit or environmental conservation-a case often argued in the past. Does the economic motive overwrite the environmental considerations? How do communities perceive the benefits and it what ways can they contribute to sustainability of agroforestry schemes? These questions are debated extensively, based on the evidence from the field cases and conclusions are presented in the paper.

CHECK DAMS PROMOTE IRRIGATION, RECHARGE GROUNDWATER, REDUCE POVERTY AND MITIGATE CLIMATE CHANGE IN INDIA'S ECOLOGICALLY-SENSITIVE DRYLANDS

AGORAMOORTHY, Govindasamy

NM Sadguru Water & Development Foundation, India

profagoramoorthy@yahoo.com

India is one among the top ten most water-starved nations of the world due to declining water availability and escalating demand. India's rainfall is concentrated during monsoons and some parts Western Ghats receive heavy rainfall even reaching up to 6 inches daily, causing extensive damage. However, most of the rainwater cannot be harvested for later use, owing to inadequate storage facilities. Global water use has tripled since the 1950s and policy makers and politicians have met this increasing water demand by building mega dams. Can mega dams solve chronic water shortages, poverty and future food security? What about building numerous small check dams in rivers? Can they enhance sustainable development in rural areas? This paper presents scientific data on how a small non-profit agency assists villages in the drylands of Gujarat, Rajasthan and Madhya Pradesh States to build cost-effective check dams in rivers to harvest rainwater for three decades. Water saved through the check dams not only transformed the infertile drylands into productive agricultural lands, but also increased ground water recharge ultimately benefiting the environment and promoting sustainable development. This model has remarkable potential to be replicated within India and also in other developing countries to reduce irrigation water stress and river water conflicts.

GREEN COVER EFFECTS ON SOIL PROPERTIES AND EROSION SUSCEPTIBILITY AT EROSION CONTROL TERRACES IN TURKEY

SARIYILDIZ, Temel

Kastamonu University, Turkey

tsariyildiz@kastamonu.edu.tr

In recent years, desertification has been considered as a key issue in environmental conservation (Komas et al., 1997, Jones et al., 2005). One of the clearest indicators of its advance is the degradation or disappearance of vegetation cover. Reduced vegetation cover leaves the soil progressively unprotected against the action of wind or raindrop impact (Kirkby et al., 1999). It favours intensification of the erosive processes and severe soil structural breakdown. Several strategies and techniques have been developed to control the impact of water erosion and to protect soils. Most of these are focused on combating soil degradation after deforestation or abandon of cropland. These strategies are of a very varied nature and cover different areas of research. Among others, terracing, use of trenches or silt traps, reforestation, treatment with mycorrhizae or waste amendments, crop rotations, and planting shrubs or live grasses have all been attempted. Several shrub species have been tested and used to prevent water erosion or for soil retention depending on their availability and cost (Andreu et al., 1998).

Turkey has a severe erosion problem. There is erosion on 59% of the agricultural area, 54% of the forestland and 64% of the rangeland in Turkey. In the erosion control activities; terracing activities are the most used one to prevent the surface erosion. The facilities such as dry wall, live threshold and wire net are also used to prevent gully erosion. In the terracing activities, the terraces are generally planted by young trees with some gaps among them. Until they get older their canopy only cover and protect small part of soil surfaces. However, in some countries, the uses of grasses and shrubs on the eroded sites have revealed better results to prevent soil losses and runoff compared to the use of only young tree planation technique.

In this study, we aim at comparing some soil properties, erosion rates and carbon stok capasities from the terraces planted by Black pine (*Pinus nigra*) with and without using covers of Sainfoin (*Onobrychis viciifolia* Scop) and Dog rose (*Rose canina*). Results show that using plant cover can reduce leaching of the fine parts within soil profile and increase water holding capacity, nutrients and organic matter amount, carbon storage capasity (Figure 1) and most importantly it reduces erosion susceptibility. In general, the erosion terraces covered by young plants can not protect soil against water and wind erosion until they reach the certain age to cover the soil underneath and around. However, naturally or artifically used plants shelter and fix the soil with their roots, reduce the energy of raindrops with their canopy. Also, vegetation can act as a physical barrier, altering sediment flow at the soil surface and store more carbon in soil.

MANAGEMENT OF SCARCE WATER RESOURCES FOR REHABILITATION OF DEGRADED LANDS IN ARID AND SEMI-ARID REGION OF SOUTHERN PAKISTAN

KHAN, Sahibzada Irfanullah

Sustainable Land Management Programme tpo Combat Desertification in Pakistan, Pakistan

sirfanullah@hotmail.com

Rationale

There are more than 3 billion people globally living in drylands that cover 40% of earth's surface; ROBIN (2002). In Pakistan, the situation is severe with 75% of the country's area receiving less than 250 mm of annual rainfall; PMD (1998). Karak is one of the driest regions in Pakistan where more than 80% people live below poverty line. Their livelihood is dependant on rainfed subsistence agriculture and livestock. The livestock is then dependant on natural range vegetation in the form of low trees, shrubs and grasses. However, due to increasing drought conditions and scarcity of rainfall, the agriculture is not more a productive activity and croplands are increasingly abandoned. The increasing number of livestock exerts extra pressure on natural vegetation of rangelands. This leads to the degradation of ecosystem and depletion of natural vegetation. The scanty rainfall condition, hot weather and sustained grazing pressure restricts recovery potential of natural vegetation. The phenomenon thus adds to desertification that compounds the problem of poverty and makes communities utterly vulnerable to the situation. . In the efforts to survive, they become heavily indebted, their health is badly affected and most of them migrate to urban areas. To come out of the situation, there is a need for locally developed and adopted methodologies for rehabilitation of the ecosystem to restore the livelihood base.

Methodology and partnership arrangements

The InteCooperation-Pakistan Delegation Office initated the Farm Forestry Support Project (FFSP) with funding from by Swiss Agency for Development and Cooperation (SDC) ecosystem rehabilitation work in District Karak in 2003. The field interventions under this initiative took place in partnership between the FFSP, the Forest Department and local community organizations. The following measures were used for rehabilitation:

(1) The development of silvopastures: Within the Karak region, 5 sights were selected for applying the "Hillside Ditch" technique to recover the fertility of soil, productive potential of the land and hence the vegetation cover. Continuous ditches along the contour line having plant pits at regular interval were excavated. The ditches were 66 centimeters wide and 30 centimeters deep, with excavated soil from ditch placed on downhill side making continuous ridge of 30 centimeters. The plant pits were planted with tree species that were fast growing and having fodder value. The inter-spaces between plants were sown with seeds of grasses and fodder shrubs. The species used on different sites included *Acacia albida, Dalbergia sissoo, Acacia nilotica, Melia azadarich,* and *Acacia Victoria* in trees, *Dodoneae viscose* and *Acacia modesta* in shrubs, and *Sorgham almum* and *Cenchrus ciliaris* in grasses.

(2) Sand-dune stabilization: Suckers of *Saccharum spontaneum* (locally called as *Kana*) were used for the purpose of stabilizing sand dunes, acting as wind-breaks for crop lands, and contributing to household income in the form of proceeds from sale of its stalks and leaves. Local communities selected 9 sites for demonstration of *Kana. Kana* suckers were planted at a spacing of 5 meter x 3 meter in straight lines Figure 10). Total cost per hectare of *Kana* establishment on sandy land including the cost of suckers and labour was Rs. 5,000 (US$ US$ 83).

Results and outcomes

According to the data collected from different sites, the average survival rate of trees planted was 40%, the average number of trees growing per hectare becoming 218. This number was manifold more than the number of trees growing on this type of lands without treatment (i.e. 14 trees per hectare; PFI (2005). The height and diameter growth rate on these sites recorded was also considerably higher. Maximum diameter and height growths were recorded in case of *Acacia albida* as 20 centimeters and 6 meters respectively, followed by *Acacia nilotica* as 15 centimeters and 5 meters respectively.

Due to retention of run-off and percolation of run-off water into soil on the site, a profuse growth of local annual and perennial grasses was recorded, in addition to the *Sorgham almum* and *Cenchrus ciliaris* that was sown during plantation activity. The average soil cover on these soils recorded was 45%, considerably high over normal cover on these degraded lands (10-15% on the average). These grasses and shrubs were of high value as a feed for local goats and sheep.

Due to use of specialized instruments and machinery, the cost was very low for applying hillside ditch technique to the development of silvo-pastures. The total cost including use of machinery, planting stock, seeds, and labor was calculated as US$ 82 per hectare. The usual cost per hectare plantation activity by the Forest Department was Rs. 19,800 or US$ 330 that was considerably higher than the cost on using hillside ditches; FATA (2007).

On the sand dunes,tThe average annual return from *Kana* site was Rs. 44,100 (US$ 735) that was profitably comparable with other land uses available for sand dunes (Gram, Canola and Mustard), except wheat.

PERCEPTION AND STRATEGIES TO RECOVER SOIL DEGRADATION IN A TROPICAL DRY FOREST WATERSHED OF MEXICO

COTLER, Helena

Instituto Nacional de Ecologia y Cambio Climático, Mexico

helena.cotler@inecc.gob.mx

As pressure on the land increases, small farmers convert the steeplands of tropical dry forest into cropland and pasture. In western Mexico, the relationship between the agricultural land conversion and the concentrated and highly erosive rainfall events (Garcia-Oliva et al. 2002) restricts and threats the rain-fed agriculture with a high probability of failure because of frequent droughts.

In this region, existing research highlights the environmental consequences of this conversion in terms of soil erosion and of lost ecosystems services (Cotler y Ortega, 2006). However, the slash-and-burn practices continue transforming the landscape. The recognition by farmers that soil erosion is a problem is the necessary precursor to any intervention (de Graaff *et al.* 2008). In this sense, we carry on a study to understand the perception and strategies undertaken by farmers to overcome this vulnerability.

Methods

At the Cuixmala watershed, located in the Pacific coast of western Mexico (Jalisco state), agricultural activities are performed on slopes with shallow soils strongly limited by the availability of phosphorus altering the quality of the soil, as stores of carbon and nitrogen, increasing the bulk density and reducing the organic matter content and aggregate stability; which increases the susceptibility of soil to erosion (García-Oliva et. al 1999; Cotler and Ortega, 2006).

In the upper part of this watershed, small farmers have settled for several decades ago. Their farming systems are composed mainly of subsistence farming and animal husbandry, distributed in 1 to 5 plots in different ecological zones. Each plot has 3 to 5 ha dominated by several natives' varieties of maize, bean and squash.

To identify the perception and strategies adopted by farmers facing soil erosion we carry on semi-structured interviews in which topics are predetermined and during which new questions arise as a result of the discussion. Interviews were held in 9 communities in the upper part of Cuixmala watershed, involving 79 farmers. The main topics were (i) soil erosion indicators, (ii) soil erosion causes, (iii) traditional knowledge soil conservation and the strategies undertaken by the families to address the vulnerability.

Results

The interviewed have an average age of 57 years and 25% of them have never attended school. In general these communities have a high poverty level. As a result of decades working on this land, the farmers have a good knowledge of their soils in term of suitability, tillage, erodibility and fertility. Field knowledge allows farmers to identify indicators of soil erosion as yield decline, yellowing of crops, less moisture retention (especially in the dry season), soil compaction, increased pests and the increased use of fertilizers. Related to this last aspect, the use of fertilizers is perceived both as an indicator of degradation and as a cause of degradation.

The farmers recognize some of their practices as triggers of soil erosion: slash-and-burn system (36%), the lack of fallow (24%) and the use of fertilizers (25%). Only 8% said they have no problem of erosion in soils. In response to this situation, the farmers are actually doing many practices to prevent and reverse erosion. Furthermore, the families undertake some strategies to overcome the vulnerability caused by their farming system. The respondents noted three main strategies: the subsidies from governmental programs (45% of them received *Procampo*), the remittances (59% has a relative migrant, mainly in the United States) and a farming system that combine agriculture and livestock activities. These strategies incorporate diversity, flexibility and allow undertaking climate variability. However, none of these strategies considers collective action within the community.

SCIENTIFIC APPROACHES TO THE IRRIGATIONAL SOIL DEGRADATION ASSESSMENT AND WAYS TO PREVENT OR OVERCOME IT FOR SECURING THE SUSTAINABLE DEVELOPMENT OF AGRICULTURE IN UKRAINE

BALIUK, Sviatoslav Antonovich; ZAKHAROVA, Maryna Anatoliivna; DROZD, Elena Mikolaivna; NOSONENKO, Alexander Anatoliivich; VOROTYNTSEVA, Ludmila Ivanivna; AFANASYEV, Yuri Oleksandrovich

National Scientific Center «Institute for Soil Science and Agrochemistry Research named after O.N. Sokolovsky», Ukraine

oroshenie@ukr.net

More than half of the territory of Ukraine is located in the zones of insufficient and unstable moistening, furthermore, the protracted periods of droughts were increased in frequency. Food and resource support of the country, as many countries of the world, substantially depends on the availability, condition and efficiency of irrigated land usage. The soil cover of the irrigated lands is extremely complex. Practically all types of the soils of theUkraineare represented in its structure, but chernozem and dark-chestnut soils predominate.

Irrigation leads to the transformation of soils, correction of natural soil processes. From the large number of soils evolution directions during the irrigation we separate: cultivation, without the changes and the degradation of soils. The direction of the evolution of soils depends on the joint influence of the natural and anthropogenic factors on their natural properties and regimes and of the direction of changes in the functions of soils and their fertility. Irrigation creates conditions for a considerable increase in the productivity of land-utilization. Nevertheless, amelioration frequently becomes the cause for appearance and development of a number of degradation phenomena.

The estimation of the soil degradation is achieved with the method of comparison of the parameters of the soils, which are fixed in the initial period of observations, or standard soils with the same parameters after the corresponding periods of the soil using. The criteria of evaluation of the development of degradation processes are worked out on the basis of these observations, the levels of their ecological danger and unprofitability are determined, the preventive and straight anti-degradation methods of using the ameliorated soils are proposed (Baliuk *et al.*, 2009).

Under "Irrigational degradation", we mean the degradation of soils, which can be developed under the effect of irrigating ameliorations and causes an increase in the expenditures for the restoration of the project production level. We determine the degrees of irrigational degradation on the level of deviation from the optimum of the basic parameters of the soils, which are determining for the fertility formation.

The most common forms of the irrigational degradation of the soils are soil overcompaction, crustification; erosion; swamping and underflooding; pollution of soils with heavy metals, pesticides, radioactive nuclides; secondary salinization, solonetzization and alcalination. They are developed after using for the irrigation waters of the not proper quality (suitable for determined limit and not suitable for the irrigation) and/or because of the low level of agriculture and insufficient resource investments - humus and nutritious elements losses.

Control of the fertility of the irrigated lands, directed to the formation of the models of steady, ecologically safe and economically effective agriculture, is impossible without:

1. Legislative and normative guarantee of soils protection.

2. Creation of united soil-land service.

3. New large-scale land survey and monitoring the soils, which will give adequate information about the soils of the country.

4. Increasing of the irrigation effectiveness due to the complex application of all kinds of amelioration and modern agro-technologies.

5. Essential certification of the agricultural lands, firstly, irrigated.

For the achievement of stated goal, the normative-methodical base (more than 300 normative documents) of soil investigations realization, agrochemical certification of the agricultural lands, ecological-ameliorative monitoring of the lands and monitoring of the soils is already created.

Food and resource support of the country, as many countries of the world, substantially depends on the availability, condition and efficiency of irrigated land usage. A necessary condition for highly effective, environmentally safe of irrigated land usage is the working out and implementing the complex of measures to manage the fertility of irrigated land, improve their agro-ecological condition and level of use. This complex must constantly adapt to the variability of natural and anthropogenic factors in order to obtain the highest possible profit subject to the requirements of resource conservation, soil protection and maintain of natural processes balance both within agromeliorative landscapes and in the biosphere as a whole. Such complex of measures is worked out in NSC ISSAR. The main elements of this complex of measures:

- reconstruction and modernization of irrigation systems, taking into account their environmental and reclamation condition.
- conversion of irrigated agriculture on the adaptive-landscape environmentally safe (compensatory) agriculture systems;
- rational structure of sowing areas and crop rotation oriented on market economy with the obligatory inclusion in crop rotation the perennial legume grasses;
- restoration of works with chemical reclamation of irrigated land and irrigation water, on the fundamentally new provisions;
- usage of internally soil reserves of calcium salts (soil self-reclamation) through the reclamation plantage plowing on the area about 500 thousands of hectares;
- a complex of engineering, agromeliorative and preventive measures nominated the composition of which for each region should take into account the occurrence causes and the development features of flooding processes;
- soil replenishment with organic matter by plant residues, organic fertilizers, crop rotation with perennial legume grasses;
- effective application of fertilizers.

FOGGARA AND THE OASIS IN ALGERIA IS ONE OF THE TEMPLATES THAT COMBATS AGAINST THE DESERTIFICATION.

ANSARI, Taha; BENHAMZA, Messouad

National Agency of Hydraulics Resources (NAHR), Algeria

ans1967@gmail.com

L'homme du désert a construit depuis plusieurs années, un environnement qui respecte la réglementation du développement durable. Cet environnement est appelé Oasis et il est composé d'une source d'eau (foggaras), village (Ksar) et une palmeraie. L'épine dorsale de cette synergie entre ces trois piliers de l'oasis est foggaras. Avec de l'eau de cette foggara, l'homme a appris et compris comment apprivoiser cet environnement très hostile. La verdure dans ce domaine très aride a été créé et perpétué par les exploits des hommes et des eaux de foggaras et une extension ou une réduction de la superficie irriguée dépend de l'abondance de l'eau, qui provient de la Foggara à la palmeraie. Actuellement, le système Foggara est influencée par de nombreuses contraintes qu'ils ont provoqué une diminution considérable du taux de la Foggara de flux, malgré les efforts et les investissements effectués par le gouvernement algérien pour sauvegarder ce système qui joue un rôle important dans le maintien de la verdure dans l'oasis car chaque litre d'eau qui disparaît est une parcelle qui est abandonné le résultat verdure est remplacé par le sable.

Les importantes contraintes qui affectent le fonctionnement des foggaras sont:

1-La baisse des niveaux de la nappe aquifère. Ouest du Nord-Système aquifère du Sahara septentrional (SASS) Ce système couvre une étendue de plus d'un million de km2, ce aquifères est partagé between Algeria, Tunisia and Libya. Ce bassin désigne la superposition de deux principales couches aquifères profondes: a) la formation du Continental Intercalaire, CI, b) the Complexe Terminal, CT. Foggara prend son eau dans la formation du Continental Intercalaire, CI. Le niveau statique de CI à Adrar, la terre de la foggara est comprise entre 6 m à 36 m, sachant que la profondeur des puits de foggaras varie entre 5m to43 m. Nous remarquons que le foggaras utilise les premiers mètres de l'aquifère. Dans d'autres foggaras, les puits, frôle le niveau statique de la formation du Continental Intercalaire, donc, toute fluctuation du niveau de l'eau a une influence directe sur le débit de la Foggara.

2 -modernité: Le savoir-faire et la compétence acquise par l'homme d'oasis, dans la préservation et la gestion des foggaras au fil des ans sont en disparition. Parce que la société a subi une métamorphose à partir d'un mode de vie traditionnel, à un mode de vie moderne et urbain.

L'eau est un élément vital et essentiel pour la préservation de ces bastions de la vie dans les zones arides hyper. La dégradation de ces oasis est un indice de la désertification, le résultat, la dégradation des terres et la perte de vie préservé et construit par l'homme depuis des siècles. Le maintien de ces foggaras et le renforcement de leurs débits sont très importants. En outre, la mise en place d'une gestion efficace, nous devons optimiser l'utilisation de ces eaux et l'introduction des concepts de productivité de l'eau est maintenant nécessaire de développer une agriculture durable dans les oasis et pour préserver le rôle écologique, social et économique des oasis

Le suivi de ces foggaras, qui irrigate11,353.04 palme haof bosquets est essentiel cherchent aussi des moyens appropriés pour améliorer et maintenir leur débit est vitale pour la protection de ces oasis. Cela a conduit l'Agence nationale des ressources en eau d'entreprendre des travaux d'inventaire et de collecte de toutes les informations techniques relatives à ce système de captage des eaux souterraines (mesure des débits, la localisation des puits et des peignes (kasria) avec GPS mesurer la profondeur des puits et la surveillance de la la qualité de l'eau de foggaras (680 échantillons en 2011) et d'intégrer toutes ces données dans un système d'information géographique. Nous avons inventorié jusqu'à aujourd'hui 1834 foggaras, positionnés par GPS 153 531 puits, 1690 peignes (kasrias).Mesuré la profondeur de 1 529 puits, ces données sont pour établir la carte de profondeur;Cette carte est une des données statiques dans le temps.Nous utilisons la carte de profondeur avec carte piézométrique (une des données qui est variable dans le temps).Les informations recueillies à partir de ces deux cartes est comme un système d'alerte précoce, qui fournit des informations sur l'état de foggaras.

Pour améliorer la capacité de résilience de ces oasis irriguées par foggaras un projet pilote initié par l'Observatoire du Sahara et du Sahel (OSS) et l'Agence nationale des ressources hydrauliques dans la région de l'Adrar à Reggan exactement dans la paume de Ait Messouad. Ce projet s'inscrit dans le cadre du projet, Système Aquifère du Sahara Occidental du Nord, la phase trois.(SASS III).

Le projet est défini comme suit:

- Le renforcement du débit de foggaras par forage avec un pompage solaire.
- Un système d'irrigation améliorée, par l'utilisation de l'irrigation localisée
- Participation réelle des habitants de l'oasis, (Association des foggaras et l'association de village).Amélioration de la gestion de l'eau en oasis pour protéger l'oasis et à faire face aux impacts futurs du changement climatique
- Amélioration de la productivité par l'amélioration de la qualité des sols et le choix des meilleures cultures.
- Ces pratiques sont acceptées par les agriculteurs, une clé de la réussite de ce projet.

RAINWATER HARVESTING TO REVERSE LAND DEGRADATION, TO MITIGATE DROUGHT EFFECTS AND TO INCREASE FOOD PRODUCTION

ANAYA-GARDUÑO, Manuel (1); CHACÓN-RODRÍGUEZ, Jhonatan (2)

1: Colegio de Postgraduados, Mexico; 2: Centro Internacional de Demostración y Capacitación en Aprovechamiento del Agua de Lluvia

anayam@colpos.mx

Rationale

Of the 7200 million people in the world, 1 600 million are without access to piped water; in 2025 could be about 3 000 million people without access to safe drinking water. There are millions of isolated communities with less than 200 inhabitants (Anaya, 2014).

The selection and application of technologies on water catchment systems will depend upon the education and motivation of the people, availability of well-trained staff, government policies, and the size of areas to be considered and the level of investment.

Currently the collection, storage and treatment of rainwater harvesting systems (RWHS) for various uses represents a real option and cost to meet demand for human consumption, domestic use, production in controlled environments and in backyards and rainfed agriculture (UNEP, 1997; Anaya, 2011).

Methods used

For the design, considering the demand in cubic meters, the net rainfall in meters and the catchment area in square meters, ensuring quantity, quality and continuity of supply with rainwater for various intended uses. Prototypes designed are the following:

COLPOS 1

Is a RWHS that meets the demand of 73 m^3/year family at a budget of 200 l/day, which has cost approximately 3 800 USD, satisfying water demand in quantity, quality and continuously. Is it supposed for a net annual rainfall of 1 000 mm, and requires a catchment area of 73 m^2 of roof-room house. The tank is coated with PVC geomembrane.

COLPOS 2

Is a RWHS for fish production in ponds and grocery circulars coated with a PVC geomembrane system, conditioned for water circulation and aeration.

COLPOS 3

Is a RWHS designed to meet the demand for drinking water at the community level, to satisfy the demand of purified water. The dimensions of the tank are 65 m long, 15 m wide and 3 m deep, lined and covered with PVC geomembrane.

COLPOS 4

A RWHS to meet the demand of various animal species, water consumption per day is equivalent to 10% of body weight. After excavation, the tank is coated and is roofed with PVC geomembrane, with a time life of 10 years.

COLPOS 5

A RWHS to meet demand (consumptive use) of various crops under controlled conditions in greenhouses, capturing rainwater from roofs and stored in a cistern lined and roofed with geomembrane and PVC floats.

COLPOS 6

A RWHS to control forest fire with a network of cisterns in zones continuosly affected by fire.

Results

Experiences of the International Centre for Demonstration and Training on Rainwater Harvesting (CIDECALLI, for its acronym in Spanish) of the Graduate College is showed in the development of prototypes for the use of rainwater for human consumption at the level of family and community, backyard production, controlled environments, animal consumption and aquifer recharge, which have been developed in México and several countries in Latin America and the Caribbean. It has also established the International Network of Specialized people on Rainwater Harvesting Systems (RIECALLI). RWHS merit consideration as a component of a large-scale water resource development; it is a need to establish national and municipal programs for the diffusion of alternative technologies.

The RWHS have great social, economic and environmental impact; are highly profitable, competitive and productive projects because they generate jobs and income. Given its low level of technological complexity, are extrapolated and easily adaptable to various cultural, social, economic and ecological scenarios. It is possible to set up programs in Regional, National, State, Municipal and Community levels and strengthen training programs for the design, construction and maintenance of the various RWHS. It is possible to supply drinking water for communities with government support, through subsidies for the construction of various types of cisterns. The access to clean and safe water is a universal right established by the United Nations Organization.

Outcomes

The CIDECALLI has fostered the development and implementation of training projects and supply with rainwater, in sufficient quantity and quality continuously, for human consumption at the household and community levels, with special attention to the marginalized populations. In the development of RWHS have obtained low construction costs, high profitability and excellent market competitiveness. Furthermore, it has generated technologies on catchment systems for rainwater backyard production in controlled environments for rainfed agriculture for animal consumption, groundwater recharge and control of forest fires. With graduate participants has formed a Network on RWHS in Latin America and the Caribbean, which allows the dynamic exchange of ideas and experiences on the various uses of rainwater, to date 833 people have been trained.

EFFECT OF CLAY AMENDMENT ON WATER RETENTION IN SANDY SOIL OF ARID AREAS: SOIL EL FJE MEDENINE IN SOUTHEASTERN TUNISIATHIS WORK DESIGNED TO STUDY THE EFFECT OF CLAY AMENDMENT ON THE WATER RETENTION OF

KARBOUT, Nissaf

institut for arid area, Tunisia

nissaf.karbout@yahoo.fr

This work designed to study the effect of clay amendment on the water retention of sandy soils in arid areas, He was led on pots containing sandy soil enriched with different rates of clay powder or gravel (0%, 5%, 10%, 15% and 20%), The sandy soil used is from the El FJE Medenine region (South-East of Tunisia). Clay amendment used is bentonite. She was taken to El Jebel Hidoudi Hamma Gabes (southeast of Tunisia). The results show that the addition of clay increases the water reserve available to the plants; this effect is evident that the percentage for clay be greater than 5% in sandy soil. From this threshold, the gain useful reserve of water relative to the unamended soil is even more important than the rate of amendment is high. The gain provided by amendment with clay gravel is slightly better than amendment with clay powder.

USING THE DISTRIBUTED MODEL EROSAR AND REMOTELY SENSED DATA FOR REGIONAL ASSESSMENT OF SOIL WATER EROSION IN SEMI-ARID RANGELANDS

BLANCO, Paula Daniela (1); DEL VALLE, Hector Francisco (1); BOUZA, Pablo Jose (1); METTERNICHT, Graciela I. (2); HARDTKE, Leonardo (1)

1: National Patagonian Center-CONICET, Argentine Republic; 2: Institute of Environmental Studies (IES), University of New South Wales (UNSW), Sydney, Australia

paulablanco8@gmail.com

Water erosion accelerated by grazing is regarded as one of the major form of land degradation in arid and semi-arid rangelands (Ravi et al., 2010). Regional-scale water erosion models that can identify where and when accelerated erosion occur, and quantify current and potential soil losses are a critical first step toward the development of policies and regulations to effective rangeland management.

This paper presents an *ero*sion model for *s*emi-*a*rid *r*angelands EROSAR, used to produce maps of simulated soil loss for a test site in semiarid Patagonian rangelands. EROSAR predicts soil loss at regional scale based on the simulation of hydrologic and erosion processes unique to rangelands, using information from panchromatic, multispectral, and hyperspectral satellite images and digital elevation models (DEMs). EROSAR describes splash and sheet erosion as a process of soil detachment by raindrop impact and surface water flow, and sediment transport by overland flow. It predicts soil loss following a distributed approach that enables input satellite images and DEMs.

EROSAR is structured around the concept of ecological sites (ES, the basic entity used in rangeland health assessment) and includes processes specific to rangelands, such as effects of soil surface degradation (desert pavements, gravels, rock fragments, bare soil) and impact of vegetation patches distribution on infiltration rate and runoff. The model considers Horton overland flow, the most common pathway of runoff in rangelands (Wilcox et al., 2003).

EROSAR integrates 1) hyperspectral and multispectral satellite data to map ecological sites (Blanco et al., 2014), 2) a DEM to account for topography and to assess the transport capacity of overland flow, 3) rainfall data to estimate kinetic energy of effective rainfall, 4) ALOS panchromatic satellite data to map vegetation distribution and connectivity of runoff source areas, and 5) a limited amount of soil field data.

EROSAR was applied to a test site of 400 km^2 in semiarid Patagonian rangelands. Six qualitative erosion classes were defined through a field survey based on FAO water erosion indicators. EROSAR performance was evaluated by comparing the simulated erosion with field data, measuring the agreement with the weighted Kappa coefficient of a contingency table.

During the period analysed (June 2006-October 2007) 115 rainfall events were recorded; 65% were higher than 1 mm, only 6% exceeded 10 mm. Catastrophic events occurred on March 8, 2007, with a record total rainfall of 26.9 mm; reaching a maximum intensity of 87 mm $hour^{-1}$ and a kinetic energy (KE) of 6,676.9 Jha^{-1}.

Figure 1b shows the spatial pattern of eroded areas as predicted by EROSAR over the whole period (115 rainfall events). The median observed erosion rate was 22 g m^{-2}, rangingfrom 0 to 2,840 gm^{-2}. Model performance was assessed by comparing the simulated erosion rates with field observed erosion, resulting in a global Kappa value of 73.8%.

Erosion rates were generally higher in ES characterized for long and steep slopes (1 and 3 in Figure 1c); erosion pavements also showed high values (ES 2); the presence of crusts and gravels reduced infiltration and encourage runoff and erosion. The lowest erosion rates were found in ES 4; the higher grass cover intercepts rainfall, protecting the soil from raindrops direct impact and dissipating the energy available to cause erosion. Ecological sites with high grass cover (ES 6) showed higher erosion than expected erosion. These channels receive *large volumes of runoff and sediment* from alluvial 'bajadas' (ES 1), partly transported, but largely are deposited.

Regarding to temporal variation of rainfall events, the main factor influencing erosion was KE; a KE of 1,000 J ha^{-1}appeared to be a threshold level beyond which disintegration of aggregates was severe, and influence of KE on erosion processes and sediment sorting could change. These findings demonstrate the need for considering KE-influenced sediment transport when predicting erosion.

This paper presents EROSAR, a model for soil erosion hazard assessment in rangelands at a regional scale. The use of remote sensing as input for EROSAR model parameters proved valuable both for ecological sites mapping as well as to assess vegetation distribution and connectivity of runoff to source areas. Largest values for soil loss are predicted for abrupt slopes at the edges of the old alluvial plain. The presence of crusts and sparse grass cover resulted in early indicators for ongoing soil degradation. These results in combination within EROSAR simulations provide valuable information for decision makers.

The main drawback of the model is that it fails to account for soil detachment by rills and gullies, and particle deposition. The main advantages of EROSAR are that it simulates processes at a regional scale and, where possible, it uses available data sources such as remote sensing imagery, and DEMs. Using EROSAR it is possible to produce regional maps on the state of soil erosion, which are far more valuable for land use planning and land management than simple extrapolations from small plot experiments.

LAND DEGRADATION IN MEXICO: PROPOSALS TO STABLISH THE NATIONAL SOIL COMMISSION

ANAYA-GARDUÑO, Manuel (1); MONCADA-DE LA FUENTE, Jesús (1); ORTIZ-SOLORIO, Carlos Alberto (1); GARCIA-SANCHEZ, Prometeo (1); CHACON-RODRIGUEZ, Jhonatan (2)

1: Colegio de Postgraduados, Mexico; 2: Centro Internacional de Demostración y Capacitación en Aprovechamiento del Agua de Lluvia

anayam@colpos.mx

Rationale

Soil degradation by human beings affects quality of life for living organisms, it is a process going faster as soil conservation and rehabilitation.

Soil degradation affects stability and sustainability of food production and generates hunger and poverty. Diminution of productive soils affects food and nutritional security. Massive migration within and outside the country, disintegrates family nucleus and it is a major consequence of natural resources degradation.

It is necessary to guarantee to level of economic, social, cultural and ecological politics, the joint of the combat of the soil degradation as a strategy of state, municipal and community development that allows to advance in the gradual achievement of a sustainable development.

Methods Used

Land degradation refers to the temporary or permanent reduction in the productive capacity of land as a result of human action. It is recognized that land degradation is a problem that is widespread, and in some areas severe. Until recently, however, there was little or no basis for estimating its extent and severity.

The Graduate College, in the last 30 years, has been evaluating land degradation in Mexico, it´s great concern refers to the advance of land degradation going more than 100 times as land rehabilitation.

The method employed for the GLASOD survey is set out in full in Oldeman (1990). In summary, a set of mapping units, relatively homogeneous in their physical characteristics, was established. For each mapping unit, national experts were asked to estimate:

Type of degradation: water erosion, wind erosion, chemical deterioration, physical deterioration, and subdivisions of these.

- Degree of degradation: light, moderate, strong, extreme.
- Relative extent of degradation, as percentage of the mapping unit affected.
- Causative factors of degradation: deforestation, overgrazing, agricultural activities (improper agricultural management), overexploitation of vegetation (cutting for fuelwood, etc.), industrial activities (pollution).

The full set of definitions may be found in Oldeman (1990). For present purposes, it is important to note the degrees of degradation, defined in terms of reductions in land productivity. In abbreviated form, these definitions are as follows:

- Light: somewhat reduced agricultural suitability.
- Moderate: greatly reduced agricultural productivity.
- Strong: biotic functions largely destroyed; non-reclaimable at farm level.
- Extreme: biotic functions fully destroyed, non-reclaimable

Mexico was divided in five meso-regions: north-west, north-east, west-center, center and south-east, in order to asses land degradation.

Results

From 200 million hectares in national territory, more than 142 million hectares are affected by degradation processes, which are reflected in climate change and severe and growing scarcity of water and food.

Land degradation processes in Mexico, are as follows:

- Meso-region north-west: 81% affected (wind erosion 3.71%, physical degradation 2.12%, water erosion 8.49%, chemical degradation 8.18%, wasteland 58.5%),
- Meso-region north-east: 81% affected (wind erosion 20.47%, physical degradation 3.67%, water erosion 10.92%, chemical degradation 16.81%, wasteland 29.13%),
- Meso-region west-central: 66% affected (wind erosion 7.18%, physical degradation 4.31%, water erosion 18.49%, chemical degradation 18.41%, wasteland 17.61%),
- Meso-region central: 68% affected (wind erosion 7.72%, physical degradation 4.71%, water erosion 13.54%, chemical degradation 23.95%, wasteland 18.08%),
- Meso-region south-east: 53% affected (wind erosion 0.33%, physical degradation 13.74%, water erosion 8.99%, chemical degradation 27.39%, wasteland 2.55%).

In Mexico and some other countries, land use systems should be consider to stablish soil and water conservation problems, considering limitative factor in forest land, grassland, rain fed and irrigation agriculture, in order to detect the best practices to reverse land degradation processes; this will be important for management of natural resources at local, municipal and watershed levels. The investment for soil and water conservation practices varies from 400 to 5,000 USD per hectare according to degradation level and land use system, this allows to stablish the budget.

According to these results, it is urgent to establish the NATIONAL SOIL COMMISSION, governing bodies in the five meso-regions to articulate, integrate, coordinate and evaluate all actions relating to conservation and sustainable management of soil and water and to strength training programs, development and implementation of projects at municipal level, with special attention to self-sufficiency in water, food and protection of natural resources, considering the principle of "local actions to a global challenge".

Outcomes

It is urgent to create the National Soil Commission as a direct agency of the Federal Government whose budget was raised in the Special Concurrent Program.

To establish rainwater cachtment systems for various uses, with special attention to areas of high poverty in the rural sector.

Improving quality and soil productivity by promoting and supporting the construction of factories of organic carbon (compost and green manures) and bio-inoculants.

A STRATEGY FOR FOOD SECURITY AND ECOSYSTEM SERVICES IN WATER-SCARCE AND DEGRADED DRYLANDS: CONNECTING THE WATER AND CARBON CYCLES

PONCE-HERNANDEZ, Raul; BURKE, Shivaan

GEORESLAR Lboratory, Environmental and Resource Science Program and Department of Geography, Trent University, Peterborough,Ontario, Canada

rponce@trentu.ca

Rationale

Water scarcity in areas of the world experiencing land degradation and desertification remains one of the primary driving forces of poverty and food insecurity, (Ahmad, 2003). Physical and economic water scarcity affects one-fifth of the world's population in every continent, (UNDP, 2006). This problem is compounded by inefficient water use, pollution of threatened water resources. Water scarcity is the main limiting factor in biomass production and crop yields, food insecurity and poverty. Addressing water scarcity is likely to enhance food security and poverty at local scale. The main tenet of this paper is that connecting the water and carbon cycles, by treating waste water from domestic and sanitation uses, and recycling it for irrigation of specifically-designed peri-urban agroforestry systems, achieves food production, carbon stocks in biomass, multiple environmental services and local employment.

Methods

The WaNuLCAS model (Van Noordwijk et al, 2011) is used to simulate the growth of crops: corn (*Zea maiz*), cowpea (*Vigna unguiculata*) and trees: peach (*Prunus persica*) using the peir-urban agroforestry site conditions observed at La Huerta, South Central Mexico, for model parameterization. Simulation results are compared for scenarios of waste water irrigation and no irrigation (i.e. rainfed conditions with unimodal rainfall, 500-550mm from April to October, which reflect water scarcity). The effect of climate parameters is included via daily rainfall, average temperature and radiation data. Irrigation with waste water was simulated by using model parameterization options to mimic the nutrient concentrations reported in waste water in the area. A number of allometric equations are used to determine biomass accumulation in trees. Two scenarios were considered: a) rainfed conditions (water scarcity), and b) waste water irrigation conditions, modelled for time periods of one, two, five and ten years, in an attempt to elucidate any long-term cumulative effects of either water scarcity or waste water irrigation. The performance of the systems in terms of carbon accrual (g/m^2) is compared based on a number of above- and below-ground carbon pools, namely: soil organic matter (SOM), tree biomass, harvested crop biomass, total carbon stocks and the resultant global warming effect of the entire system.

Results

The results show significant accumulation of biomass (kg/m^2) and Carbon by the crops and trees in each zone over a simulation period of 3650 days (i.e. ten years). These accruals occur within individual above- and below-ground carbon pools including soil organic matter (SOM), tree biomass, harvested crops, as well as total carbon stocks gained by the entire system irrigated with waste water (ww), relative to the system with water scarcity from rainfed conditions (lim). The total global warming potential is significantly less for waste water irrigated conditions (ww) than for water scarcity (lim) conditions (Figure 1). The results show, over all timescales, a much greater, even erratic variability in biomass under conditions of water scarcity. Under waste water irrigation the production of biomass, SOM accrual and crop yields do not only increase but are also more sustained throughout the simulation period. The accrual of biomass and carbon in the irrigated scenario increases significantly over time. As the agroforestry system matures, these increases become more significant. Total carbon stock grows almost exponentially over time with waste water irrigation (ww). This ensures that agroforestry farmers have a larger and more reliable harvest when treated waste water is recycled for irrigation purposes. The global warming potential of both systems (Figure 1), in terms of CO_2 equivalents per m^2 indicate that the mitigation capacity of the agroforestry system irrigated with waste water increases greatly over time, and is significantly greater than that of the water scarcity scenario. This is an added benefit to the enhanced food security that the waste water irrigated scenario represents.

Outcomes

This study compares the predicted performance of a peri-urban agroforestry system, in terms of biomass generation and carbon storage with a specific focus on crop yield production, under conditions of water scarcity and waste water irrigation in order to demonstrate the advantages of connecting the carbon and water cycles. water scarcity is central to conditions of food insecurity and poverty, especially in drylands and degraded lands (Rijsberman, 2005). By increasing crop yields this type of land-use management works towards improving food security at the household and community level, while simultaneously offering farmers the opportunity to sell surplus goods at market to supplement the household income. While the sale of farm goods is the most common method of farm income generation the production of ecosystem services, namely carbon sequestration, is a tangible way for farmers to diversify their income while improving their production performance (Wise and Cacho, 2007) and contribute to mitigate the concentration of greenhouse gases and climate change. This study demonstrates clearly the advantages of connecting the water and carbon cycles in areas of water scarcity, such as drylands and degraded lands in arid and semi-arid regions of the world.

GULLY EROSION AND REGULATED RIVER IN ALGERIA

ARABI, Mourad; KEDAID, Oumelkir; BOUROUGAA, Lakhdar

INRF, Algeria

almouraddz@yahoo.fr

Algeria is a mountainous and semi-arid mediterranean country. Since the beginning of the 20th century, it has known very tough problems of erosion. On the high plains in the Cheliff river catchment, where marls from the Miocene are extremely vulnerable to water erosion, two pairs of experimental research catchment basins (ERB) have been selected near Boughezoul dam. All basins were observed during year 2000 to 2003 for testing the efficiency of antierosive structures. In the developed basins, researches carried on the comparison of various types of check-dams, made of local materials (rocks, plastic bags, metallic fence and used tires). These checks dams were compared with conventional "gabions" (rocks wall trapped into a metallic fence) and diversified vegetative cover replanting techniques. These researches aim at orienting the action of Authorities in the conservation of soils for reducing water pollution and preserving the hydraulic infrastructures against erosion.

After three years of effort in erosion control, check-dams resisted the violence of the autumn and winter floods and have been filled quickly since the first year. Volumes of deposits trapped behind micro dams reach 3005 to 2917 m^3 in three years, either 70 to 80 % of the measured volumes. But after regulated river, the specific deterioration passed respectively of 42 to 9 t/ha/year to Sedara, on marls and 23 to 1,4 t/ha/year to Hririza, on sandy clays. Many vegetation techniques permitted to fix earths, to consolidate slopes and to cover accretion quickly behind weirs. For a comparable efficiency, the experienced checks dams cost can be brought back below the ½ of the price of "gabions" reference. The evolution of vegetation is so remarkable that in little time, gully taken the pace of a linear oasis.

WATER EROSION AND SOIL MANAGEMENT PRACTICES IN A MEXICAN ARID SMALL WATERSHED

LOREDO, Catarina (1); LARA, José Luis (1); ANGELES, Betsaida (2); BELTRAN, Sergio (3); TOVALÍN, Jorge (2); WOO, José Luis (1)

1: Autonomous University of San Luis Potosí, Mexico; 2: Professional Services Providers; 3: Office professional services INAGROTEC

catarina.loredo@uaslp.mx

Rationale

The productive capacity of ecosystems in Mexico, is being lost considerably due to overuse of resources. The rangelands are the ecosystems most deteriorated due overgrazing has damaged 60 million hectares. Secondly damage are forest areas and thirdly rainfed agriculture, which has identified 21 million hectares with problems of water and wind erosion (Ortiz *et al.*, 1994). The soil and water management programs with watershed approach are considered essential for the sustainable management of resources (Loredo *et al.,* 2007). The objectives of this project were to characterize the small watershed "El Charquito" resources, assess the potential and actual erosion risk, propose and implement a program of management and soil conservation. This small watershed is located in an arid area of the municipality of Villa de Arista in the state of San Luis Potosi, Mexico, has 600 inhabitants and a surface of 13023.21 ha

Methods and partnerships

The water erosion risk was estimated, using a GIS and the prediction model: USLE (Wischmeier y Smith, 1978). Five categories were considered: no apparent erosion risk (soil loss less than 2.2 t ha^{-1} yr^{-1}), slight erosion risk (2.2-10 t ha^{-1}), moderate (10-50 t ha^{-1}), high (50-200 t ha^{-1}) and very high (> 200 t ha^{-1}). A database was performed; the available technology for resource management was analyzed and management practices more appropriate for conservation and restoration land were identified. Integrating efforts of various institutions currently has actions of range management and soil and water conservation in 545 ha, which include rangeland rehabilitation, reseeding with grasses, reforestation and mechanical practices as successive formation terraces. Since 2003 a working group was organized with 75 members, which received support from the federal and state governments to perform these actions, under the State Program of Microwatershed, to achieve integrated and sustainable use of natural resources.

Results

The mean annual temperature in "El Charquito" is 17.17 °C; mean annual precipitation: 352.3mm. The elevation is 1610 meters above sea level. The soil types are litosol: 43%; litosol in association with fluvisol calcareous: 16%; calcareous fluvisol 29% and haplic xerosol 12%. The actual soil use presents the following distribution: 93% are special associations of vegetation (crasirosulifolio scrub, shrubs and izotal); 3 % are agricultural use land, 3% is grasslands. The principal use land is the livestock. 1% are erosion lands. Classes of potential land use are distributed as follows: Class VIII covers 36.08% of the area, the class IV/s 26.11%, the 16.29% is a Class VII/s, 20.25%% class VI/s and 1.25% is Class III; the main restrictive factors are the climate, topography and the soil depth. The surface of the watershed affected by slight erosion risk (0-10 t ha^{-1}) corresponds to 48.5%, 48.5% for a moderate erosion (10-50 t ha^{-1}), the 16.5% corresponds to high erosion (50-200 t ha^{-1}) and very high erosion (> 200 t ha^{-1}) covers 15%. The management practices (vegetative and mechanical) proposals were stoking control, rangeland revegetation, reforestation, to increase the vegetal cover, and mechanical practices as successive formation terraces, settles trench, sediment control structures for gully control erosion. With the application of these practices, the grade of actual soil erosion could be reduced from high to moderate.

Outcomes

The surfaces with potential and actual water erosion risk and the expected erosion and mechanical cover management practices in the "El Charquito" watershed were identified with the USLE model. With the active participation of producers was possible to define priority actions for the management of water, soil and vegetation resources. This information was integrated into the Master Plan of the watershed "El Charquito", where there have been mechanical and coverage management with support from federal and state government practices. Lack assesses the impact of such actions and that this actions to be continued.

Acknowledgements

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USE OF WIND ENERGY FOR DRY SEASON IRRIGATION OF VEGETABLES - OPTIONS FOR SUSTAINABLE DEVELOPMENT OF DRIER REGIONS OF GHANA

KRANJAC-BERISAVLJEVIC, Gordana

University for Development Studies, Ghana

novagordanak@gmail.com

Rationale

Irrigated dry season vegetable production is an on-going practice in the Northern part of Ghana. This activity is of considerable importance for farmers, as it provides income at the time when most major crops are harvested and there is available labour. Some studies also indicate that dry season irrigation reduces migration of youth to Southern Ghana, looking for seasonal labour opportunities. Household nutrition is also improved, through higher consumption of vegetables. Most of the vegetable-producing schemes depend on water from dams and dugouts. However, Gung irrigation project in Northern Region was developed by Government of Ghana to use wind powered pump for the same purpose. The Gung scheme was established in 2003 by Village Infrastructure Project (VIP) of the Ministry of Food and Agriculture (MoFA). Especially designed wind mill (Poldaw type), suitable for low wind speeds, was installed for use of the farmers on 6 ha project site.

TRADITIONAL KNOWLEDGE IN LAND DEGRADATION MANAGEMENT AND CLIMATE CHANGE ADAPTATION – ANAMBRA STATE, NIGERIA CASE STUDY

CHINWEZE, Chizoba

Chemtek Associates, Nigeria

ud2001ng@yahoo.com

The study area, Anambra state is the hotspot in Nigeria for landscape degradation, accounting for 65% of gully erosion incidences in the country. The total land area of 44,116sqkm has 40% severely gullied. Soil erosion consequence of intense flooding attributed to climatic variations constitutes the major challenge to agricultural development and livelihoods as the people are mainly an agrarian society.

Increases in precipitation levels and extreme weather events such as flooding, as indicated by International Panel on Climate change (IPCC) reports (IPPC, 2007; IPPC, 2014) is evidently escalating gully erosion in the area. The topographic features of the area consist of pronounced rolling hilly terrain and long steep slopes which enhance runoff velocity that speedily detach and transport soil particles thereby enhancing the gullies. Gully erosions occasioned by intense flooding makes the people vulnerable to a range of shocks and stresses, stretching from loss of agricultural lands, displacement of humans to forced migration; thereby further threatening severely agricultural productivity, livelihoods and poverty challenges in the area. It is worthy to note that Nigeria has 67 percent of the entire population living below poverty level (NBS, 2012); and further stresses arising from land degradation could jeopardize substantially development in the area.

The method adopted in this study includes data acquisition and evaluation from field survey. The study also identified areas highly susceptible to land degradation in the state.

The adaptation measures employed by the indigenous people that enhance resilience are traditionally-based with focus on maintaining the cultural landscape by reducing flood velocity and gully escalation through the use of locally fabricated materials and planting native trees that are also used as fodders. However these community-based adaptation methodologies are grossly inadequate to address the challenges of climate-induced gully erosion in the area; thus there is need to integrate good engineering, science, advance technology and adequate funding to combat the imminent disaster due to climatic induced ecological challenges.

The paper contributes to the growing knowledge on land degradation management and climate change adaptation strategy of local people in sub-Saharan Africa.

A TREND ANALYSIS OF THE EMERGENCE OF SCIENTIFIC AND KNOWLEDGE-BASED CONCEPTS FOR COMBATING DESERTIFICATION AT GLOBAL LEVEL OVER THE YEARS (1977-2012)

AMIRASLANI, Farshad

University of Tehran, Iran, Islamic Republic of

amiraslani@ut.ac.ir

Rationale

'Desertification' term was emerged in 1930s and has been incorporated gradually into the scientific and public literature since then. However, a particular attention to this topic became more pronounced in the 1970s after a series of droughts and famine in Africa. Later, the Earth Summit in 1992 created a milestone for the establishment of three UN Conventions including UNCCD.

UNCCD has encouraged channelling the knowledge and information for policy-making of combating desertification over the past. Through the establishment of the Committee of Science and Technology and its recent affiliated subsidiary group called Science-Policy Interface, it has given the public arena confidence that there is a crucial link between science and combating desertification programmes and policies.

This research attempts to evaluate the trend of incorporation of scientific and knowledge-based terms in the literatures related to combating desertification at global level within a 35-year timeframe (1977-2012). The premise of this research is that the appearance of scientific terms in the literature emphasises the pivotal and supportive roles of science and knowledge in combating desertification programmes and policies.

Methodology

In total, 140 research papers having "desertification" term in their title were collected. As one of bibliometric methods, the "functional information density" procedure was followed which is defined as "the frequency of the occurrence of a separate search term in a separate search field, taking into account all search terms in a particular search field" (Kardos and Boh, 2000, p.295). The *search field* of this research was 'desertification' and *search terms* were varied including land degradation. Those words frequently used together in titles, abstracts, or lists of keywords (Neff and Corely, 2009) were considered and then entered into a spreadsheet while the following considerations were made:

No time limitation, nor any boundary of the specific discipline for selecting entries

Only singular forms of words

Removing general words such as "and", "the", etc

No duplicated words out of each article

After the completion of data entry, the data were analysed using the logics of Structured Query Language (SQL). This is a programming language composed of a series of coding to record, manage and retrieve data through improving data search options according to the needs and requirements of users.

Results

This research encompassed a database of 1905 entries covering a 35- year period (1977-2012). Here, however, only findings relevant to this research are examined. Some key findings regarding the trend of appearance of 'science', 'knowledge' and 'research' terms in the literature related to desertification are illustrated in Table 1. Summarily, the number of terms relevant to science, knowledge and research was generally very low and very recent:

Both terms ('science' and 'knowledge') shared a very low percentage (less than 1%) amongst all 1905 entries

Except in one case (year 2000), terms relevant to 'science' and 'knowledge' have been just appeared in literature since 2006

The 'research' term has been cited since 1993 but with higher frequency from 2002

Table 1. Classification of scientific and knowledge-based terms in literature in the field of combating desertification cited since 1977 (Out of total 1905 terms)

Class	Examples of covered terms	Frequency	Ratio to the total	Timeframe of appearance
Science	scientific, scientific knowledge	12	0.6%	2000-2011
Knowledge	Knowledge management	10	0.5%	2000-2011
Research	Researcher, research communication	8	0.4%	1993-2008

Outcomes

Over the last decades, research on desertification has been continued in all academic disciplines, but with greater emphasis on bio-physical manifestations of desertification rather than socio-economic fields (Seely and Wöhl, 2004).

Although low frequent appearance of science and knowledge terms can be attributed to the less number of scientific publications in the earlier years compared to the current situation, this research showed that the integration and acceptance of science and knowledge for harnessing desertification are new to the field. This is despite the fact that combating desertification is considered as a science-based and knowledge-driven activity.

In addition to this failing, there has been a weak linkage between scientific publications and practical actions on the ground in relation to combating desertification (Seely and Wöhl, 2004). Clearly, this shows a gap between findings of research institutes and executive field works almost in all countries.

A PARADIGM OF AGRO-ECOSYSTEMS OF DATE PALM OASES UNDERSTOOD IN THE WIDER CONTEXT OF ECONOMIC AND CULTURAL ECOSYSTEMS THROUGH TRANSFER OF KNOWLEDGE AND TECHNOLOGY IN THE DESERT REGIONS.

PIESIK, Sandra (1,2); ZAID, Abdelouahhab (1,3); COLEMAN, Jim (1,5); SHEEHAN, Peter (1,4); MANGELSDORF, Wolf (1,5); ALKHOURI, Saher (1,6); POPO-OLA, Sunday (1,7)

1: Research & Development Group Eco-systems, United Kingdom; 2: 3 Ideas Ltd; 3: The UAE University; 4: Tourism and Culture Authority (TCA) Abu Dhabi; 5: Buro Happold Ltd; 6: The Applied Research Institute – Jerusalem Society (ARIJ) Palestine; 7: Imperial College London

sandra.piesik@3ideasme.com

Rationale

Cultivation of date palm forms an important part of the agricultural economy in over 40 desert countries. Date palm oases contribute to increased humidity levels and creation of micro-climates within a desert environment that then contributes to increased productivity of various crops and improvements of agro-ecosystems. Through centuries these oases formed an important trade, economic and cultural hub that extended their function beyond agricultural activities. One of these activities related to economic circulation of agricultural by - product derived from date palm cultivation: dry palm fronds. Each tree produces around 10 palm leaves annually that need to be cut off for the next year harvest. Historically, these fronds were used for the construction of buildings for thousands of years, today with forces of globalisation these practices are dying out and leaves landfilled.

This paper will examine successful case studies of traditional knowledge transfer in date palm leaf technologies by adopting traditional use to modern applications through engineering and science.

With global shortages of renewable resources and desertification, improved agricultural productivities of date palm oases, re-introduction of date palm leaf into economic circulation, introduction of new technology and education can contribute to the sustainable development and reduction of poverty through new employment opportunities.

Methods used and partnership set up

Multidisciplinary exchange of knowledge and practices in disciplines of:

- Agriculture and economy (agro-ecosystems and increased productivity of date palm oases)
- Archaeology, building conservation, architecture and structural engineering - (traditional knowledge, local technologies and contribution of science to innovative new technologies)
- Land management and education (sustainable communities and engineering capacity building)
- Ongoing Research & Development Programme centred on tests initiated in 2009

Based on six years of the collaboration of Sandra Piesik (of 3 ideas Ltd) on date palm leaf technologies with distinguished authors in individual partnerships a Research & Development Group Eco-systems has been established to facilitate a greater transfer of knowledge and practices between the authors and local communities.

Results

Harnessing over 25 years of best practice in date palm leaf cultivation, a case study of improved agro-ecosystems of date palm oasis in Al Ain (UAE) will be provided by *Professor Dr Abdelouahhab Zaid.*

Peter Sheehan, Archaeologist and Historic Buildings Manager of TCA Abu Dhabi will examine traditional building knowledge in the UAE and the wider Arabian Peninsula and the role of agencies responsible for the management and preservation of cultural heritage in promoting and transferring that knowledge. The paper will focus on the UNESCO World Heritage Site of Al Ain where *Sandra Piesik*, *Wolf Mangelsdorf and Buro Happold Structural Team* are contributing to a

case study project in Al Ain Oasis called the Food Shelter. An integrated project aimed at combining the best of western engineering with the best of local, eco-friendly, traditional building materials for construction of a large span date palm leaf modular structure. It is the first modern date palm leaf building in the Arabian Peninsula, demonstrating use of date palm for building as a structural element. Long term application of this technology could also be utilised for the construction of other structures such as community centres, greenhouses, nurseries, clinics, schools and refugee camps in desert regions.

Saher Alkhouri, Research Associate ofThe Applied Research Institute – Jerusalem Society (ARIJ), West Bank, Palestine will examine the role of date palm cultivation inthe West Bank in particular of Jericho and Al-Aghwar Governorate, and provide examples of measures taken to aid increased productivity and comprehensive planning and management programmes aimed at helping to create self-resilient and self-sustainable communities and enhance ecosystem productivity in the region.

Outcomes

Dr Jim Coleman, an economist of Buro Happold, London will offer a perspective on the possible impact of improved agro-ecosystems of date palm oasis in MENA countries as well as the potential for re-introduction of the date palm leaf back to economic circulation.

Dr Sunday Popo-Ola, a Research and Teaching Fellow of Imperial College London will present a paper on Engineering Capacity Building and Higher Educationin the Sub-Saharan Africa (SSA) focusing on sufficient engineering capacity as an essential tool to the economic and social development and seen as a key driver for innovation and growth.

All authors will contribute to possible areas of policy making in the desert regions in relation to date palm cultivation and a sustainable development understood in the widest possible sense.

IMPROVED EXTENSION METHOD OF PRACTICAL TECHNIQUE TO COPE WITH DESERTIFICATION IN NIGER, WEST AFRICA

SASAKI, Yuko (1); TANAKA, Ueru (1); IKAZAKI, Kenta (2); SHINJO, Hitoshi (3); TOBITA, Satoshi (4)

1: Research Institute for Humanity and Nature, Japan; 2: Department of Urban Environmental Science, Tokyo Metropolitan University, Japan; 3: Graduate School of Global Environmental Studies, Kyoto University, Japan; 4: Japan International Research Center for Agricultural Sciences, Japan

yukosasaki@chikyu.ac.jp

Introduction

In the Sahel region of West Africa, which is known as the forefront of desertification, many international organizations and aid agencies have tackled on the issues from various aspects (Hirano 2009). However, twenty years of efforts since UNCCD (1994) have not yet fully achieved (Tollefson and Gilbert 2012). One of the reasons for that the situation of the local society has not been fully taken into account (Sato 2003). To disseminate the technology to a targeted region, it is necessary not only to be practicable for the residents but also to find the appropriate way of technology introduction to enable them to continue after adoption. Standing on the above understanding, the purpose of our study is to figure out the social structure and its network and to elucidate the appropriate way of introducing and disseminating the technology to cope with the desertification.

Methodology

In western and southern part of Niger, we developed one practical technique against desertification, called 'Fallow-Band System' which enables to reduce wind erosion and concurrently to improve crop yield without inputs of additional labor, cost and materials in rain-fed millet cultivation (Ikazaki et al. 2011)

Supported by Japan International Cooperation Agency (JICA) and Global Environmental Forum (GEF), the technique has been practiced by 439 households in 75 villages, 23 districts and 5 regions in Niger, as of March 2013.The extension of the technique looks successful. Follow-up survey in one village called Finaré, however, revealed that the technique was practiced by the limited households, not by the entire village. To identify the reasons, we applied social-network survey to visualize the networks of information, the network of confidence, opinion leaders to all 136 households of the village.

Actual questions we asked are : 1) "Who are the person(s) you usually talk without hesitations?" (information networks), 2) "When you have some trouble at home and working place, who can you talk to?" (network of confidence), "Who are the persons who have strong influence to opinions and behavior of the population?" (opinion leaders). The locations of each household taken by GPS were dropped on the map and written the arrows from subjects (respondents) toward the persons named by the respondents. It took from 30 minutes to 1 hour per household and the exchanges were conducted in local language.

Results and Outcomes

We represent the arrow's directions extending from and to the subjects (out-degree and in-degree) the relationships. If he has responded that he exchanges information with an unspecified number of persons in public spaces such as mosques without citing a specific name, it was represented the arrow toward the mosque.

The result of information network shows that some parts are dense but other parts are sparse and there are persons who don't have any information networks (Figure). When we see the distribution of the households who practiced the technique, all of them have information networks with the village chief. It suggests that the range of diffusion might be limited by the networking with and distance to this contact person if a new idea or technology is introduced to a village through a local chief as a contact point which is commonly advocated in "participatory approaches" for rural development. Even though the introduced technology is scientifically sound, technically rational, and matching the needs and situation of local people, it is not widely adopted in the entire village due to such reasons. A social network survey could make clear this black-box in conventional rural development approaches. We also identified some opinion leaders located in key nodes of the network from the social network survey. These individuals could be additional access points for introduced ideas and technology. From these results, we propose a modified method of technical dissemination by combining the component of social network survey.

CAPACITY BUILDING THROUGH AN ON-LINE COLABORATIVE PLATFORM: THE UNIVERSIDAD VIRTUAL DEL AGUA

MARIN, Luis E (1); LEAL, Rosa Maria (2); MIER, Tomas (3)

1: Universidad Nacional Autonoma de Mexcio, Mexico; 2: Unidad de Ciencias del Agua, Centro de Investigación Científica de Yucatán; 3: Grupo Ha´, Mexico City, Mexico

lmarin@geofisica.unam.mx

Rationale

There are few formally trained water resources managers in Mexico. Within the government, one finds the best expertise at the federal government level. Within the state governments, one may find well or not so well trained personnel. At the municipal level, however, the training may be poor to non-existent. The same goes for NGO´s. Thus, Mexico as a country is lacking capacity in water resources management. This is particularly important for hydrogeology. Although more tan 75 million Mexicans depend on groundwater as their primary (and in many cases, it is the only source of water, such as the Yucatan Peninsula) source of water, we have less than 30 trained hydrogeologists with graduate training.

Methods

To help address this issue, we have developed a colaborative, on-line, capacity building platform. The platform is based on Moddle. We have started a collection of 48 lessons. Each lesson is designed to take between 45-60 minutes of instruction. The lessons have been grouped into four courses of 12 lessons each. After each lesson, there is an inter-active evaluation. The participant must obtain 80% or more correct answers before being able to advance to the next course. The courses are: Water management in Mexico (which provides an overview of water management in Mexico both from a physical as well as from a legal framework), source water protection (how to identify water-based risks and how to develop a mitigation plan), water quality (addressing the main concerns of water quality in Mexico), and water sustaintability (how to best prepare for long-term processes such as climate change, and shorter-term processes such as land use change, water contamination, reforestation, etc.).

Since the platform is available on-line, it allows the instructors to keep their teaching material up-to-date, as well as to use multi-media material such as photographs, videos, news clips, etc.

The instructors come from academia, the federal government, and NGO's. The courses have been used both at the Earth Sciences Graduate Program and at the Unidad de Ciencias del Agua. We are currently developing additional courses for both industry, NGO´s, and different governmental institutions, such as the National Water Commission and the Basin Councils.

Results

We currently have more than 125 enrolled participants. The constant feed-back that we are getting from the users is allowing us to make improvements to the platform, and to make sure that our users are being able to meet their capacity-building needs.

As we have different hydroclimatic conditions (as well as hydrological and hydrogeological conditions), we´ve recently started to develop a section called "water in your water-shed" (el agua en tu cuenca) whereby we are trying to upload oficial water-related information (which comes primarily from the National Water Commission) in a way that is relatively easy to follow.

As we don´t have many professionals in the water management sector, this is helping us to offer undergraduate and graduate level courses even in areas where an institution may lack trained personnel. One would hope that this can help to jump-start a national, regional, and local capacity building program for Mexico. Currently, the material is only available in Spanish, however, it could easily be translated into other languages.

We are currently developing additional curricula in the following areas: hydrology, environmental geology, hydrogeology, and groundwater modelling. The groundwater modeling course, is actually being developed in English, and will be co-taught with scientists from the USGS in Cancun in the Spring of 2015. The course will then be translated into Spanish.

As part of this process, we have developed a photographic geodatabase with more than 30,000 water-related images. As a capacity-building tool, this geodatabase is with our training efforts, as we can quickly show images that make it easier for the participants to understand the concepts we are trying to communicate.

Outcomes

The co-authors are working closely in order to be able to develop an on-line profesional masters degree in water resources management. The degree seeks to meet the capacity-building needs of members from civil society (NGO´s), industry, and both state and municipal government agencies. As our number of collaborators increase, we hope to be able to be better able to meet national, regional, and local water-related issues.

We do have two drawbacks that we are trying to address. Not everybody, particularly in rural Mexico, has access to computers, internet, etc. Thus, a limitation that we are facing, is how to make the platform available to these rural communities. Also, in many areas, we still don´t have full internet connection. However, one would hope that as the internet connections improve, we will be able to contribute through our training platform, to help society at large improve their water-based decision making.

BEST PRACTICES ON SUSTAINABLE LAND & ECOSYSTEM MANAGEMENT: LESSONS LEARNT FOR INTEGRATING TRADITIONAL PRACTICES AND SCIENTIFIC RESEARCH FOR OPTIMIZING ADAPTIVE CAPACITY TO COMBAT DLDD

SAXENA, Vivek (1); SUD, Ridhima (2)

1: Forest Department, Government of Haryana,India, India; 2: Ministry of Environment & Forests,Government of India

viveksax1@gmail.com

Desertification, Land degradation and Drought have emerged as serious environmental concerns, further aggravated by climate change and unsustainable practices causing erosion and degradation of natural resource base and severely affecting the adaptive capacity, poverty map and livelihoods. Appropriate land use and sustainable site specific agro-ecosystem based management practices can be the principal means for poverty reduction, sustainable development, arresting and reversing drivers of land degradation and attaining aspirational goal of land degradation neutrality in the context of sustainable development (UNCSD 2012). Sustainable land use and ecosystem management best practices, based on integration of traditional practices and scientific research through multi-sectoral approach to land management, biodiversity conservation and climate change mitigation and adaptation issues have potential of optimizing adaptive capacity in short, medium and long term for combating Desertification, land degradation and drought (DLDD) for poverty reduction and sustainable development as well as in meeting the operational objectives and strategic objectives of the UNCCD 10 year strategy (2008-2018) (UNCCD, 2008). The Performance Review and Assesment of Information System (PRAIS) portal based National reporting by member countries to UNCCD have also incorporated reporting on best practices on Sustainable Land Management technologies, including adaptation. In India, the total land area undergoing process of degradation is about 105.48 m ha, which constitute about 32.07 % of the total geographic area of the country (Ajai *et. al* .2009). The abstract of arid, semi-arid and dry sub humid land and land degradation in India are shown in Figure1. Appropriate best practices have the potential of arresting further degradation while also restoring and rehabilitating the degraded lands by pursuing sustainable land management, engaging communities and adopting participatory approaches which will also lay the basis for compensating local communities for maintaining flow of ecosystem services.

The Sustainable Land and Ecosystem Management (SLEM) project under the Country Partnership Program (CPP) of Government of India and Global Environment Facility(GEF), was a five year programme implemented in 11 States of India wherein six projects were implemented in partnership with Government organizations, non-government ,civil society organizations and GEF agencies (World Bank, UNDP and FAO). The projects implemented in diverse agro-ecological zones including arid, coastal and mountain ecosystems addressed the diverse aspects of land and ecosystem management, with an approach for integrating traditional practices and scientific research to optimizing adaptive capacity to combat DLDD .The projects envisage identifying gaps and barriers to sustainable land management, and documenting best practices in various agro-ecological regions, which could be up-scaled and mainstreamed. Identification, collection, documentation and dissemination of best practices in areas of land management, water resource conservation, eco-system service enhancement, biodiversity conservation, climate change adaptability under the SLEM-CPP are the main objectives.

The SLEM projects address issues related to land productivity, sustainable utilization of biological resources, water resource management, long term sustenance of ecological goods and services, opportunities for off-farm livelihood and sustainable livelihood generation, targeted at relevant stakeholders such as farmers groups, community based organizations, policy makers, land /natural resource management based institutions and organizations. The experiences/lessons learnt, highlighting field experiences in the form of case studies, best practices, intervention models and other knowledge products can be replicable at appropriate scale for improved land management practices with a potential of enhancing adaptive capacity of communities and

influencing policy makers for appropriate modifications in policies and investment decisions aimed at improved land management practices for combating Desertification, land degradation and drought.

The paper analyses the lessons learnt under SLEM-CPP projects in various agro-ecological regions of India. For each of the case study sites, the data collected through quantitative surveys and qualitative interviews of stakeholders is examined to identify the critical success factors that help in mainstreaming best practices emerging from the field into the policy landscape. The knowledge products generated during the course of the project period provide insights on the pre-conditions necessary for transforming individual projects into scalable models.

The findings reveal that up-scaling of SLEM best practices with respect to land management can be achieved at sectoral, institutional and community level. The dissemination of best practices to relevant stakeholders through appropriate channels at appropriate levels (community, land holder, decision makers and policy makers), integration of such traditional and scientifically-proven best practices for sustainable land management and appropriate supported financing strategies for investment decisions are the key to sustainable land and ecosystem management. The documented best practices through appropriate information channels that include innovative information technology tools should be accessible to relevant stakeholders for making informed choices and decisions. There is need for developing a mechanism to monitor and evaluate local traditional conservation practices, land management innovations and traditional land use systems to enable decision makers for optimum integration and use of traditional knowledge and scientific innovations for optimizing adaptive capacity in short, medium and long term for combating Desertification, land degradation and drought (DLDD) and attaining UNCCD Strategy objectives.

CONSENSUS BUILDING FOR NEW APPROACHES TO SOIL CONSERVATION IN MEXICO

COTLER, Helena (1); ARELLANO, José Luis (2); BAROIS, Isabelle (3); BURGOS, Ana (4); CADENA, Martin (5); CAMAS, Robertony (6); CRAM, Silke (4); LÓPEZ, Jaime (6); LOREDO, Catarina (7); MARTINEZ, Mario (8); MARTINEZ, Sergio (4); ORTEGA, Mariana (10); PINEDA, Raul

1: Instituto Nacional de Ecologia y Cambio Climático, Mexico; 2: Comisión Nacional del Agua; 3: Instituto de Ecología A.C.; 4: Universidad Nacional Autónoma de México; 5: Universidad Autónoma Agraria Antonio Narro; 6: Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias; 7: Universidad Autónoma San Luis Potosí; 8: Colegio de Posgraduados; 9: Universidad Autónoma de Querétaro; 10: Consultora independiente

helena.cotler@inecc.gob.mx

Soil degradation in Mexico is estimated to be present in 45% of the land area, and directly contributes to the decline of agricultural productivity, to pollution of rivers, to sedimentation of reservoirs, loss of biodiversity and to the emission of greenhouse gases. Despite this critical situation, soil deterioration goes unnoticed because the issue is not clearly positioned on the public agenda.

While discussion on soil conservation in Mexico dates back by several decades, the absence of a specific public policies and an agreed strategy has caused concerned institutions to fail in the coordination of collaborative efforts to address the existing problems.

Mexican programs for soil conservation began in the mid-twentieth century by implementing comprehensive plans, technology transfer, training and education (Martinez, 1999). Over time, however, the focus of these programs has changed. Today, the emphasis is on the implementation of practices promoted by federal grants through centralized planning. The absence of an assessment of the indicators regarding environmental and social impacts of conservation practices, makes it difficult to promote adaptive management (Cotler et al., 2013).

To address this deficiency, the 2015 celebration of the International Year of Soils will bring together researchers from nine research institutions in the country, looking for the establishment of general guidelines for soil conservation plans at different scales under the environmental, institutional and social conditions of a country as vast and diverse as Mexico.

Methods and partnerships

The theme of degradation and soil conservation is addressed by several public institutions in the country, but they maintain weak relationship and interaction between them. To start building common approaches to this subject, the workshop "Planning for the use and soil conservation in Mexico" was organized in September 2014 by a governmental agency, the National Institute for Ecology and Climate Change, and two educational institutions the National Autonomous University of Mexico and the Colegio de Posgraduados. The workshop outlined a national strategy for soil conservation that includes a multifunctional approach to soils and a spatial multiscale approximation to planning of soil conservation that considers the major ecological regions of the country. We sought to define guiding principles for promoting addoption of soil conservation practices by landowners, a crucial element to a successful policy.

The workshop was attended by researchers from nine academic and public institutions spread over the country. The discussion identified three key areas: (i) region-specific experience of soil conservation in terms of local planning considering socio-environmental conditions such as land tenure, production systems, and ecological conditions, (ii) the identification of colateral conservation practices for increasing soil productivity, conserving biodiversity and adapting to climate change, and (iii) the mechanisms necessary for the appropriation of conservation practices by producers and government institutions.

Results

The workshop put together the experience in soil conservation, accumulated in different research groups as well as lessons learned after many years of research and practice. Some important results were:

The planning of soil conservation should be performed iteratively at different scales, establishing criteria for prioritizing regional and national level, and promoting interagency coordination and statewide land use planning at the catchment and community scales.

It is necessary to consider local social and environmental conditions for the implementation of conservation practices. In this regard, an initial list of the most important measures was elaborated relating to several environments: arid, temperate, and dry and humid tropical.

As part of sustainable land management, soil conservation plays an important role in increasing agricultural productivity, biodiversity conservation and adaptation to climate change. For each of these issues, we identified measures that grant broad collateral benefits, which allow greater addapting by producers and enable progress towards mitigation of land degradation in Mexico.

The strengthening of a network of experts in soil conservation in Mexico should seek to articulate science with public policy.

Outcome

The results of this workshop will allow to enrich, refine and correct some public policy programs related to soil conservation in Mexico, climate change adaptation, biodiversity and agricultural productivity. Also participating institutions have established a roadmap for raising the issue of soil conservation on the public agenda.

RECENT ADVANCES IN THE DEVELOPMENT AND APPLICATION OF TOOLS TO SHARE AND USE LOCAL AND SCIENTIFIC KNOWLEDGE RELATED TO SUSTAINABLE LAND MANAGEMENT – THE WOCAT NETWORK

LINIGER, Hanspeter; MEKDASCHI STUDER, Rima; PROVIDOLI, Isabelle; GURTNER, Mathias

WOCAT Secretariat, Switzerland

hanspeter.liniger@cde.unibe.ch

Rationale

Current negotiations over a post-2015 development agenda have lent a new sense of urgency to land degradation issues and reignited interest in sustainable land management (SLM). For years already, various national and international organizations (GOs, NGOs, donors, etc.) have been working on issues of land degradation and alternative forms of land management. Numerous land users worldwide – especially small farmers – have been testing, adapting, and refining new and better ways of managing land. All too often, however, the resulting SLM knowledge has not been sufficiently documented and shared. This has often prevented valuable SLM knowledge from being channeled more widely into evidence-based decision-making processes. Over the years several knowledge management / sharing portals have been created, such as WOCAT, UNCCD-SKBP, LandPKS, JournalMap, etc.. The challenge is to link these various portals and get more effective use of scientific and local knowledge related to SLM.

Methods

Founded in 1992, WOCAT was one of the first programmes to promote better documentation and use of knowledge on SLM in response to land degradation (www.wocat.net). WOCAT and its network partners have developed comprehensive, standardized tools and a global platform for documenting, assessing and monitoring the impact of SLM practices, evaluating and sharing SLM knowledge to support decision making in the field, at the planning level, and in scaling up identified good practices. The tools are participatory and allow SLM specialists (including land users, agricultural advisors, project managers, researchers, etc.) to assess the impact of SLM and land degradation and share their knowledge at various levels.

The tools are also flexible and build on a modular system in order to meet the needs of different user groups. A fixed and standardized set of questions related to SLM practices builds the core of the Modular Knowledge Management system ("WOCAT light").

Results

1) WOCAT Light

2) Newly designed database with easier help and support for data collection as well as for use in decision support

3) New methodological framework for decision support at national / local level

Keeping the WOCAT framework flexible and open for additional topics on global issues (climate change adaptation and mitigation and watershed management) allows the link/harmonize to other SLM databases, platforms and advocates. On the other hand, keeping a fixed core of questions allows standardized documentation, sharing, analysis of data originating from a range of projects and programmes, growth of the evidence base for informed decision making, and knowledge synthesis leading into different forms of outputs.

Over the years, the WOCAT Network was able to confirm that SLM has major positive impacts / benefits on global issues such as food security, climate change adaptation, disaster risk reduction, and water crisis/conflicts.

Based on the WOCAT tools and methods various knowledge products have been produced which are available on the WOCAT website under "knowledge base": https://www.wocat.net/en/knowledge-base.html

Some examples of global, regional and national overview books: inventories of practices and guidelines are:

The WOCAT book 'where the land is greener - case studies and analysis of soil and water conservation initiatives worldwide', 2007. (Liniger & Critchley, 2007).

'SLM in Practice - Guidelines and Best Practices for Sub-Saharan Africa' is a TerrAfrica Partnership Publication which has been prepared by WOCAT and coordinated by the FAO of the UN, 2011 (Liniger et al. 2011).

The Desire for Greener Land – Options for Sustainable Land Management in Drylands, 2012.

Water harvesting – Guidelines to Best Practices (2013).

NEPCAT Fact Sheets, (Nepal).

Outcomes

The WOCAT Network has recorded many achievements and evolved into a substantial global network, database, and knowledge resource on SLM, building on collaboration between Network Members and in response to international, regional, and national demands.

Taken together, the tools and platform enable SLM specialists to identify priority areas for interventions, to determine suitable SLM technologies and approaches, and to share existing expertise and new discoveries on land management. They help people make informed decisions both in the field and in the context of high-level planning – e.g. when seeking to scale up best practices at the local, national, or global level.

In early 2014, WOCAT's growth and ongoing improvement culminated in its being officially recognized by the UNCCD as the primary recommended database for SLM best practices, including measures of climate change adaptation. Further, the UNCCD gave WOCAT a mandate to support the 196 signatory countries in recording their SLM technologies and approaches, and using the SLM knowledge of stakeholders worldwide – from land users to decision-makers – to improve local and regional land management.

At the same time, much still remains to be done in order for the WOCAT Network to fulfil its role as the professional standard-bearer of SLM knowledge management and decision support. Among other things, specific efforts must focus on further mainstreaming and institutionalizing WOCAT's tools and information-sharing platform and to link it with other existing SLM knowledge portals.

APPLICATION OF THE GLOBAL LAND-POTENTIAL KNOWLEDGE SYSTEM (LANDPKS) MOBILE APPS TO LAND DEGRADATION, RESTORATION, AND CLIMATE CHANGE ADAPTATION

HERRICK, Jeffrey E (1); ACHEAMPONG, Ernest (2); BEH, Adam (3); BENISTON, Josh (1); KARL, Jason (1); KIMITI, David (3); NDUNGU, Lillian (4)

1: USDA Agricultural Research Service, United States of America; 2: African Technology Policy Studies Network, Kenya; 3: New Mexico State University, United States of America; 4: Regional Center for Mapping of Resources for Development, Kenya

jherrick@nmsu.edu

Rationale

Combatting land degradation, promoting restoration and adapting to climate change all require an understanding of land potential. Land potential is the capacity of the land to support ecosystem services required to meet the needs of people without compromising the ability of future generations to meet their own needs. Land potential varies with climate, topography and soils. Variability in land potential at farm, watershed and regional scales is often ignored because the necessary knowledge and information do not exist or are not accessible to users. Where information does exist, it is often difficult to find it, or to determine its relevance to the user's specific conditions. A system is required to share and apply relevant knowledge and information based on land potential. This system is urgently needed as land use change and the conflicts associated with it continue to increase (Catley et al. 2012).

Methods

A global Land-Potential Knowledge System (LandPKS) is being developed that will address many of these limitations using an open source approach designed to allow anyone with a data-enabled mobile phone to access and contribute to knowledge that is relevant to their specific conditions (Herrick et al. 2013). The System is being developed through a global collaborative effort with funding from the USAID and USDA-ARS. Informal partnerships have been established with cooperators working for a number of organizations including the ATPS, ICRAF, AfSIS, NRT (Kenya), RCMRD, Ministries of Agriculture, and of Land and Resettlement (Namibia), NRCS, BLM, NMSU, and UNCCD SKBP among others. In Phase I, we are piloting a preliminary version with partners in northern Kenya and northern Namibia. We are testing its relevance to a number of user objectives, including land use planning, identifying areas with high potential for rangeland restoration, and determining the potential productivity and sustainabiity of crop production. We have also developed an integrated rangeland monitoring module, which uses the LandPKS to characterize the site, allowing for trend comparisons to areas with similar potential. Climate change adaptation is addressed by modifying the climate inputs to the models, allowing the impacts of different climate change scenarios on land potential to be compared.

Results

The *information* necessary to determine land potential is generated using a combination of user inputs and existing geospatial databases. User inputs are collected using a mobile app. They include land use, topography, and readily observable soil properties including cracking, salt accumulation texture, and color by depth. The app assumes no soils training, and little to no literacy. Short videos illustrate a dichotomous soil texture key, the phone's camera provides a rough estimate of soil color, and slope is determined by matching a drawing or using the phone's internal clinometer. The data can be collected off-line: the information is automatically sent to the cloud-based LandPKS the next time the user has connectivity.

Additional inputs including climate and independent topography estimates are extracted from existing databases based on the user's location (from phone GPS). The LandPKS then makes the best match to previously described soil profiles and extracts the physical and chemical information necessary to run predictive models, and to identify other areas with similar potential. The *knowledge* necessary to determine land potential is *currently* provided by a suite of predictive models which simply rank sites within the pilot areas based on (a) potential

productivity, and (b) soil erosion resistance for each of several different production systems (e.g. forage and annual crops). Phase II versions will use a wider range of knowledge sources, including global sustainable land management best practice knowledge bases, such as WOCAT (Liniger and Schwilch 2002), and the inputs of other app users managing land with similar potential. It will also facilitate communication among the users themselves. In Phase III, we hope to integrate socioeconomic and infrastructure factors that affect the ability to manage land to its potential. More pilot areas will be added during each phase as time and resources allow. We do anticipate that a global version of the site characterization and monitoring applications will be released by the time of the Scientific Conference.

Outcomes

The response to pilot tests of both the LandPKS core app and the rangeland monitoring module have been extremely positive. In northern Namibia, over 100 individuals were trained to use the rangeland monitoring module to monitor the impacts of community-based rangeland management initiatives. In northern Kenya, the app is being used to target and then monitor rangeland restoration projects in 20 community conservancies and as a primary tool in the development of a rangeland monitoring plan for Samburu County. In both cases, there is a high level of satisfaction with the user interface, and recognition that the current feedback provided by this very early version of the System is necessarily quite limited.

Acknowledgements

We thank hundreds of LandPKS contributors. The author list represents only those who contributed to this abstract.

DEVELOPING AN ADVISORY AND RURAL DEVELOPMENT SERVICE TO SUPPORT DAIRY FAMILY FARMERS, TO COPE WITH THE WORSENING OF THEIR CONDITIONS OF PRODUCTION IN SEMI-ARID AREAS (BRAZIL)

FAGES, Marjolaine (1); LE GUEN, Roger (1); SILVA DE MELO, Airon Aparecido (2)

1: Ecole Supérieure d'Agriculture d'Angers, France; 2: Unidade Acadêmica de Garanhuns / Universidade Federal Rural de Pernambuco, CEP 55292-270, Garanhuns/PE, Brazil

m.fages@groupe-esa.net

Pernambuco is the second largest milk-producing state in the Northeast of Brazil. The dairy sector is principally located in the southern rural region of the state, subject to desertification (Alves et al., 2010). About 63% of dairy farms are family-owned, selling less than 50 liters of milk per day (Gomes, 2008). From 2000 to 2011, milk production in the region increased by 246% (IBGE, 2013) thanks to good conditions for forage production. Nevertheless, the drought in 2012 and 2013, coupled with the destruction by the carmine cochineal (*Dactylopius sp.)* of fodder palm plantations, traditionally used in the feeding of cattle, has strongly affected dairy farms. The lack of an effective service which provides advice to farmers, highlighted by several research reports, interfered with the technical capabilities of farmers to cope with this crisis (Gomes, 2008; Oliveira et al, 2013; Reis and Silva, 2013). The aim of this study is to analyze the relationship between the availability of services focused on rural development in the southern rural region of Pernambuco state and farmers' demand for them, in order to consider possible responses to a more and more restrictive agro-climatic context.

The study was based on a sociological survey conducted between April and June 2014 in four municipalities in the southern rural region of Pernambuco. Two databases have been established: first, to characterize the offer from 46 individual semi-structured interviews with professionals in the dairy sector; secondly, to characterize the request from 21 group interviews with dairy farmers and members of their families, which mobilized 276 dairy farmers representing 221 family farms. These farmers belong to different rural communities: (a) conventional producers associations, (b) traditional communities of quilombolas (descendants of freed former slaves) and indigenous populations, and (c) settlements of landless farmers. Additional surveys were conducted in dairies and dairy farms in order to better understand the answers of the respondents. The interview phase was conducted in collaboration with the regional professional and scientific institutions (agricultural unions, cooperative, public bodies for rural development, Dairy Technical Centre, Federal Rural University of Pernambuco).

Half (52%) of rural advisors, called "professionals", and 70% of farmers surveyed consider that there is no real offer of advice in the region. Specific initiatives, from dairies, specialty shops which sell fodder, concentrate and veterinary products, agricultural unions, farmers' cooperatives or agencies of the state of Pernambuco were mentioned by farmers (35% of answers) although they were found to be very inadequate.

Among public and private structures encountered, 36% provide advice for dairy farmers occasionally and 30% offer technical and business consultations. Professionals explained the inefficiency of the service for rural development by the lack of staff (57%) and lack of skills (47%), poor implementation of public policies (30%), the bad working conditions (26%) and interference or, conversely, the disinterest of politicians (20%). The producers would like a service based on meetings and/or regular visits in each locality of the municipality: 65% of them are demanding monthly meetings with a professional. They are willing to discuss collectively with the professional about the organization of the visits so that all persons in their respective rural associations can benefit from support and progress. They would like a professional who will meet them on their farms, and who is competent to provide technologies appropriate to their conditions of production and is able to carry out practical tests in cooperation with them; they should also have some knowledge of farm management, accounting and taxation. Nearly two thirds of the producers were willing to participate in financing this service: 19% say that it depends on the results and 13% are willing to hire the services of an independent professional in the absence of a satisfactory public service.

More than half of professionals believe that the counseling and rural development service should be carried out by state agencies and 20% of them believe that it is important to form partnerships among government agencies, private companies and producer organizations to arrange this service. For 80% of them, the proposed service should involve multidisciplinary teams, implement participatory methods to work with farmers on their production system while facilitating farmers' access to public policies aimed at them.

Both producers and professionals underline the importance of the improvement of the agricultural advisory and development system to secure the future of family farms and the dairy industry in the region. But engaging a dynamic like this means creating opportunities for dialogue between the various stakeholders to agree on the organization and financing of that service on the one hand, and the political commitment on the other. Thus, effective and efficient measures can be put in place to maintain a dairy farming family fabric, including helping them to adapt to climate change. It would then be possible to reduce both the poverty of these families and the rural exodus.

ACACIA TORTILIS AND REVIVAL OF TRADITIONAL NOMADIC RESOURCE MANAGEMENT UNDER NEW SOCIO-ECONOMIC REALITIES.

KRZYWINSKI, Knut (1); ANDERSEN, Gidske Leknæs (2); HOBBS, Joseph (3); TALIB, Mohamed (4); SAADALLA, Ahmed Ebaid Mohamed (5); PIERCE, Richard Holton (1)

1: University of Bergen, Norway; 2: UNI Research, Norway; 3: University of Missouri, Columbia, USA; 4: Red Sea University, Sudan; 5: Egyptian Environmental Affairs Agency, Egypt

Knut.krzywinski@uib.no

Rationale

There are recurring questions about the ecological sustainability of indigenous resource management and what traditional ecological knowledge and rationale underlie them. Nomads in the Red Sea Hills of Egypt and Sudan have relied on drought persistent *Acacia tortilis* treesfor millennia as an adaption to climate variability and extreme events. Presently political, social and economic globalisation is accelerating in the region, eliciting changes in society, livelihood and land use. As indigenous inhabitants depart and assimilate to a modern lifestyle, their land use and tending practices cease, and essential knowledge is lost. Interviews and long-term observations have documented traditional practices and underlying ecological knowledge about the use and tending of *A. tortilis*. These have been held up against independent scientific studies of the ecology, population genetics and dynamics of this resource. Continued nomadic use and encouragement to revive nomadic lifestyle and resource management within the new socio-economic reality may mitigate desertification, land degradation and conceived drought and improve income generation and development.

Methods

This paper examines interactions between five pastoral nomadic culture groups of the Egyptian and Sudanese Red Sea Hills and their most important stable resource, *Acacia tortilis*.. Nomads from the Hadandawa, Amar Ar, Bishaari, Ababda and Maʿaza tribes have relied on drought persistent *Acacia tortilis* treesfor millennia. The present study is based on structured, conversational, open-ended interviews involving clearly presented topics designed to elicit relevant responses that were conducted between autumn 2010 and spring 2013 and data gathered over more than 25 years of ecological research in the study area. The subject of trees was raised in a broader socio-environmental context.

Results

A. tortilis is the most important reliable fodder resource for the pastoral nomads while also providing fuel and other useful products, ecosystem services for people and animals, and increased biodiversity by providing diverse microhabitats and resources for other species. *Acacia tortilis* is a keystone species both ecologically and culturally: the trees play such critical roles in ecosystems and social groups that their removal would greatly impact both systems. Interviews revealed deep insight into traditional ecological knowledge and traditional perceptions and uses of the trees. This guides pastoral decision-making in both normal and stressful circumstances. The significance of trees on the cultural landscape is also related to aspects of kinship, territorial organization, tenure and tribal law. The rich body of cultural associations with acacias also generally helps to safeguard the trees. Acacia attributes draw from and contribute to the social, spiritual and moral characteristics of people who value the tree.

Traditional practices and underlying ecological knowledge about the use and tending of *A. tortilis* during all its growth-stages may fairly be said to preserve an early stage in the development of arid land forestry. A variety of local practices — trimming (*shiishaknooyt* and *tasliih*) and pruning (*waak, janii*, *gariid*, *taghsiin* and *tahsiin)* — considered to be destructive by many outsiders, demonstrably conform to good pruning practices as described in modern literature. The traditional "gardening" of trees still practiced in the RSH clearly has beneficial effects that undoubtedly protect, strengthen and renew the trees.

Ongoing detrimental changes affecting acacia populations in the study area correlate more strongly with social impacts than with climatic factors. Social and economic pressures on cultural and natural resources are severing the intimate bonds between nature and nomadic culture. Present social and economic changes and sedentarization among nomads may have strong and lasting environmental costs. Understanding and addressing these linkages are critical challenges for social and natural scientists and policy makers.

Outcomes

Our research challenges current views that nomads are agents of deforestation and ecological destruction and must be rehabilitated. It reveals that tribal pastoral nomadic peoples with different ethnic and cultural roots have developed analogous ecological knowledge about how to manage their vital acacia resources with optimal efficiency. Sustainable indigenous resource management strategies and tactics enabling life in the desert are based on TEK. Strategies for dryland development should consider maintenance and reestablishment of local traditional pastoralism as viable alternatives to agricultural development and other unsustainable land uses in regions of extremely unpredictable rainfall.

The concepts of both cultural keystone species and cultural landscapes provides an opportunity to work with (not on behalf of) local communities to re-establish relationships with places and resources that are crucial to ecological conservation and restoration. It is necessary to support and empower the peoples and the culture that have maintained these landscapes for so long. It is more important than ever to document and understand the dynamic forces in motion and the concurrent changes in indigenous perspectives on resource management. These insights will have valuable roles to play in development going forward.

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JOURNALMAP: DISCOVERING LOCATION-RELEVANT KNOWLEDGE FROM PUBLISHED STUDIES FOR SUSTAINABLE LAND USE, PREVENTING DEGRADATION, AND RESTORING LANDSCAPES

KARL, Jason W. (1); HERRICK, Jeffrey E. (1); GILLAN, Jeffrey K. (2)

1: U.S. Department of Agriculture, Agricultural Research Service, United States of America; 2: Jornada Experimental Range, New Mexico State University, United States of America

jkarl@nmsu.edu

Rationale

Finding relevant knowledge and information to prevent land degradation and support restoration has historically involved researchers working from their own knowledge, querying people they know, and tediously searching topical literature reviews. Over the past two decades, vast quantities of knowledge and information have been made accessible, but finding that which is relevant often remains difficult and inefficient. The relevance of knowledge is determined by how closely the context in which it was created matches a given situation (Karl et al. 2012). In land stewardship and restoration, context includes both patterns of the biophysical (e.g., soils, climate, landform) and human environment. However, the ability to determine what is known about a land use or restoration practice in a particular landscape is hindered by current search technologies because they still rely primarily on key word, topic, text, and author searching – concepts of cataloging and searching for published information that have changed little since the late 1800s. With the addition of geographic filters and the locations of where studies have occurred, search results could be limited to specific areas and searches could be extended to contextually-similar areas across the globe.

Methods

To address this need we created JournalMap (http://www.journalmap.org), a map-based scientific literature database and search engine (Karl et al. 2013b). JournalMap uses study area descriptions from an article (not author affiliations) to map where the research was actually conducted. All articles in JournalMap are geotagged, either automatically using pattern recognition algorithms looking for geographic coordinates or manually from text-based descriptions. Article content in JournalMap comes from partnerships with publishers (e.g., Taylor & Francis, Pensoft, IOP) and research organizations, existing literature georeferencing efforts, and crowdsourcing from JournalMap's users.

JournalMap makes it easy to search for literature from specific places through a simple map interface. Results of JournalMap searches can be exported in different formats or saved as a collection with a unique URL for a spatial bibliography on a topic. For many topics, though, there has been little research done in many parts of the world. But, research conducted in areas with similar physical, environmental, cultural or political contexts can, in many cases, be relevant to these understudies regions (See Figure). JournalMap currently allows users to search for literature based on a few existing spatial layers including geology, soils, vegetation, through a simple overlay analysis of existing spatial data layers.

Results

JournalMap's literature database currently contains records for over 20,000 articles on a diversity of topics, and new content is being added continually. We have found that across knowledge domains approximately 85% of published studies are attributable to a mapable location, and around two-thirds of modern studies report geographic coordinate values that can be automatically extracted. Automated mapping of scientific knowledge could be improved by the adoption of standards for location reporting. In addition to map- and similarity-based searching, Journal Map data has been used to look at the distribution and spread of knowledge on topics over time like species conservation and to evaluate bias in the location and distribution of knowledge.

To illustrate the potential for JournalMap to identify relevant knowledge for an given area, we examined research studies from the Chihuahuan Desert of the southwestern United States. We mapped the locations of more than 800 journal articles that were returned from a Web of Science™ search on "Chihuahuan Desert". Only a third of the search results were actually from the target area. Additionally, the keyword literature search missed any study in the area that didn't use those two terms. In JournalMap's existing database, we found over 100 articles in the target area that were not included in the keyword search.

Outcomes

JournalMap's ability to search for ecological and agricultural literature thematically *and* geographically improves the ease of accessibility of potentially relevant research findings, promote syntheses and meta-analyses, provide mechanistic understanding to environmental patterns and causes of land degradation, facilitate evaluations of bias in ecological knowledge, and limit redundancy in conducting new studies (Karl et al. 2013a). JournalMap's database could be easily extended to include governmental reports on land degradation and restoration, providing a powerful tool for discovering and using the "dark data" that is often hidden in these documents because they are not easily discoverable. Additionally, through a publically available application programming interface (API) JournalMap's geographic search capabilities and georeferenced literature database can easily be combined with other databases (Karl and Herrick 2013) of land use practices (e.g., WOCAT), conservation projects, and site-based assessments of land potential (e.g., Land Potential Knowledge System).

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TRANSFORMING DROUGHT INFORMATION FOR AGRICULTURE PRODUCERS AND FACILITATING DECISION MAKING PROCESS

CAZAC, Valeriu (1); DARADUR, Mihail (2)

1: State Hydrometeorological Service, Moldova; 2: Research and Project Centre "Eco Logistica"

mdaradur@yahoo.com

Rationale

Droughts have a wide range of impacts across all sectors of development. However, the most vulnerable sector is agriculture which, in terms of human and economic development, is of vital importance to many developing countries in the dry lands. With the majority of the rural population both poor and dependent on the agricultural sector for livelihood, improved drought assessment and management is the highest priority for their development agenda (UN, 2012). This study carried out to ensure more effective use of the actual and modelled drought data at high resolution in terms of aligning with management design information and decision support tools that are requested by a variety of models and decision making.

Methods used and partnership set up

Transforming information and developing drought decision-support tools have been undertaken on the example of the Republic of Moldova, the country located in the South-Eastern part of Europe with a typical dry climate and high frequency of drought. The geographical distribution of drought to a considerable extent is attributed to topographic effects and their particularities are often not accurately captured by the national monitoring systems. Therefore the drought assessment and management in Moldova tend to be regional or even local (Cazac and Daradur, 2013).

The Precipitation Deficit (PD), as a difference between precipitation (P) and potential evapotranspiration (*E*), is used for measuring drought condition (Daradur et al., 2007). To produce accurate spatial estimates of drought, the statistical and spatial interpolation has been implemented to be effective in identifying and mapping *Drought Sensitive Areas* (DSAs). The return time concept associated with extreme drought event given intensity is suggested as a convenient tool for drought assessment within a particular location.

Participatory approach and wide engagement of key stakeholders have been highly critical to establishing the corresponding tools and in the practical and decision making dimension research. These interactions promote also the design and dissemination of drought decision support tools and associated training materials.

Results

Unlike the other drought and aridity indices, the PD gives the estimates in absolute values (liters/m^2) that has important practical implications in terms of the simplicity and perception for agriculture producers and decision makers. Besides that, the PD estimates are essential for designing a *smart agriculture* and provides an effective approach for rational use of limited water resources in the dry lands, since, in essence, the values of the PD are an equivalent to the amount of water that need to be added by irrigation to reach agro-ecosystem potential productivity.

In the target area the zonal values of the PD experience 100-400 liters/m^2 rate. At the same time a major part of the Moldavian territory (74.5%) experiences a considerable water deficit (>200 liters/m^2) and relates to "dry lands" which are at the high risk of drought and desertification processes. Accumulated values of the PD over growing period show that the local variations of the PD values can reach 100 -150 litres/m^2 that is comparable to the zonal changes. It suggests a different rate of ecological services and investments to reach balanced water conditions for maintaining a sustainable productivity of agro-ecosystems and assumes also an unequal market capabilities for agriculture producers that need to be considered in the policy implementations (for example in the *environmental services taxation).*

For the operational purposes and for presentation drought information in a form to make decisions, the *average return time* (F(t) =0. 50) of drought has been established. Apart from that, a confident return time is introduced, which represents a forestalling time interval during of which the drought occurs precisely once with 95% and higher confidence level (F(t)=0. 95). The proposed system of estimates improves existing drought decision-support tools, extends hydro-meteorological services, and ensures more effective drought policy interventions at all managenet level.

Outcomes

This paper introduced the new drought decisions-support tools and implementation approaches that lead to more effective decision making process and the adoptions of climate-resilient agriculture practices at local level basis in the conditions of limited water resources.

An effective system of drought decision-support tools designed to improve warning programs at all management levels has been established. It allowed accurately to represent the potential drought risk at high resolution and to upgrade existing tools for drought early warning systems based on the return level and waiting time concept.

An extended and new hydro-meteorological services to improve accessibility of the design information has been promoted. Realizing system of the drought decision-support tools for vulnerability communities across target area will benefit decision makers at all management levels. However, to be more sustained the outputs leading to improving accessibility and increased awareness, the efforts is underway to form a partnership with the key stakeholders in developing new design products based on real-time web-based services combined with integrating guiding information.

ENCOURAGING THE CAPACITY TO INNOVATE IN ORDER TO MEET THE CHALLENGES OF DRYLAND SYSTEMS

THOMAS, Richard James

ICARDA, Jordan, Hashemite Kingdom of

R.Thomas@cgiar.org

Rationale

It is recognized that drylands require an integrated systems approach that takes into account the economic, social and environmental co-benefits needed to achieve viable livelihoods and ensure social and environmental well being. The approach needs to handle the threats of climate change induced changes in soil moisture and temperature and in the demographics of pests and diseases and, increasing land degradation caused by wind and water erosion.

This effort must occur at the expected scale of impact that is, millions of farmers across millions of ha of dryland. Further a functioning science-policy interface is required that helps governments and international bodies deliver changes on the ground to rural people. The approach needs to identify opportunities for the agricultural sector in the context of new national development plans that can reverse the lack of investment in dryland areas.

At the same time innovation platforms need to be created that add to value chains by encouraging diversification and local income generation by harnessing local and 'scientific' knowledge that, when combined with responsible private sector investment, will result in local clusters of economic activity incorporating other livelihood options such as renewable energy, ecotourism, artisanal goods and biodiversity for pharmaceuticals and medicinals.

Here I describe processes to stimulate innovation in the research community and in the targeted populations via the establishment of a large dryland system 'research in development' program that applies integrated approaches to solve the challenges of drylands.

The approach

The Dryland Systems Program of the CGIAR focuses on the interacting and interrelated sets of activities that are the source of interdependencies that define the complexity of dryland agroecosystems or socio-ecological systems (www.drylandsystems.cgiar.org). Two principal environments are studied 1) the marginal production areas where greater resilience is required and 2) those regions where agriculture can be sustainably intensified. Within these environments research focuses on 5 agricultural livelihood systems defined as the principal agricultural or farming systems, the individuals, households and communities and their interactions with external systems that help secure their livelihoods. These are a) pastoral, b) agro-pastoral, c) intensive rainfed crops, d) irrigated crops and e) tree-based systems. The primary scale is the agricultural livelihood system but it also considers the wider environmental and institutional aspects and where necessary, explanatory insight that is mainly strategic research on system components.

The program develops and tests, with development partners, feasible combinations of technical, market, governance and policy options capable of kick starting and sustaining improvements in agricultural livelihoods by understanding the social, financial, technical and environmental contexts for which they are appropriate, thereby generating a knowledge base for better targeting interventions.

New science is applied in systems research through forging partnerships that can use planned comparisons in large trials, with crowd sourced data for monitoring and evaluation, bringing recent developments in information science and technology to bear on the problems of the poor and vulnerable.

Systems innovation platforms are being fostered that add to value chains by encouraging diversification and local income generation by harnessing local and 'scientific' knowledge that, when combined with responsible private sector investment, will result in local clusters of economic activity incorporating other livelihood options such as renewable energy, ecotourism, artisanal goods and biodiversity for pharmaceuticals.

This new 'research in development' approach will directly improve the effectiveness of development spending at local scales, at the same time as producing generalizable knowledge, and forging new partnerships, that will impact development of livelihood systems across the global drylands.

Within the research community a change in mind set is required shifting from multi-disciplinarity to trans-disciplinarity, more participatory approaches, knowledge synthesis and sharing. For communities it is crucial to support and strengthen their capacities to innovate and adapt through training, strategic partnership development and innovation platforms.

Results and outcomes

The program has established 15 innovation platforms across 5 regions bringing together researchers, policy makers, academia, NGO's, farmer groups and the private sector. A specific strategy on youth has been developed and is attracting increasing attention. Here the possibilities of introducing modern information and communication technologies to service the requirements of famers while stimulating job creation among youth holds great promise. The data derived from these studies will be incorporated into an open data management and access system that will enable widespread access and linkages to other existing databases. Capacity development occurs via the research process in most cases and currently there is a particular emphasis on mainstreaming gender into the activities. Specific results and outcomes will be presented that demonstrate increased capacity to innovate.

SCIENTIFIC KNOWLEDGE OF DDLD IN ARGENTINA: TENSIONS BETWEEN THE VISIBLE AND THE EXISTING

TORRES, Laura; ABRAHAM, Elena

CONICET-IADIZA, Argentine Republic

ltorres@mendoza-conicet.gob.ar

The present study is a continuity of a previous one, conducted as part of a wider framework of analysis under the umbrella of a Task Force on Land and Soil promoted by DesertNet International. In this framework, the existing scientific knowledge of DDLD in Argentina was analyzed, understanding "existing" knowledge as that likely to be captured in major international databases. The adopted methodology consisted of a biobliometric analysis of scientific papers captured in Web of Science between 1993, when the first record is computed, and 2012.

This experience reveals the existence of contributions that have a strong disciplinary bias and a great predominance of papers produced from the physical-natural sciences, most of them published in English and in foreign international journals. In a parallel manner, it is observed that databases fail to capture a large number of papers and authors that have made seminal contributions to the understanding of desertification processes in the region, even before establishment of the UNCCD (Abraham 2003). At this point of the path, it begins to become evident that the "existing" is much broader than the "visible", it then being necessary to further analyze the reasons that account for the lack of visibility of knowledge relevant to the region. Complementarily, and because the UNCCD insists from its very origins on the need to generate processes of dialogue between the scientific community, decision makers and the most affected populations (Poulsen 2013; Matallo 2008), it turns out important to examine the extent to which scientific knowledge –visible and existing- is taken into consideration at the time of planning and implementing combat actions. Three interrelated goals are proposed in the present work:

1. Describing scientific knowledge of DDLL in Argentina which is visible in international databases.
2. Retrieving existing scientific knowledge that is not visible, particularly knowledge that has made contributions to an integrated understanding of desertification and that opens channels for dialogue between the physical-natural sciences and the social sciences.
3. Analyzing the limitations attested to by decision makers, particularly those involved in the design of actions to combat desertification, in their access to available scientific knowledge, also considering the alternatives they envision to bridge the existing gaps between the political and academic fields.

The working methodology adopted is the result of combining quantitative and qualitative methodologies for scientific research. Among the former, bibliometric analysis is resorted to, and a description is made of the scientific studies of DDLD generated in Argentina which are visible in international databases. Based on the knowledge captured by Web of Science, the contributions are analyzed from shared categories of analysis (scientific disciplines from which studies were generated, fields of knowledge that have been integrated in each case, languages in which papers have been published, and places of origin and characteristics of the journals containing them). Subsequently, the technique of document analysis is applied to the scientific papers on DDLD, existing but not visible, generated in Argentina. The relevance of these papers is considered in virtue of the approach they take and of the degree of coupling they show in relation to agreements achieved within the UNCCD. Finally, and using qualitative techniques, in-depth interviews are made to decision makers, which are key to the implementation of actions to combat desertification. In the first and second axis of analysis, corresponding to goals 1 and 2, work is done at national level; for the qualitative adjustment, corresponding to goal 3, work is at provincial level. Therefore the province of Mendoza is considered, given that it is amongst the areas most affected by desertification in the country and that it has developed early action measures to combat desertification.

The recorded results allow noticing that knowledge construction processes cannot be considered making abstraction of the place where they occur. On the contrary, the geographies of scientific knowledge are historical spatialities that exert a strong influence on the contexts in which researchers approach the study of reality (Ramos et al 2004). In Argentina, it is also observed that the existing knowledge is far broader than the internationally visible knowledge. In turn, the latter appears to be detached from the problems exhibited by local contexts and are relatively strange and little accessible to decision makers. Conversely, internationally less visible studies are more accessible locally, not only because they are published in Spanish but also, and fundamentally, because they seek to think of desertification processes as related to the local contexts and regions where they occur, and because they favor higher levels of dialogue between the physical-natural and social sciences.

DEVELOPMENT OF BIOENERGY AGROECOSYSTEMS TO REDUCE THE IMPACT OF DESERTIFICATION

TARARIKO, Yuri Aleksandrovich; DATSKO, Ludmyla Valerievna

Institute of Water Problems and Land Reclamation, Ukraine

datsko05@mail.ru

Unlike for African countries, where land desertification occurs mainly due to the lack of rainfall, for the Eastern European countries, which include Ukraine, signs of desertification, in accordance with Annex V of the UN Convention to Combat Desertification, are also associated with land degradation, especially soil erosion processes and irrational land use (Bai and other).

It should be noted that for Ukraine the problem of desertification is relevant because 50% of its territory is exposed to soil erosion processes and 33% of the territory located in the arid areas (Тарапіко і ін., 2006). In Ukraine, for the past 20 years ofagroecosystemsmanagement resulted in a negative balance of not only essential nutrients, but also carbon, part of which is lost during mineralization of soil organic matter in the form of CO2 emissions, which, in turn, negatively affects climate change (Балюк і ін., 2010).

The extent of negative processes taking place in recent years, such as significant increase of arable land, land erodibility, emissions of CO2 and N2O in the agricultural sector, progressive loss of soil fertility, can be reduced by improving land tenure system with the introduction of erosion control measures and water reclamation.

Ukraine is a large agricultural country, with agricultural land occupying 54% of its territory; therefore the objective of this research was to develop a model of sustainable land use, which would provide food security without harming the environment, i.e., to minimize or mitigate negative processes associated with land desertification and degradation, and greenhouse gas emissions.

Long-term research of the Institute of Water Problems and Land Reclamation Academy of Agrarian Sciences of Ukraine showed that the important step for high economic efficiency of agricultural production on the dry and marginal land is the adaptation of so called resource-potential cropping systems, which is based on the use of the most productive cropssuited for this region, and the application of organic and organo-mineral fertilizers.

The first step in improving the economic performance of the farm is the livestock production in the rate of 150 cattle per 100 hectares of arable land. Another important componentsof economic infrastructure is the implementation of bioreactors, which would allow utilization of organic waste for obtainingbioenergy, and effective fertilizer and irrigation system use. Studies have shown that relatively to natural background levels of soil fertility, irrigation or use of organic and synthetic fertilizers increasescrop productivity more than two times, whereas without fertilizers - 1.4 times.

Loss of fats, proteins, carbohydrates and hydrocarbon from the agroecosystem is possible only as gaseous constituents of the atmosphere (C, N, O, H) – see Figure 1.

Macro-and trace elements (N, P, K, Ca et al), which are removed from the soil as non-grain biomass, remain in a closed cycle within the agroecosystem as a type of organic fertilizer – vermicompost. This allows for savings by abandoning syntethic fertilizers and switching to organic farming systems with its relevant benefits on the market.

Development of bioenergy agoecosystems will enable to simultaneously harness from each hectare of arable land up to 1 T of sugar, 1-1.5 T of meat and dairy products, 0.2-0.4 t of biodiesel, 1.4-2.3 thousand m3 of methane gas, as well as reduce CO_2 emissions by 10 t, reduce synthetic fertilizer use by 0.4 t, while improving soil fertility. Average gross income from produce sales is estimated to be $10,000/ ha.

Examples of successful application of such complex agroecosystems are private entity "Agroecology" Shishatsky Poltava region, "Ukrainian Milk Company" Zguriv district, Kyiv region, and the company "Danosha" Kalush district, Ivano-Frankivsk region.

ADOPTION OF GREEN ECONOMY AS A RIGHT STRATEGY TO ADDRESS DESERTIFICATION: AN AFRICAN PERSPECTIVE

AMBALAM, Kannan

Wollega University, Ethiopia

kannan615@gmail.com

Rationale

Green economy is an emerging development paradigm, which systematically integrates economic development with environment, human well-being and socially-inclusive growth. Achieving the principles of green economy in Africa remains major challenge due to accelerating trend of desertification since it is caused by complex interactions of a number of factors. Besides, the African countries are highly vulnerable to a number of natural disasters. In Africa, the drylands particularly both arid and semi-arid areas are expected to expand by between 5% & 8% by 2080. This will lead to a reduction of approximately 60-90 million hectares of fertile land. Africa has achieved low level of socio-economic development. Further, the limited availability of resources and lack of access to environment-friendly technologies affect the mitigation & adaptation strategies in the region, which has serious impact in achieving the objectives of sustainable development & green economy. In this context, this study will make an attempt in examining the challenges involved in achieving the core values of green economy through addressing the problems of desertification. It will provide an insight on how the adoption of green economy will be a right strategy to address desertification in a sustainable manner in Africa.

Methods

The study will use descriptive method. Also it will apply analytical approach to critically examine on how the adoption of green economy will address desertification, and the challenges in achieving the principles of green economy in Africa. The study will specifically focus on the measures taken by the governments in Africa in implementing core values of green economy and the strategies of UNCCD implementation. Among various principles related with green economy, the study will give major emphasis on the environment, human well-being and socially-inclusive growth in Africa.

The study will use secondary data from government documents, reports of United Nations' specialized agencies particularly the United Nations Environment Program (UNEP) and the United Nations Development Program (UNDP) on green economy, the global and regional advocacy groups and research institutes, policy briefs of the Secretariat of Multilateral Environmental Agreements (MEA) including United Nations Convention to Combat Desertification (UNCCD) and United Nations Framework Convention on Climate Change (UNFCCC), Convention on Biological Diversity (CBD), books and Articles.

Results

This study provides a clear conceptual and theoretical framework on the relationship between desertification and green economy. This identifies that adoption of green economy is a right strategy to address desertification and examining major challenges in achieving green economy. Further, this descriptive study evaluates a number of policy and administrative measures taken by the governments & other stakeholders to implement the principles of green economy through addressing the problems of desertification. This work specifically focuses on how the strategies like streamlining, integration, mainstreaming etc applied in implementing the UNCCD helps in achieving the core values of green economy.

Outcomes

Since green economy has emerged as alternative development paradigm, this study will help the governments and other stakeholders to have a better understanding on the complex relationship between green economy and desertification. Also it will underline the importance of adopting green economy to addressing desertification in Africa. Due to various reasons, achieving the principles of green economy will be an impossible mission without addressing desertification in Africa in a sustainable manner. This study will help the governments to apply the principles of green economy to address desertification through formulating appropriate policies and frame right strategies. Also this study will help in establishing a strong linkage between the strategies adopted to implement the UNCCD and the principles of green economy. This will help the governments to appropriately integrate their socio-economic development policies with environmental protection strategies. By identifying different challenges in adopting green economy, this study will help the African countries to formulate appropriate policies in the fields of natural resource management, industrialization, investment, infrastructure and social development through government intervention, private investment, public–private partnership, public and community participation, which in turn addresses desertification. Besides, this study will help in sharing best practices in the area of green economy.

DÉKPA BOTANICAL RESERVE, AN EXAMPLE OF INNOVATION AGAINST LAND DEGRADATION AND FOR CONSERVATION OF PLANT DIVERSITY ON MINE SITES (CÔTE D'IVOIRE)

VROH, Bi Tra Aimé; OUATTARA, Djakalia; TIEBRE, Marie-Solange; N'GUESSAN, Kouakou Edouard

Université Félix Houphouët-Boigny, Côte d'Ivoire

vrohbitra@gmail.com

Introduction

Mining companies are usually accused as "devour" biodiversity on all their area; which promotes land degradation, advancing desert, drought and the increasing poverty of local communities (Vroh *et al.*, 2014). In Côte d'Ivoire, after an environmental and social impact study of the gold mine's operation work, a mining company agreed to create a safe area for biodiversity offsets: the Dékpa Botanical Reserve. Dékpa forest means in local language, family or community forest reserve. We have described the various steps or studies conducted in order its creation. The objective was to assess the plant diversity of this site, its value for the flora conservation, availability of plants for traditional uses in the locality. The study also shows the partnership between scientific, the mining company and local people.

Method

In order to creation of the Dékpa refuge area, several activities have been defined in a proposed development and rehabilitation. The first group of activities concerned meetings with mining company and local communities of the 5 closest reserve villages. These meetings included the selection of community volunteers and strengthen their capacities. The second group of activities concerns mapping reserve and its delimitation, physical and technical management and the realization of nature trails. Third, we assess the initial flora and some ecosystem services in the reserve. In older plantations, fallow and forest fragments belonging to the botanical reserve, the presence of all plant species was noted in plots of 200 m^2. The circumferences of trees with dbh ≥ 5 cm were measured. The special status species were identified (rare and threatened species according IUCN, 2014). Local people were also interviewed on the use of plant species. The fourth group of activities concerns to reforestation and the creation of plants nursery (collection of seeds of rare, endemic species) that will strengthen the management of the reserve.

Results

Sessions of meetings have to get approval and membership of chiefs customary, chiefdoms and communities in 5 closest villages of the refuge area. Chiefs of villages selected 30 people (6 per village) to serve as community liaisons or peer educators. These will help in achieving the other development phases of the reserve.

The mapping carried out allowed that this forest block covered in 1998 an area of 136.5 ha. In 2012, there were only 12.19 ha. In 2013, it remains only 8.05 ha of which half is almost converted to plantations or fallow. So these are the remaining 8.05 ha, which were actually protected. Farmers were compensated on the site. This area may increase after negotiations with other surrounding farmers.

The botanical survey has identified 358 species of which 30 (Table) are among those classified as rare, threatened (IUCN, 2014) or different levels of endemism (Aké-Assi, 2001-2002, Poorter *et al.*, 2004). These are species such as *Cola lorougnonis* and *Drypetes singroboensis* considered by national botanists as missing in Ivorian flora. The interview of local people shows that 24% of species can be used in the treatment of various diseases, for food, crafts use or timber. The most important tree species are *Celtis zenkeri*, *Pterygota macrocarpa*, *Mansonia altissima*, *Ricinodendron heudelotii*, *Ceiba pentandra* and *Nesogordonia papaverifera*. All these timber species have high demand in the area because overexploitation. *Elaeis guineensis* is variously used to its roots, leaves, seeds and sap, very popular and intensely extracts produced in all regions of Côte d'Ivoire. Seeds of *Garcinia Kola* named locally "Petit cola" are cited in the food industry and for their aphrodisiac and fortifying virtue in the fight against erectile dysfunction. Some of these species with special status and priority for local communities have been in the

nursery for further rehabilitation of the reserve. Germination tests of other species not present on the site were initiated to increase the value for the conservation of biodiversity.

Conclusion

The creation of the reserve knows especially community and scientific progress. The study suggests that development of the reserve activities should consider the needs of local people, as their traditional knowledge may be a factor in the preservation of species. A second phase of the project is expected in 2014 for the assessment of faunal diversity (avifauna and mammals) in the reserve. It will be especially important for the assessment of ecosystem services (support, regulation, procurement and socio-cultural). We need to continue reforestation and monitoring of the nursery.

The example of the "Dekpa Forest Reserve" deserves to be repeated on all mine sites in Côte d'Ivoire. All ecological zones of the country are certainly relevant, but mainly the most vulnerable to erosion and land degradation areas (savanna regions of Northern and Central) which are fragility and the gateways to the desert.

EXPERIENCE OF INTEGRATED DEVELOPMENT OF NIZHNEDNEPROVSK SANDS IN UKRAINE

SHEVCHUK, Victor Vasilievich

State Enterprise "Steppe Branch named after V.M. Vinogradov of Ukrainian honored with "Znak Poshany" Research Institute of Forestry and Forest Melioration named after G.N. Vysotsky., Ukraine

stepfilial@bigmir.net

The Nizhnedneprovsk sands cover the territory of theLower Dnieperon its left bank in the form of seven vast massifs-arenas. They stretch from the town ofKakhovkato theBlack Seashore for 150 kmin the South-Eastern Ukraine and occupy 160.9 thousand ha. Together with inter-arenale sandy-loam lands they cover the territory of 209.4 thousand ha. The climate of the region is characterized by the prevalence of eastern and north-eastern winds with the speeds of up to 20-25 metersper second: relatively low air humidity (30—40 per cent, sometimes to 15 per cent); low cloudness; average annual amount of precipitation about 360 mm; relatively wide variations in daily and annual temperatures. The minimum air temperature in January and February sometimes is as low as —31.4 °C, and the maximum in July is +37,5 °C, and in August - up to +38.5°C.

In the past, as a result of excessive grazing and plowing up, the vegetation of the sands was being destroyed, the soils blown off, and the sands turned shifting. Sand dunes caused a great deal of damage, sometimes swallowing up to 9000 ha adjacent valuable farmlands per year, contaminating the air with very thin dust, and burying crops, plants, roads, lakes, farmsteads and whole settlements. In 1924 was based Aleshkovsk Sand- Reclamation Experimental Station which began work on of problem of finding cost-effective methods to use sands for planting forests and growing crops parallel with their reclamation which guarantee sand dune fixation. Besides, it was necessary to determine the impact of sandy massifs on the local climatic conditions.

Based on the materials of the expedition of the USSR People's Commissariat of 1932 there was a plan of development of Nizhnedneprovsk sands. Based on the conditions and possibilities, the plan that envisaged under the sands master: viticulture, fruit, vegetables, industrial crops, fodder crops, improved grasslands and pastures. Securing sands planned establishment of forest plantations, planting willow and forest shelter belts. Finding study of forest species and the development of ways of development of sand under different culture. Has developed a new agricultural machinery.

The new agrotechnology and sand afforestation is based on deep, partially subsurface loosening of sandy soil ground, which ensures a high degree of root-striking and safety of plants, their resistance and anti-erosion protection. The agro-technology includes measures of forest protection against pests and diseases. Wide-scale introduction of new agrotechnology into production has been possible due to total mechanization of technological processes - tillage, planting of seedlings, consecutive treatment of young crops. Seedlings are grown in local nurseries. Introduction of scientific developments directly in forestry enterprises, state and cooperative farms located in the area of Nizhnedneprovsk sands, finished laying around100,000 hectaresof high conservation of soil conservation plantings, about12,000 hectaresof vineyards and more than5,000 hectaresof gardens.

The total area of wooded land Kherson region according to the state forest inventory as at 01.01.2011 amounts to116,300 hectares, where75,300 ha(64.7%) belong to the state forest fund, of which62,500 ha(83.0%) - an artificial forest origin. Forests dominated by conifers -62,500 ha or 60.2% of the area of wooded land. Wooded area - 4.1%.

The main reasons for the deterioration of the forest of Kherson region is the growth of anthropogenic load and environmental factors - long hot periods of drought, strong winds, increase in the average temperature of the air, the lack of rainfall. Increasing the number of areas covered with forest and due to fires. In pine plantations reaching 40-50 years of age more frequent forest fires in large areas. The causes of forest fires are in the first place - the anthropogenic factor, as well as extreme weather conditions - high temperature and low humidity. Contributes to forest fires and a large supply of litter, which is due to low humidity and high temperatures very slowly mineralized. Critical situation requires urgent scientific invention and reliable methods of forestation of burnt forest areas in order to restore the balance of oxygen in the atmosphere and reduce the negative impact of carbon dioxide that is released as a result of fires.

THE EFFECTIVENESS OF METHODS OF LAND REHABILITATION

AHMADOV, Hukmatullo Mahmudovich

Tajik Soil Sciences Institute, Tajikistan

ahmadov@yandex.ru

Rationale

The problem of the sustainable development in the mountainous countries is closely connected with the soil degradation. The desertification leads to the decrease of soil fertility, to the reduction of the agricultural areas; and destroying of national - economic objects etc. The desertification is widespread in Tajikistan. 97.9 % ofTajikistanterritory is subjected to soil degradation. In 1973 this index came to 68% that is for the last 40 years total areas of the eroded lands increased by 30 % (Ahmadov, 1997). During 60-80 years many soil degradation problems were investigated. However, a lot of issues of desertification, erosion control methods and influences of degradation on food security, for the strong eroded territory still remain unstudied and require the detailed exploration. These issues are of principle meaning in the process of projecting anti-erosion measures and solution of the social-economic processes.

Methods

The research conducted over the whole territoryofTajikistanin fieldwork, experimental, expeditionary and laboratory conditions.In experimental plotsdifferenterosion controlmethodswere tested.The expeditionary methods (Sobolev, 1949) allowed measuring the washout of soil by investigating the volume of rill erosion on the elements of the relief forms.

For sustaining of the existing land managementit was necessary to collect and analyzed best land use practices.Tajik Soil Science Institute which is apartner organizationofWOCATsince2000, jointlywith other Institutes,NGOsandinternational projectsby usingWOCAT toolscollectedand documentedsuccessfulsuitable soil and water conservation (SWC) technologypractices from scientific researchers,land managementinnovations which come through the international projects and existing local traditional knowledge of farming for different land use type and ecological zones of Tajikistan.Up to now more than100 SWC technologies and approaches described on Tajikistan are listed in the WOCAT database.

Results

The effectiveness of the anti erosion measures (AEM) depends on combination of the nature factors. There is a complex of AEM for each high-natural zone.

Combat to Desertification in the valley zone must be carried out in two directions: first, raise of soil resistance to wash out; second, correct using of the irrigated lands and application of progressive soil protective irrigation techniques. The most effective of the AEM must be: cessation of cultivation of one-year crops on the steep slopes (more than 12 degrees); the use of eroded lands under perennial grass and gardens; deep cultivation across the slope; introduction of modern surface methods of irrigation; minimizing the excessive water and others. The gullies lands must be filling-up. It is proposed to plant the 2-10 rows shelter belts of dry-steady trees in the wind erosion zone. Arrangement of trees and quantity of rows depended on direction and speed of the wind.

For protection of the soil degradation in the low mountain zone (900-1500 mab. s.l.) it is necessary to undertake the system of agro-ameliorative and forest – ameliorative measures. This zone has been used as a rainfed one for a long time, therefore all AEM must be directed at the further stopping and reduction of the erosion processes. Here it is necessary to take the complex of the AEM-prophylactics measures, agro-ameliorative measures, hydro-technical measures, etc.

The middle mountain zone (1500-2500 mabove s.l.) is used as summer pasture. The areas of the rainfed lands are insignificant. Therefore the most of AEM is pasture – ameliorative measures and agro – ameliorative measures. Here especially sparely attention must be paid to afforestation of the steep slopes.

In previous years buffer zones and "handing" gardens have been widely used in the Low Mountain and middle mountain zones of Tajikistan. Now such application is very rare.

The high- mountain zone (more than2500 mabove s.l.) is mainly used as the summer pastures and therefore pasture ameliorative measures play the important role. Application of the insignificant standards of mineral fertilizer and regulation of grazing are especially very effective. Other AEM are less effective (Ahmadov et al., 2005).

Outcomes

The implementation of AEM in mountain conditions is an important issue. The mechanic transportation of AEM from European part of the former USSRinto the mountain territory often caused intensive soil erosion development. For the mountain territory it is necessary to recommend a complex of measures, as simple transportation of AEM from one zone to another is low effective. The best effect for the mountain territory renders local, often ignored AEMs such as, buffer zones, "hanging gardens". During the USSRperiod, the terracing was widely spread, but from our point, this kind of farming in the mountain territories is low effective. Terraces often may serve as places for gully formation. We recommend 1 – 2 m^2 plots for tree planting, which strongly lessens the erosion process and give good effect.

DESERTIFICATION OF ALPINE PASTURES, SOIL AND BIODIVERSITY CONSERVATION IN TAJIK MOUNTAINS

AHMADOV, Hukmatullo Mahmudovich (1); BRECKLE, Siegmar-W. (2)

1: Tajik Soil Sciences Institute, Tajikistan;; 2: University of Bielefeld,Federal Republic of Germany

ahmadov@yandex.ru

Rationale

Natural pastures and haymaking of Tajikistan occupy more than 3.5 million ha (The Pastures..., 1977). They are the major sources of various high-grade forages for livestock. Forages on pastures make up more than 1.6 million tons of dry mass per year (Tajikistan, 1982). Pastures in the country are characterized by a progressing decrease of their fodder productivity by anthropogenic factors. The productivity of pastures changes greatly during the years and productive livestock is rarely provided with constant amount of forage. For maintenance of a stable livestock population during fodder stress additional feeding of animals is required. In this connection, strategy of pasture uses and cattle keeping should be varied in different regions of the republic. By extensive grazing development of grass shoots is completely absent, morphology changes, plants become stocky, above-ground system of shoots partially forms rosettes, leaves decrease by 2-3 times, height of grasses is reduced strongly (on low-herb meadow pastures from 40-50 cm to 3-5cm), above-ground biomass is concentrated in lowermost ground layers. Desertification is developing intensively (Ahmadov & Gulmahmadov, 1999).

Methods

The impact of anthropological and natural factors has been studied by natural, laboratory and analytical-statistical methods. Statusof plantformations anddegree of soil erodibility was studied with $20m^2$-plots.Duringthe Tajik-German expeditionin the Pamirdifferentmethods of SLM (Sustainable Land Management) of pastureshave been documented. Controlmethodsfor differentgroups depending on the conditionof pastureerosion were combined.

Results

Extensive use and drought periods have caused a strong degradation in many parts of the subalpine and alpine zone. The basic indicator for degradation of pastures is the change of vegetation cover. Under excessive grazing a significant change of species composition of the bluegrass-sedge pastures is obvious. Poisonous, harmful and unpalatable plant species (e.g. *Hordeum leporinum, Centaurea squarrosa, Alyssum desertorum*) develop. Productivity of herbs decreases 5-10 fold. Biodiversity changes from highly variable vegetation patches to monotonous overgrazed areas.

During recent years the grazing pressure on the winter-spring pastures has considerably increased. All-year-round grazing of cattle became common. But not only overgrazing of vegetation and pastures, also felling of trees, cutting bushes and subshrubs for fuel had very negative effects. Productivity decreased and pastures became seasonally poor (Ahmadov et al., 2005). In general, desertification of the various pastures (Table) lead to an invasion of toxic and harmful species and a great loss of biodiversity by the disappearance of many high grasses (cereals), sedges, legumes, valuable forbs and associates.

For nature conservation and maintaining high biodiversity in vegetation and pastures it is necessary (1) to systemize pasture of the cattle (management plans); (2) to use the same territory only once in three years; (3) to apply once in 2-3 years small doses of mineral fertilizers on some sites for the improvement of quality and biomass of the plants; (4) to apply ameliorative measures for the improvement of the pasturelands; (5) to remove the poisonous and unpalatable plants, brought in by cattle from winter pastures (jointly with local communities and by hand - because all summer pasturelands are located on steep slopes); and (6) to show to local communities and farmers new progressive technologies for an efficient conservation and improvement of high mountain pasture lands on experimental plots. For water and soil management in the pasture zones the regulation of cattle grazing, the restoration of woods, as well as using crops to promote a species-rich grass cover to prevent erosion.

Outcomes

Overgrazing for centuries caused a substantial change of mountain vegetation. The natural species composition of pastures became contaminated by unpalatable plants – mainly *Cousinia*, *Acantholimon* but with many other harmful and poisonous herbs and nonproductive grasses. Thus, range degradation, loss of biodiversity and accelerated soil erosion are the consequences of long term unsystematic pasturing. Development of methods for sustainable use and for restoration of natural pastures and creation of high-productive cultural pastures is the most effective and reliable way against degradation of pastures, in order to maintain pasturable forages for cattle and other livestock.

In future it will be very important to apply new energy sources in order to be independent from organic matter. This would be the best preservation of the unique pasture vegetation and thus reducing soil degradation effectively.

COMBATING LAND DEGRADATION IN PRODUCTION LANDSCAPES FOR ADAPTIVE AND RESILIENT LIVELIHOODS: LEARNING FROM GEF PROJECTS APPLYING INTEGRATED APPROACHES

BAKARR, Mohamed Imam; APEL, Ulrich; SINNASSAMY, Jean-Marc; CHILOMBO, Andrew

Global Environment Facility, United States of America

mbakarr@thegef.org

Rationale

As a financial mechanism of the UNCCD, the GEF has played a key role in promoting innovative approaches to combat land degradation in drylands. The GEF, through its investment in sustainable land management, is helping to advance innovative approaches to promoting stewardship of production landscapes—agricultural, rangeland, and forest—in the developing world. An important contribution in this regard has been the promotion of integrated approaches —practices that integrate the management of land, soil, water, biodiversity, and biomass—for combating land degradation in those landscapes. Therefore projects financed over the last two decades present an invaluable opportunity to generate knowledge on innovative practices, experiences, and lessons for wider dissemination. During the period 2011-2014, the GEF Secretariat undertook a series of learning missions focused specifically on understanding the catalytic effect of these integrated approaches. The learning objective was in accordance with the GEF focal area strategy to combat land degradation, which embodies the landscape approach and integrated ecosystem management principles to maximize the global environmental benefits of project interventions. As a result of that focus, the strategy also addresses the need to harness and safeguard ecosystem services (carbon cycling, biodiversity, hydrological flows, and healthy soils).

Methods used and partnership set up:

The overall learning was focused specifically on projects financed under the Operational Programs on Integrated Ecosystem Management (OP12) and Sustainable Land Management (OP15), which were the financing windows for countries to receive GEF resources to combat land degradation. The learning process involved reviewing project implementation reports, assessing trends in projects financed under OP12 and OP15, and field visits to selected projects. The learning missions were organized in partnership with GEF Agencies, and government institutions and partners in three countries: Burkina Faso, China, and India. The overall finding were synthesized in the form of a publication,[1] highlighting the context and rationale for GEF financing under OP12 and OP15, the catalytic role of GEF financing in promoting integrated approaches, and lessons from its application of integrated approaches in the context of combating land degradation. Because the focus was entirely on learning, the report does not include any specific judgments or interpretations about environmental or development impacts of GEF investments. Rather, it highlighted the processes, practices, tools, and knowledge innovations embodied in projects that apply integrated approaches.

Results

The portfolio of GEF financed projects applying integrated approaches to combat land degradation accounted for a total grant of over US$469 million, and generated an additional US$2.07 billion in co-financing. Regionally, countries in Africa accounted for nearly 27 percent of the total GEF grant, followed by the Latin America and the Caribbean (20 percent) and Asia (17 percent) regions. The projects were all focused on management of production systems to address multiple focal area priorities (land degradation, deforestation, climate change), and designed to produce synergistic benefits geared toward overall sustainability and resilience of the system. The learning missions involved field visits to GEF projects, in Burkina Faso, China, and India. Each project was designed to integrate institutionally from local and landscape levels to subnational and national levels. The catalytic role of GEF financing was demonstrated in the overall project design, approach to implementation and good practices in agro-ecosystems, and approach to enhancing sustainability of outcomes. Participatory planning with communities and

multi-scale integration of decision-making was a major focus for GEF financing. As a result, improvement in ecosystem services flows across the production system was linked directly to development and livelihood needs of local land users, and specifically taking into account gender differences. The four projects also provide clear examples of how GEF financing promotes the use of an ecosystem approach, as established by the Convention on Biological Diversity (see Table 1).

Outcomes

With GEF financing now more predictable than ever, countries are increasingly designing multi–focal area projects that link sustainable land management with conservation of biodiversity, climate change adaptation and mitigation, and management of transboundary water resources. As a result of the portfolio review and learning on integrated approaches, the countries now have access to lessons and experiences that will help them design innovative projects in a more constructive manner. The GEF is now well placed to provide strategic guidance on options for multi–focal area programming, baseline scenarios to justify GEF incremental financing, types of integrated approaches for investing GEF resources, and expectations for global environmental benefits. Such guidance will ensure improvement in the quality of multi–focal area projects at entry, options for achieving synergies in global environmental benefits at full scale, and indicators for monitoring and quantifying the benefits.

Acknowledgments

The learning involved many individuals in the GEF Secretariat, GEF Agencies, the Scientific and Technical Advisory Panel, and government agencies and partners in Burkina Faso, China and India.

[1] GEF 2014: Combating Land Degradation in Production Landscapes: Learning from GEF projects applying integrated approaches. Global Environment Facility, Washington, D.C.

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EFFECTS OF GRASSLAND DESERTIFICATION AND DUNE STABILIZATION ON PLANT DIVERSITY IN THE SEMI-ARID REGION OF INNER MONGOLIA, CHINA

LIU, Zhimin; QIAN, Jianqiang; LIU, Bo

Institute of Applied Ecology, Chinese Academy of Sciences, China, People's Republic of

zmliu@iae.ac.cn

Introduction

Biodiversity conservation in fragmented habitats has been a major research focus in recent decades. Grassland desertification, leading to the formation of sand dunes, might has crucial impacts on plant diversity (Wu, 2012). Plant diversity in inter-dune lowland of active sand dunes plays an important role in biodiversity maintenance and contributes significantly to the dynamic equilibrium of partly vegetated dune fields (Liu *et al.,* 2007). Dune stabilization, leading to a dramatic decrease in shifting sand, might have profound influences on plant diversity (Yan and Liu, 2010). However, how grassland desertification and dune stabilization influence plant diversity, and how the effects of dune formation and stabilization on plant diversity are linked to spatial scale have been rarely reported.

Here, we reported 1) how plant biodiversity changes when grassland changed to active sand dune during desertification processes, 2) how plant biodiversity in inter-dune lowland of active sand dune changes with lowland area, and 3) how plant biodiversity in inter-dune lowland of stabilized sand dune changes with lowland area in the semi-arid region of Inner Mongolia, China.

Materials and Methods

This study was conducted in the semi-arid region (119°39'–120°02'E, 42°29'–43°06'N, 480 m a.s.l.) of northeastern Inner Mongolia, China.

1) Effects of grassland desertification on plant diversity

Six 500 m×500 m plots along a desertification gradient were selected. The grid with 10 m×10 m resolution and 1 m×1 m quadrats were established to investigate the species richness, abundance and frequency. To quantify grassland desertification degree, a desertification index was generated by integrating lowland density, area percentage and isolation.

2) Relationship between plant diversity and lowland area in active sand dunes

Twenty-five inter-dune lowlands in an active sand dune field were selected. In each lowland, two transects (one was running along the dune-extending direction, and the other along the dune advancement direction) were established. 1 m×1 m quadrats (3 m apart) along each transect were selected to investigate species richness, abundance and frequency.

3) Effects of dune stabilization on plant diversity in inter-dune lowlands

Eleven paired inter-dune lowlands of different sizes in both stabilized and active sand dunes were selected to determine the changes in plant diversity after dune stabilization. The selected ranges of inter-dune lowland area and surrounding dune height between stabilized and active sand dunes were approximately same.

Results

At both landscape and patch scales, grassland desertification had non-linear effects on species richness. Species richness peaked when the desertification index was 15% at the landscape scale. At the patch scale, species richness in sand dune was lower than that of the grassland (without desertification) when inter-dune lowland was smaller than 6 ha, but higher when larger than 6 ha when same area was involved. Grassland desertification caused an increase in number of plant functional groups.

Species richness increased with lowland area following a power function in the active sand dune field. The relative richness of psammophytes decreased logarithmically with lowland area. With decrease of lowland area, frequency of psammophytes logarithmically increased, but that of non-psammophytes logarithmically decreased. When lowland area was about 2 ha, frequency of the

psammophytes was equal to that of the non-psammophytes.

Species richness of inter-dune lowlands in stabilized dunes increased logarithmically with lowland area. When the area was same, species richness in stabilized dunes was 15 more than that in active dunes. Endemic pioneering dune species *Artemisia wudanica* did not occur in inter-dune lowlands of stabilized dunes.

Discussion and Conclusions

We concluded that 1) grassland desertification has non-linear effects on plant diversity at both landscape and patch scales, and grassland desertification and the formation of active sand dune may lead to an increase in species richness and functional type; 2) lowland size is an important determinant of species diversity in active sand dune field, large lowlands are crucial for species richness while small lowlands are more favorable for psammophytes; 3) dune stabilization, on one hand, raises species richness, and on the other, leads to the loss of endemic or rare psammophytes in inter-dune lowlands.

For plant diversity conservation practices, maintaining species richness and conserving endemic or rare species are equally important in sand dune field. Our findings indicate 1) in some cases the formation of active sand dunes is favorable for plant diversity conservation, 2) thresholds should be taken into consideration in the biodiversity conservation of semi-arid sand dunes, and 3) sand stabilization is favorable for species richness but unfavorable for endemic or rare species. For the active sand dune field, to maintain plant diversity, we should focus on large inter-dune lowlands, but to conserve endemic psammophytes, we should focus on small inter-dune lowlands. Furthermore, stabilizing active sand dunes is necessary for species richness maintenance, while preserving some active sand dunes is crucial for endemic or rare species conservation.

INNOVATIONS IN USING DOCUMENTED KNOWLEDGE ON SLM BEST PRACTICES FOR VARIOUS STAKEHOLDERS AT DIFFERENT LEVELS

LINIGER, Hanspeter; HARARI, Nicole

WOCAT Secretariat, Switzerland

hanspeter.liniger@cde.unibe.ch

Rationale

For over 20 years the World Overview of Conservation Approaches and Technologies (WOCAT) network (www.wocat.net) has built up a knowledge base on sustainable land management (SLM). This knowledge can be accessed through an online database which contains over 500 SLM Practices. Based on a decision support tool by DESIRE-WOCAT (Schwilch et al., 2012), a new "Decision Support Framework" is currently being developed to identify priority areas and most promising SLM strategies for up-scaling. In April 2014, the UNCCD mandated WOCAT to host the global SLM best practices database.Taking advantage of this particular momentum and building on the existing knowledge base, WOCAT is further investing in innovative, attractive and future-oriented tools based on audio-visuals, multimedia and interaction to better reach the various users and facilitate a broad dissemination of SLM knowledge. In this paper, two innovations are presented: the use of video and the development of a tablet application (App).

Methods used and partnership set up

The first innovation is the use of video to transform and package documented SLM knowledge into informative and authentic audio-visual material. Videos are produced together with land users who are the protagonists of the videos. The video production team in collaboration with a local organization selects innovative, experienced land users who have successfully implemented a SLM practice on their farm and are willing to capture their personal story on video. In a process of several days first, a storyboard is developed together with the land user and then the implementation and functionality of the practice, the benefits, and the problems it solves captured through demonstrations on the farm and interviews. The filming process follows a pre-defined format based on guiding themes and a template for interview questions. Three video types are produced: instructional videos, short thematic videos and video clips.

The second innovation is a tablet App incorporating existing information on SLM reaching from an illustration of SLM principles to an in-depth presentation of SLM groups linked to case studies from all over the world. Available content from different media and formats, e.g. websites, publications, databases, videos, is repackaged in an attractive and user-friendly way. Different levels of depths of information are created for various user groups: projects, agricultural extension, trainers, agricultural schools, and policy makers. Through multimedia, interaction, and a flexible usage the App enhances access to and learning from "those who have done it" and guides the user through the flow of available information. In addition, the integration of social media enables users to share experiences and contribute to a global SLM knowledge base.

Results

In a pilot project with the International Fund for Agriculture Development (IFAD) WOCAT produced five prototypes of instructional videos on SLM practices (www.ifad.org/climate/wocat.htm). The videos serve as audiovisual guide for the implementation of SLM practices and aim at motivating land users to replicate a practice on their land. They are part of a larger training package including a written documentation.A user manual was developed (www.ifad.org/climate/resources/usermanual_wocat.pdf) describing the procedure for an independent production of instructional videos by project people.

Several thematic videos were produced (www.wocat.net/en/knowledge-base/documentation-analysis/videos.html), screened at various events, and disseminated on particular internet platforms to advocate for SLM. These short videos cover a certain topic in the field of SLM, e.g. principles of SLM and SLM for disaster risk reduction. Information is transmitted mainly through land users' personal insights and demonstrations and complemented by a narration.

Video clips which comprise of short statements by land users regarding particular topics, e.g. costs, onsite or offsite benefits of a SLM practice were produced for use in different events. The clips are directly linked to the WOCAT documentation of SLM practices and will be integrated into the online WOCAT database in the future.

In a joint pilot project with DOCMINE (www.docmine.com), a company with broad experience in designing tablet content, WOCAT is currently in the process of producing the content and design of the SLM knowledge App and testing a first prototype with different potential user groups. One of the main advantages of the tablet App is its long shelf life when compared with other sources of information in hard copy format due to the possibility of offering frequent updates to the users.

Outcomes

The tools presented both address various target groups at different levels acting as intermediaries to reach the ultimate target group and beneficiaries, the land users. At field level they address technical staff, extension workers, agricultural advisors, and project implementers; at (sub-) national level planners, project designers, decision makers, and researchers; and at regional and global level policy makers, international programme planners, and donors. Due to this versatility, the fact that they provide authentic, audio-visual information from the field and the possibility of user interaction with content, they are promising tools not only for a successful dissemination of SLM practices but also for extensive advocacy for SLM.

AN ECONOMIC VALUATION OF A LARGE-SCALE RANGELAND RESTORATION PROJECT THROUGH THE HIMA SYSTEM WITHIN THE ZARQA RIVER BASIN IN JORDAN

GUDKA, Masumi Sandeep; WESTERBERG, Vanja

International Union for Conservation of Nature, Kenya

masumi.gudka@iucn.org

Jordanian rangelands deliver livestock produce and valuable ecosystem services including, climate change mitigation and adaptation, purification and infiltration of ground water, carbon storage, biodiversity and medicinal plants (Al-Tabini et al., 2012). These services are being jeopardised by acceleration of desertification, land degradation and drought in the Jordanian Badia, resulting in livestock feed deficits, soil erosion, loss of biodiversity and vegetation cover. The pastoral livestock sector is reliant on healthy rangelands but rangeland condition has dramatically deteriorated primarily due to policy reforms further exacerbated by declining rainfall, abandonment of sustainable practices in rangeland and water management (Al-Satiri et al., 2012), rangeland conversion, continuous years of drought, high water run-off, and changes in tenure regimes (Al-Jaloudy 2006; MoA 2013, Al-Tabini et al., 2012). In the 1980s a feedstock subsidy was introduced in response to their rising prices, encouraging livestock owners to increase herd sizes beyond rangeland carrying capacity, intensifying rangeland deterioration (Al-Tibini et al., 2012). IUCN has demonstrated low cost community based approaches to sustainable rangeland management. This cost and benefit analysis was conducted to inform decision makers of the value of Hima scale up.

This study examined the contribution to of Hima revival to securing the long-term viability of rangelands for climate change mitigation, and food and water security. This study is the first of its kind to demonstrate both the market and non-market economic values associated with rangeland restoration. A comprehensive economic valuation study of a large-scale rangeland restoration scenario within the Zarqa River Basin was undertaken. Biophysical models were used first to predict impacts of adopting Hima on key ecosystem services. GIS and biophysical Soil and Water Assessment Tools were elaborated to rigorously calibrate the impact of land use changes on forage availability, ground water infiltration, carbon sequestration and sediment stabilisation. High-resolution remote sensing and ArcSWAT (Soil and Water Assessment Tool) were then integrated with economic analyses of key regulating and provisioning ecosystem services. Associated costs of establishing Hima systems were considered, to better understand the immediate constraints to restoring rangelands. Using an *ex-ante* Cost Benefit Analysis, the ecosystem services that arise from rangeland restoration were valued using a combination of stated preference, avoided costs, replacement cost and market prices approaches. Large-scale Hima restoration values were estimated as increased edible biomass the premium associated with increased natural forage, the extent of improved water infiltration, and reduced sedimentation of dams (increased storage capacity) over a 25 year time horizon.

The study found societal benefits of using Hima restoration to be substantially higher than its investment costs over a 25-year time horizon. Large-scale adoption of the IUCN-piloted Hima system (based on rotating use of rangelands) within the Zarqa River Basin may deliver between 17 and 35 million JD worth of net-benefits to Jordanian society, and global benefits of up to 72 million JD at a discount rate of 2.5%. The present value benefit of avoided sedimentation of the dam is 10.9 million JD (at r=5%). Our results also show that the Net Present Value (NPV) to pastoralist communities of avoided forage purchase is in the order of 14.9 million JD (at r=5%), assuming that the communities themselves were to bear the management costs of the Himas. Present value benefit of increased carbon sequestration potential as a result of improved vegetation cover from Hima restoration is 6.9 million JD (at r=5%). Pastoral communities in the Zarqa Basin could gain 11.8 million JD (at r=5%) from adopting Hima systems and bearing the associated management costs. Given these results we argue that ensuring pastoral communities have long-term stakes in rangeland resources, the government should first and foremost assign appropriate land tenure rights to pastoral communities. However, the appropriate policy

instruments to engender sustainable rangeland management and Hima practices are therefore likely to be found in a mix of regulatory and economic incentives.

There is growing interest in reviving Hima systems as a suitable land management tool helping reverse rangeland degradation within pastoralist communities in Jordan, spanning across all levels, from government, community, civil society to the Royal society. The re-introduction of the Hima system cannot take place in the absence of effective common property regimes achieved through a delegation of long-term management rights to local communities. In response to IUCN's on-going SLM work the Jordanian National Rangeland Strategy was updated in 2012 and placed emphasis on the promotion of pastoral communities. Under the patronage of Prince Hassan of Jordan, IUCN organised a Hima forum bringing together various stakeholders to discuss the road map for scaling up the Hima, leading to a declaration signed and supported by the Jordanian Royal family. Scaling up Hima to the wider Arabian Peninsula has also gained some support through the Arab League.

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DECISION SUPPORT FRAMEWORK FOR MAINSTREAMING AND SCALING-UP SUSTAINABLE LAND MANAGEMENT

LINIGER, Hanspeter (1); BUNNING, Sally (2); HARARI, Nicole (1); MEKDASCHI STUDER, Rima (1); NACHTERGAELE, Freddy (2)

1: WOCAT Secretariat, Switzerland; 2: United Nations Food and Agriculture Organization, Rome, Italy

hanspeter.liniger@cde.unibe.ch

Rationale

The United Nations Food and Agriculture Organization (FAO) and the World Overview of Conservation Approaches and Technologies (WOCAT) are key players in the global effort to combat land degradation through the promotion of assessment, mapping, and documentation tools for Desertification, Land Degradation and Drought (DLDD) and Sustainable Land Management (SLM) practices. This includes knowledge management and capacity development of stakeholders for local level plans and actions and for wider scale watershed management, climate resilience and disaster risk reduction interventions, as well as development of decision support tools for improved cross-sectoral and participatory land use/resources planning and strategic investment frameworks. Both parties identified the need for establishing an evidence-based decision-making process to support countries in mainstreaming and scaling-up SLM.

Methods used and partnership set up

The multi-level decision support framework (DSF) is developed within the 3-year FAO-GEF project 'Decision support for mainstreaming and scaling-up of SLM' implemented in 15 countries in Africa, Asia, Europe, Central Asia, and Latin America where the type, extent and severity of land degradation and the resulting loss of goods and ecosystem services depend largely on the pressures of the disparate land users through inappropriate practices and over-exploitation of resources as well as on population, market and governance drivers.

The DSF is based on existing tools and methods developed by WOCAT, FAO and related projects over the course of the years: The decision support tool by the EU-DESIRE project to identify, assess and select SLM strategies based on stakeholder participation and best practices (Schwilch et al. 2012); the guidelines for the creation of a national Land Use System (LUS)/Land Management System (LMS) map developed by the Land Degradation Assessment in Drylands project (LADA); the Mapping Questionnaire (Liniger et al. 2008); the local level assessment tools prepared by LADA in collaboration with WOCAT; and the WOCAT questionnaires and databases on SLM Technologies (Ts) and Approaches (As). It furthermore utilizes the DPSIR framework to help analyze assessment findings and interrelations at national and local levels and the DFID Livelihoods Framework.

Results

The DSF comprises the following steps: STEP A at (sub-) national level, STEP B at local level, and STEP C at policy level. Depending on the countries and institutions, their available data, previous involvement in using the methods, and resources, the steps can be carried out at different degrees of depth and detail. The DSF is therefore flexible allowing:

- different entry points for newcomers (basic) and advanced users, and
- different degrees of depth from basic to advanced and detailed assessment of LD/SLM and decision making.

The aim of STEP A is to obtain a comprehensive picture of the status of the LUS/LMS in a country and identify and select priority regions and/or LUS/LMS and promising SLM T-groups and As through: 1) a stakeholder workshop, where problems, potential solution areas, existing policies, national goals and the framework for compilation of the evidence base are defined, 2) compilation of the evidence base by national experts who assess and map LUS/LMS per admin. region/watershed, identify "hot regions and "bright regions", and promising SLM T-groups and As, and 3) a final workshop, where objectives, criteria and bottlenecks for up-scaling SLM are identified, priority regions and/or LUS/LMS for intervention and SLM T-groups and As are selected, and M&E tools and indicators are defined.

STEP B supports and refines the findings of STEP A and is carried out in the priority regions and/or LUS/LMS selected in STEP A with the aim to select pilot locations and SLM Ts and As for implementation. The same steps (1-3) are completed and in a further step (4), selected SLM Ts and As are implemented in pilot areas and then (step 5) monitored and evaluated for up-scaling.

In STEP C, through a policy-maker stakeholder workshop at (sub-) national level, findings regarding bottlenecks and opportunities are reviewed and recommendations made for the development or adaptation of a national/regional strategy for mainstreaming and up-scaling SLM. Results and lessons learnt from the different locations (from STEP B) are aggregated, integrated in the national evidence base and combined with the results from the policy level workshop to help stakeholders in prioritizing regions/areas, selecting adapted SLM Ts and As, defining institutional responses and capacity development plans and procedures, and planning the integration in national/regional policies and financing mechanisms.

Outcomes

The proposed framework supports countries in taking decisions for mainstreaming and up-scaling SLM that are based on an in-depth assessment and analysis of the WHERE, HOW, WHAT and WHEN to invest. Priority regions, areas and locations/landscapes are evaluated, negotiated and selected through a thorough analysis of different options and criteria set by national and local decision-makers and relevant stakeholder groups. A flexible use of the DSF depending on national/regional preferences as well as different entry levels (from basic to advanced users) allows for a wide flexibility in the application by different countries.

ENVIRONMENTAL CRISIS: LAND DEGRADATION OR SUSTAINABLE DEVELOPMENT? A CASE STUDY IN THE MIXTECA ALTA, OAXACA, MEXICO

OROPEZA-OROZCO, Oralia; CRAM-HEYDRICH, Silke; FERNÁNDEZ-LOMELÍN, María del Pilar

Institute of Geography, National Autonomous University of Mexico, Mexico

orooro@igg.unam.mx

The region of the Mixteca Alta, located in the state of Oaxaca, in southernMexico, is an ecological catastrophe on the basis of the extent of the depletion of its natural resources and the soil degradation since pre-Hispanic times.

This environmental crisis has been worsened by inadequate government policies regarding rural development, policies that have led, in their turn, to the deterioration of the quality of life of its inhabitants, in particular to an upsurge in conditions such as poverty, marginalization and migration.

In the face of this crisis two options present themselves: either comprehensive remediation strategies are implemented in order to achieve a condition of sustainable development or, through a lack of timely action, the process of deterioration is left to continue unchecked.

The present work aims to expose the initial outcomes of a case study in the Mixteca Alta with the potential to promote —through the creation of a geopark— geoconservation and geotourism activities to attain the sustainable development of the region in spite of its serious environmental degradation.

This work is part of a larger project, still in its initial stages, currently taking place in the municipalityof Yanhuitlán, Nochistlán district, in the Mixteca Alta region. This area suffers from widespread land degradation resulting apparently from agricultural practices that first developed between 3.400 to 3.500 years ago (Leigh *et al.*, 2013) on soils and geological materials prone to water erosion. As a result of these erosion processes, a series of spectacular landscapes dominated by gullies and badlands were produced (Figure 1).

Given their appealing nature, these eroded landscapes represent a unique opportunity as settings for activities aimed at encouraging tourism and recreation, as well as other roles that could be ascribed to them. In light of the ideas expressed above, we propose opening a geopark as a means of controlling, reversing and preventing land degradation through geoconservation and geotourism, in compliance with current sustainable development guidelines (Burek and Prosser, 2008).

Geoparks provide a tool with which to enable the sustainable development of an area through geotourism. It is an area with well-defined boundaries enclosing a significant number of sites of geological interest and of particular importance, rarity or aesthetic significance, valuable both for their biodiversity and their historical and cultural aspects. The methodological criteria applied in this document are based on the guidelines published by the Global Geoparks Network (UNESCO, 2010).

In the first stage of the project, a characterization and diagnosis of the natural conditions of the area under study was performed. From this analysis, the geosites, geomorphosites, pedosites and erosive landscapes were identified, described and assessed for inclusion in the inventory of the future geopark.

As part of the project, a list was drawn —accompanied by detailed descriptions— of additional sites that were to be integrated to the natural and cultural heritage of the geopark. Regarding geoconservation strategies, surfaces showing different levels of soil degradation were identified, together with the assessment of reforestation campaigns and practices of soil preservation.

As part of the present study, a survey of the socioeconomic status of the region's inhabitants was conducted in order to procure information with which to guide governmental policy as it pertains to the sustainable development through geotourism and geoconservation. Simultaneously, a list of the facilities and the infrastructure necessary for the operation of the geopark began to be prepared.

Finally, the authors and their colleagues, together with municipal authorities, conducted workshops where the community at large was invited to express their concerns about this project. The results of these workshops have been encouraging, partly because members of the community have shared a feeling of empowerment and, in the process, became interested in the project's success.

The creation of a geopark as a sustainable development strategy constitutes a novel approach to the problem of land degradation inMexico, since it involves redrafting zoning guidelines. This project is intended to foster geotourism in areas where soil recovery is no longer possible or is very expensive to carry out. Nevertheless, the appealing nature of the landscape, resulting from its destruction, constitutes an asset capable of generating financial resources that could alleviate the poverty experienced by the rural population of the region and, consequently, improve their quality of life.

In addition, reforestation campaigns and the application of traditional farming technologies, inspired by those developed and used in pre-Hispanic times, as well as inexpensive modern technologies have managed to remediate the partial degradation of the soil of some areas.

Geoparks help promote a culture of prevention and/or reduction of land degradation through the education and dissemination of knowledge together with the interpretation of the history and evolution of a given region. Through various initiatives that comprise the geopark project, the objectives of the Agenda, Programs and Conventions related to combatting land degradation and desertification can be fulfilled.

REVEGETATION OF ARID REGIONS: THE CASE OF MINING SITES IN ARGENTINA

CONY, Mariano Anibal; PAEZ, Jesús Antonio; FERNANDEZ, María Emilia

CONICET, Argentine Republic

mcony@mendoza-conicet.gob.ar

Rationale

Restoring ecosystems impacted by diverse economic activities includes, in most cases, "assisted" revegetation of such environments. In arid regions, drastic climate conditions and unfamiliarity with physiological aspects of native plant species relative to their establishment complicate the tasks for recovering these ecosystems (Cony, 1995). "Assisted" revegetation turns out to be an indispensable practice if the aim is to achieve restoration in the short and/or medium term. Development of "technological packages" for revegetation practices, based on a particular analysis of the environment to be restored and plant species to use, enhances the likelihood of recovery success. In the particular case of arid environments impacted by mining activity, total removal of vegetation and modification of soil physicochemical features are daily scenarios in this activity. Different techniques for revegetation of arid regions in Argentina are then discussed, as well as the need to generate non existent basic knowledge of the plant species occurring in them, taking the example of studies which are underway in mining fields, at different levels of development.

Methods used and partnership set up

Research activities were focused on two mining sites l

A) Bajo de la Alumbrera (Catamarca, 27° 19' 42" S, 66° 36' 30" W); 2600 masl; 1100 mm of water deficit. Open-pit porphyry copper mine. It was necessary to develop revegetation techniques using native species in rehabilitated "sterile dumps" and "tailings dams"

Both areas were rehabilitated using covers made of known non-acid forming substrates, such as epidote-chlorite, barren core (dumps) and alluvial material (tailings).

B) Potasio Río Colorado (Mendoza, 37° 06' 33" S, 69° 23' 02" W); 980 masl; 1000 mm of water deficit. Potassium chloride production . It was necessary to develop revegetation techniques with native species in quarries, trial pits and well locations built during the mining project.

Methodological stages

1) Assessment of weather information

2) Physico-chemical characterization of soils and/or substrates.

3) Natural vegetation coverage in impacted and non-impacted areas

4) Studies on reproduction methods of native species.

5) Identification of areas to revegetate and studies of soil seedbank

6) Selection of species

7) Collection, analysis and conservation of native germplasm .

8) Development of methods for producing nursery seedlings.

9) Revegetation trials assessing different variables:

   a) species, b) irrigation, c) use of water-retaining gels, d) use of inorganic fertilizer, e) nursery seedling size, f) planting season, g) type of cover, and h) use of vermicompost

Survival and growth parameters were recorded during 2 and 3 years. The data obtained was subjected to the pertinent statistical analysis

Results

A) Bajo de la Alumbrera

1) Rainfall was concentrated on summer and varied between 180 and 230 mm, across the different years.

2) Vegetation coverage was zero in the impacted areas, while in non-impacted areas it reached..

3) In each rehabilitated area no seed banks were found

4) Reproduction methods were successfully developed for 8 species .

5) They were reproduced successfully in nursery.

6) In dumps, the use of transplants, epidote-chlorite as cover, vermicompost (5 dm3/plant) and 2 establishment irrigation instances (25 m^3/ha, 2500 plants/ha) allowed survival to reach values close to 90% (Fig. 1). Inorganic fertilization (urea) was detrimental to this parameter. The use of hydrogel, different sizes for nursery plants and different transplant times (fall and spring) produced no significant statistical variation, neither on the survival nor on the growth of plants. Growth for all species increased when irrigation was higher (75 m^3/ha). On barren core, most species had a lower survival rate (74% on average) and growth increased with more irrigation (75 and 150 m^3/ha)

7) In tailings dams the survival was close to 90%for all species tested.

8) Direct seeding failed to establish plants of any species.

B) Potasio Río Colorado

1) Rainfall varied between 200 and 270 mm during the trials and was also concentrated in summer.

2) 5 species were selected and were reproduced in nursery.

3) After two years and 2 establishment irrigation treatments (11 m3/ha, 1111 plants/ha), survival in test pits and well locations reached average values among 62% .The use of vermicompost did not affect survival or growth of the species tested.

Outcomes

Revegetation using native species of Argentinean arid regions is possible for mining sites with annual rainfall as low as 200 mm, and the survival rates reached are higher than 65% for the species selected..

- The higher irrigation levels used in the different trials did not increase survival values for any species, though it favored growth.
- The use of vermicompost was indispensable in the cases of rocky substrates used as covers.
- Water-retaining gels, planting time and seedling size did not affect plant survival or growth.
- Technological packages were developed for revegetating mining sites in arid regions of Argentina.

SAND DUNE STABILIZATION THROUGH PROMOTION OF COTTAGE INDUSTRY BASED ON SACHCHARUM (KANA) SPECIES.

SHAHZAD, Tayyab

INDIVIDUAL CONSULTANT, Pakistan

tshahzad68@yahoo.com

Rationale

Main source of livelihoods of inhabitants of 10 villages in Aba Khel valley in district LakkiMarwatis subsistence agriculture and livestock rearing. Due to drought/ lack of timely rains, their agricultural production declined. Agricultural fields failed to even produce fodder for livestock, resulting in overgrazing of range and waste lands. A water course in some of the villages erodes land during rainy season. These conditions lead to desertification and loss of fertile layers of soils. Some part of the area is hilly, and heavy rains cause flash floods resulting in heavy soil erosion and gully formation. Plains are almost sandy and in dry months, hot and desiccating winds cause soil shifting.

The area provide habitat for growth of Kana (Sachcharumspontaneum). Women and children are involved in preparation of "Ban" (ropes) and "Chik" (curtain) from kana. The making of Kana products however involves manual processes, physical exertion, and extended time consumption on the part of women and children.

Methods used and partnership set up

Sustainable Land Management Project (SLMP) and its Implementing Partner, Bannu Forest division collaborated with local community to use Kana as a source of protection against this eroding factor of sand dunes. Kana being a local species is highly resistant to water stress and has high growth rate in adverse conditions. Kana crop grown in strips can provide effective protection to crops in between strips as it breaks wind velocity and stop shifting sand particles. But most of all, Kana as a plant has already provided a boost to local cottage industry in the form of products like ropes, furniture, local household pots and roofing material. Mostly women of the area are dependent upon this cottage industry to earn their livelihood. Keeping in view this importance, the SLMP and its implementing partner facilitated the local communities in following activities:

Growing Kana on 100 acres for the specific purpose of wind breaks, and also on the low productive lands to increase the production of Kana raw material for cottage industry.

Using Kana leaves to support crop cultivation on 50 acres. In this practice, Kana leaves are spread on sites with poor soil conditions. The leaves act as filters to capture moving sand particles from the wind and conserve it on-site for cultivation. Cultivation of gram has showed better results with this activity.

Mechanization in Kana cottage industry was introduced to relieve the women and children from manual exertion. Under this activity, 7 hammering machines and 7 *Ban* making machines were installed and people trained in their operation. The hammering machines take the toll of heavy physical work involved in separating and softening the Kana leave fiber to produce high quality ropes used for a number of purposes. Ban machines save time and add quality to the ban produced locally.

Results

Under the project the people are brought together and motivated for self-help in an organized way and guided to strengthen their liaison with other Department to their needs. The activities improved overall socio economic condition of the people. Kana production increased which is a cash crop and it resulted in improvement in the income level of the people. Beside other benefit kana is also a source of fodder for livestock in dry season. Results of project are as follows:

- Ten CBOs formed
- Land use plans for 10 villages
- Three water ponds

- 430 ha of rangelands rehabilitated by sowing/planting in contour trenches, hill side ditches, construction of katcha boundary pillars with white wash, sand dune stabilization by planting kana, callygonum & tamarix, energy plantation, spreading of kana residues on fields and natural regeneration of forest plants
- Shelterbelt plantation on 50 Avenue Kilometers
- Ten forest plant nurseries of 200,000 plants.
- Demonstrate of 7 ban manufacturing and 7 hammering machines to promote kana crop cottage industry and raise farmers income
- Retaining wall & Gully plugging on 5,000 cft.
- Installation of a Pressure Pump to provide water for drinking, forest plantation and farmer nursery.

Kana plantation is able to protect the sand dunes from wind erosion and thus making the farming feasible. Gram crop cultivated on land spread with Kana leaves showed an increase of 29% in yield. Raw material harvested from Kana plants amounts to about 10,000 Kg per acre. Per acre income is more than 100,000 rupees.

As mostly women and children are involved in cottage industry, mechanization process has facilitated them by relieving them from heavy physical work and saving their time which they could use in other household chores. Mechanization has increased value of Kana products by improving their quality.

Impact

The activities addressed poverty alleviation, women empowerment and dry land degradation and desertification with economic advantage. Interventions resulted in conservation of soil, increasing productive potential of land and preparing farmers to invest more in their land for better livelihoods.

TOWARDS A PROACTIVE SOIL SECURITY: A STRATEGY FOR A SUSTAINABILITY TRANSITION BY COMBATING DESERTIFICATION, LAND DEGRADATION AND DROUGHT FOR POVERTY REDUCTION AND SUSTAINABLE DEVELOPMENT

BRAUCH, Guenter (1); OSWALD, Ursula (2)

1: Peace Research and European Security Studies, Germany; 2: National Atunonomous University of Mexico, Mexico

hg.brauch@onlinehome.de

Rationale

This paper emerged from two previous publications of both authors (Brauch/Oswald Spring 2009, 2011). This text will carry the argument further starting out from two alternative longer-term impacts of climate change as a 'threat multiplier' by focusing on the security implications and as a 'threat minimizer' aiming at strategies, policies and measures towards a transition to sustainability. By linking two alternative scientific discourses on the securitization of climate change and on sustainability transition the paper will explore whether and how policies and measures that aim at a "Proactive Soil Security" may contribute to "A Strategy for a Sustainability Transition by combating desertification, land degradation and drought for poverty reduction and sustainable development".

Methods used and partnership set up

The methodological approach of this paper is threefold:

Conceptual: It aims to develop the concept of a "proactive soil security" further since it was presented in a report for UNCCD (2009) and in an academic scientific chapter (2011). While a continuation of business-as usual policies and measures on climate change may result in international, national and human security consequences, the proposed "Proactive Soil Security Concept" aims to counter a militarization of global environmental change problems, especially on desertification, land degradation and drought.

Empirical: The paper focuses on the potential of renewable energy sources (solar, wind) in drylands and deserts that could contribute to alternative livelihoods and sources of income by reducing poverty and enhancing the prospects of sustainable development. The empirical focus is on the development of the DESERTEC project with a special focus on projects in Morocco. The relevance of this economic and ecological project will be discussed for the deserts of Mexico (Sonora, Chihuahua) and for the drylands of Northeast of Brazil (Ceara) that have experienced repeated severe droughts.

Praxeological: In a policy analysis the emerging international cooperative renewable energy projects in Morocco will be contrasted with the economic and political pressure for new hydrocarbons (Canadian tar sands, fracking of natural gas) in NAFTA and the lack of policy discussion in Mexico and Brazil to use the energy potential of the deserts and drylands as a key element of a sustainable energy transition policy.

Results and Outcomes: Case Studies on Morocco, Mexico and Brazil

In his report, on climate change and security, the UN Secretary General (2009) pointed to both the security impacts of global climate change (considered as a 'threat multiplier') and to the potential of policies of sustainable development that use climate change as a 'threat minimizer'. In the context of the policy debate on alternative goals, coping strategies and on the scientific research on sustainability transition the second part of this papers discusses alternative livelihoods in drylands for exploiting the technical energy potentials of renewables for Morocco, Mexico and possibly also for Brazil.

Policy developments in North Africa have increased the interest to move towards a people-oriented sustainable energy policy, especially in Morocco that relies on energy imports. A previous chapter discussed possible policy responses for addressing climate change in the MENA region, and projections up to 2100. It pointed to the need for improving the knowledge base by

research calling for a fundamental change in scientific paradigms, in world views of scientists, and in the mindsets of policymakers to cope with the multiple projected security challenges.

Since 2009, partly in the framework of DESERTEC and its university network, the scientific and economic cooperation on renewables between Morocco and its European partners has increased. While research and development efforts on renewables have also increased both in Mexico and in Brazil, so far there has been no strategic policy discussion in Mexico to exploit the solar and wind potential of its deserts (Sonora, Chihuahua) and of the drylands in the Northeast of Brazil (Ceara) for developing alternative livelihoods and new sources for the people in both regions. This paper will address manifold constraints and obstacles that have prevented a long-term oriented strategy for exploiting these significant theoretical potentials.

The paper will be structured as follows:

- Projected climate change impacts on land degradation, desertification and drought;
- Security consequences of policies of business as usual (militarization of drylands);
- Coping with climate change impacts through a Proactive Soil Security Policy and Strategy;
- Towards alternative goals and coping strategies (sustainability transition);
- Alternative livelihood in drylands: Exploiting their technical energy potentials
- Case studies on Morocco, Sonora (Mexico) and Ceara (Brazil)

Conclusion

Towards a joint strategy on addressing: climate change and land degradation by combining the policy efforts of UNCCD and UNFCCC.

WINDBREAK EFFECTS IN REGION OF MANGA (SOUTHEASTERN OF NIGER) ON ECOLOGICAL RESTORATION

TIDJANI, Adamou Didier (1); AMBOUTA, Karimou (1); ABDOURAHAMANE TOURÉ, Amadou (2); BIELDERS Charles (3); RAJOT, Jean-Louis (4)

1: Agronomy Faculty - Abdou Moumouni University of Niamey-Niger; 2: Faculty of Science and Technology - Abdou Moumouni University of Niamey-Niger; 3: University Catholic of Louvain - Belgium; 4: Institut de Recherche et de Développement - IRD - France

didierta@yahoo.fr

In the region of Manga in Niger, the consequences of siltation and degradation of the land have been and continue to be disastrous for the environment. The technics used to fight against this scourge are based primarily on mechanical and biological fixation. The main objective of this paper is to assess the environmental effects of dune fixation in Manga. Three sites located along a north-south transect, are chosen to provide support for this assessment. It is respectively Boulladjamma, Dounia Koura and Gatawa in the department of Gouré.

A device allowing the subsoil and grass cover characterization according to the state of degradation and the morphology of a dune without vegetation is used. As a result the sources of the materials used for the construction of fences, their effectiveness and the effect of their removal on the environment were identified. Also The Characterization of the grass cover and the soil, made according to the fact that the portion evaluated is situated on an accumulation or deflation zone, was used to assess the effectiveness of the practice of restoration depending on the fact that the area is deflated or sanded.

What is more, sectors exposed to winds are richer than those who are distant. The recovery rate and the amount of dry grass are more important in the accumulation zone of the fence exposed to the harmattan wind. For instance the average rate of organic matter is higher on the fixated sites (3%) than those of the degraded standard site (1.5%) Moreover within the same site, the accumulation zone presents higher organic matter content than the deflation zone.

Based on the results, the dune fixation technic used in the southeastern Niger is effective. It improves the quality of the grass cover and the subsoil while maintaining the production potential of materials used for making windbreak of harvesting areas.

YOUTH EMPOWERMENT TO COMBAT DESERTIFICATION IN BRAZIL: CASE STUDY OF THE NGO "ENGAJAMUNDO".

ARAÚJO, Beatriz Azevêdo (1,2); ARAUJO, Fernanda Castelo Branco (3)

1: Universidade Federal do Ceará, Brazil; 2: Engajamundo (NGO); 3: Centro Universitário Christus (Unichristus), Ceará, Brazil

beatrizbaa@hotmail.com

Rationale

The problem of desertification can't be adressed without the human factor included. Land degradation is caused mainly by human activities. Therefore, to tackle the issue, the community involved has to be empowered in order to understand that, by improving their land management, they'll be improving their life quality. In this context, it is crutial to empower youth to take action, since it's this and the next generations that are going to live with the degraded land and the effects of climate change. If youth is driven to combat desertification, the solution will be sustainable, once new generations will always replace those who are no longer involved with direct actions. The Brazilian NGO Engajamundo, with volunteers in all regions of the country, is designed to empower youth and to integrate their representatives in decision making processes, by promoting capacity built on how youth can make a difference. Supporting actions like this NGO's gives youth the necessary stimulus to take action and change their realities and also to multiply the process, gathering more people and promoting more change.

Methods used and partnerships set up

The study was constructed through bibliographic and field research and it was conducted by a partnership between a graduation researcher from Universidade Federal do Ceará and a post graduated researcher and teacher at the law course of Centro universitário Christus (Unicristhus), Ceará. Young leaders related to environmental issues, policy makers from federal and local governments, civil society representatives, researchers from other institutions and local people directly affected by desertification and climate change (farmers, small landholders and their families, indigenous peoples) were interviewed. Firstly, the concepts of sustainable development were studied as a mean to make communities more adapted and resilient to desertification and climate change. Youth was, then, assessed as a key factor to promote sustainable development locally, local youth leaders were interviewed along with local policy makers. Secondly, the NGO Engajamundo was evaluated as case study on how to empower youth to solve problems locally and take their contributions to international conferences as lessons learnt. Finally, federal and local policies were mapped from the perspective of youth, through documental research and interviews with federal and local policy makers, in order to assess how the implementation of the UNCCD in Brazil can empower youth and how government can include youth representatives in decision making proccesses.

Results

It was found the high capacity of youth to transform reality, what makes extremely relevant that this generation is empowered to know their capacities and encouraged to participate in internacional decision fields, having special spaces on international conferences. The Brazilian Comission to Combat Desertification, national deliberative body with representatives from federal, states and municipalities governments, civil society and private sector, does not have a seat for youth yet. There isn't a national or local (Ceará State) public policy to empower youth to combat desertification and combat climate change. It is extremely necessary to create spaces where youth can dialogue with policy makers and to create iniciatives to empower more youngsters in order to multiply local change makers. The participation in decision making processes empowers youth to take action locally, therefore, public policies addressing this matter must be implemented, in order to combat desertification and fight climate chande through youth mobilization. The Brazilian government, especially in the federal level, has supported such initiatives, for instance, by taking a youth representative as a member of their delegation to UNCCD COP11 and by proposing the creation of a youth constituency to the Parties. However, such efforts have to be implemented nationally. During UNCCD COP11, a youth representative of

Engajamundo negotiated with the Brazilian governmental delegation and managed to include in the Brazilian official proposals the creation of a constituency inside UNCCD to represent youth. The sugestion was adopted by the Parties and it was decided that youth, local communities and indigenous peoples would be included in the accreditation process, with a view to ensure the increased and more representative participation of civil society organizations in the sessions of the Conference of the Parties and its subsidiary bodies (Decision 5/COP11).

Outcomes

The mapping work developed by NGO "Engajamundo" on public policies regarding to desertification shows that there is not a space designed for youth at national brazilian level, neither at local level (Ceará). Therefore, youth must be included as a priority in public policies to combat desertification and spaces for youth effective participation have to be created in decision making processes. In addition, it is necessary that Brazilian Government implement UNCCD decision 5/COP 11, what can be obtained through a national process composed by an empowerment phase followed by the edition of a final position to be taken to Conferences.

Abstracts of contributions presented in session 3: MONITORING AND ASSESSMENT

How can we best measure the performance of actions to combat land degradation and desertification? How can we cost-effectively evaluate the efficiency of drought-mitigation strategies?

Monitoring and evaluation systems are required to measure the progress achieved in the fight against land degradation and poverty. They must in particular:

- *Validate technical, economic and environmental standards for new farming and natural resource management practices and other income generating means;*
- *Define performance indicators to measure short-term effects and long-term consequences, for both biophysical (soil parameters, quantity and quality of water, plant and animal biodiversity, etc.) and socio-economic (production system sustainability of production systems, employment, income, food security, access to health and education services, access to knowledge and technologies, etc.) characteristics;*
- *Evaluate the efficacy of management and aid systems under crisis situations, including their impacts as an emergency response in the short-term and longer-term effects on the target populations, e.g. on vulnerability, reduction of poverty, and productivity.*

Questions need to be answered on the balance between and roles of scientific research and the use of traditional and local knowledge. Local populations often are stewards of a wealth of relevant knowledge, and are well placed to collect data and take part in monitoring and evaluation. Cooperation needs to be improved between scientists and those on the ground, including diverse men and women community stakeholders, technical advisors, administrators and policy makers. How can effective participatory research schemes be developed? Can we create a database that links scientific research to traditional practices to enable the transfer of knowledge and experience directly to those on the ground? How can forms of direct cooperation be set up between developing countries and/or countries in transition?

FUNCTIONAL DIVERSITY AS A POTENTIAL UNIVERSAL INDICATOR OF ECOSYSTEM TRANSITIONS BETWEEN SUB-HUMID AND SEMI-ARID

BRANQUINHO, Cristina (1,2); NUNES, Alice (1,2); MATOS, Paula (1,2); PINHO, Pedro (1,3)

1: Centro de Biologia Ambiental, Faculdade de Ciências, Universidade de Lisboa, Campo Grande, C2, Piso 5, 1749-016 Lisboa, Portugal; 2: Departamento de Biologia e CESAM - Centre for Environmental and Marine Studies, Universidade de Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal; 3: CERENA - Centro de Recursos Naturais e Ambiente, Universidade de Lisboa, Instituto Superior Técnico, Av. Rovisco Pais, 1049-001 Lisboa, Portugal

cmbranquinho@fc.ul.pt

Rationale

Understanding the consequences of changing precipitation and temperature patterns in drylands is vital considering they support 38% of the human population (Reynolds et al., 2007).Moreover, climate change is expected to cause several impacts at the global scale and drylands will be among the most affected areas.

As a result of global change, dryland ecosystems may change non-linearly meaning that beyond a certain pressure the ecosystem may undergo a sudden change towards another alternative state (Bestelmeyer et al. 2013). This is called a critical transition and the pressure value above which the transition occurs is called a tipping point (Scheffer et al. 2012).

In order to anticipate the occurrence of critical transitions from sub-humid to semiarid in these ecosystems the development of early warning indicators is of critical importance. It's currently accepted that these indicators should be based on the overall response of ecosystems. However, at present no early-warning indicators of such processes are available. It is hypothesized that the identification of traits and respective functional groups can potentially be used to build such indicators. Additionally remote sensing methodologies can then be used to upscale that information at the landscape level. In this work we have 3 main aims:

1. to study taxonomic and functional plant diversity along an aridity gradient in natural dryland ecosystems. We expected that plant functional diversity, by providing an insight into plant traits influencing ecosystem processes in water limited areas, would better indicator in response to aridity, than taxonomic diversity alone.
2. to identify lichen key functional traits and respective functional groups that respond to aridity. We focused on how lichen composition varied along an aridity gradient, and how lichen functional diversity responded to this environmental driver, trying to identify the most relevant traits to this response.
3. to determine how much concurrent and normal precipitation (historical) control phenology and productivity of Mediterranean evergreen woodlands at the landscape level. This was evaluated over a spatial precipitation gradient on a dryland, area between semi-arid and dry-sub-humid climates, in southwest Europe.

Methods

Plants functional diversity was sampled in 49 savanna-like dryland sites, composed by mostly annual grasslands with shrubland patches. For that we used functional dispersion within a community. Eight plant traits were selected, for being responsive to aridity including life cycle, height, specific leaf area, nitrogen-fixing ability, onset of flowering, flowering duration, dispersal mode and seed bank persistence.

Lichen diversity was sampled in open holm-oak woodland along an aridity gradient in SW Europe (Iberian Peninsula). Lichen functional traits that could be easily identified and related to water uptake were selected to be tested: type of photobiont, growth form and reproduction strategy. Lichen species composition was related to the aridity gradient.

The upscale using remote sensing was done by correlating long-term precipitation (30 years normal) and concurrent precipitation (12 years) to a series of seasonal metrics (Modis, average of 12 years) measured in a savannah-like system, Mediterranean evergreen woodlands, located in southwest Europe (Portugal).

Results

For plant functional diversity we found a non-linear decrease in functional diversity computed for eight relevant traits with aridity. There is a strong reduction in ecosystem functioning - on which relies the provision of ecosystem services - below a certain aridity threshold. We show that dryland ecosystems, despite inter-annual climatic fluctuations, exhibit functional stability over time, which is decoupled from species diversity.

Lichen species composition was related to the aridity gradient. More specifically crustose and fruticose lichens, isidiate species and the ones with Trentepohlia as photobiont were related to the less arid part of the gradient. Foliose species and cyanolichens, on the contrary, were associated with the most arid areas.

In remote sensing images we found non-linear relationships between metrics of productivity and phenology and long-term precipitation. Areas with less long-term precipitation presented lower annual productivity, due to a shorter growing season, and less ability to support evergreen vegetation.

Outcomes

A predicted increase in aridity would dramatically reduce the functioning and ecosystem services provided by dryland ecosystems, impairing the ability to support more than one third of the human population.

We were able to identify lichen traits responding to aridity, making a critical advance towards the construction of an early-warning indicator of desertification. The easily identifiable traits chosen, particularly type of photobiont, seem to be a promising tool with a potential for universal application.

We suggest the existence of ecosystem response thresholds in the response of vegetation to precipitation. Unlike previous short-term studies the results of this work clearly show that the response of vegetation depends on the long-term climate.

Overall, this work provided information that can be used to prevent the irreversible changes of dryland ecosystems and the loss of ecosystem services provided by them.

Acknowldegdments

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FOREST CARBON IN DRYLAND. AN EXPERIENCE IN SANTIAGO DEL ESTERO ARGENTINA

PEREZ PARDO, Octavio

College of Agricultural Engineering of Santiago del Estero. Argentina, Argentine Republic

octavioperezpardo@gmail.com

Rationale

This paper describes the advances related to the development of the main methodological and operational options that would enable implementing proposals on forest carbon in drylands.

Since 2006 several government and non-governmental institutions in Santiago del Estero. Argentina have been developing an interesting process of building new knowledge related to forest carbon in drylands. Such knowledge includes those relating to Reducing Emissions from Deforestation and Forest Degradation, as knowledge about carbon sequestration in forests and soils through development of agroforestry and afforestation with native species.

Within the methodological options chosen, progress has been made in the design of methodologies for calculating carbon afforestation, forests, and soil in drylands.

Within the operational options, have been analyzed institutional settings, policy, regulatory gaps and the necessary knowledge to promote sustainable practices, which allow holders of land, access to new benefits based on the valuation of environmental services in drylands.

Both options (methodological and operational) aim to not only meet and develop the method of checking quantities of carbon in soil or biomass, but rather identify recognized carbon sequestration practices that could be incorporated into a future carbon market for drylands

Methods used and partnership set up

The method used was based to establish an interdisciplinary technical team; composed of agronomists and forestry engineers for working on developing methodologies for the calculation and monitoring of carbon stocks in forests and soil; Accountants and economists to assess the opportunity costs of land, the marginal cost of abatement and transaction costs of a forest carbon project; Sociologists, to design and conduct surveys of interpretation, to learn about what are the most important causes of deforestation and / or forest degradation in drylands; Lawyers to discuss current legislation and regulatory gaps that allow designing an implementation framework for the development of a potential forest carbon market, Communicators to carry out a program that includes training and dissemination, capacity building; diffusion of technological and management tools and campaigns at different levels.

Other element was the selection of different pilot sites sampling, monitoring, analysis of agroforestry practices in different types of soil and vegetation in drylands.

In relation to the partnership set-up, the activities are implemented under public private agreements between local, national and international scientific institutions; Provincial and national governmental and non-governmental organizations, to provide a strong interagency group aimed at establishing on one hand, a process to manage a system of monitoring emission and capture measurable, reportable and verifiable greenhouse gases and other side to identify, certify and supervise recognized agroforestry practices of carbon sequestration.

Results

In function of the activities, we may note the following results:

- Design and development of a methodology for carbon sequestration, which was elevated and approved by the Board of the CDM of the UNFCCC. AR-AM0012 Afforestation or reforestation of degraded or abandoned agricultural lands
- 2,013 hectares were reforested with native species (Prosopis alba) in degraded drylands, where the project is monitoring carbon in soil and biomass.

- Estimates of carbon were performed for different soil types and different forest types and have installed monitors to measure carbon in different agroforestry practices in drylands in the province of Santiago del Estero
- The team has established a database of experts in calculation of carbon stocks in forests and soil in order to know existing technical capacity in the country and in the LAC region.
- The technical team has carried out surveys of interpretation for the major causes of deforestation and / or degradation of forests in the Province and the knowledge that individuals and institutions have about carbon markets.
- Economic researches have been carried out to assess the opportunity costs of dryland in the Province, in order to know economic values of a potential carbon market.
- It have been analyzed the current regulations and undertaken an analysis of regulatory gaps for the implementation of a Forest Carbon Strategy in the Province.
- Pilot sites have been established in different areas of the province where different agroforestry practices are developing. They are being monitored to identify good practices for carbon sequestration in drylands that could be incorporated into a future "carbon market" for dryland
- 86 small farmers have been trained in sustainable development practices that improve the stock of carbon in the soil and forest.
- The technical team has made the first maps of historical forest cover loss in the province of Santiago de Estero from 1990 to 2012.

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INDICATORS FOR ASSESSING THE IMPACT OF SLM PROJECTS AND PROJECTS TO COMBAT LAND DEGRADATION AND DESERTIFICATION

AMSALLEM, Isabelle (1); BIED-CHARRETON, Marc (2)

1: Agropolis productions, France; 2: French Scientific Committee on Desertification (CSFD)

amsallem@agropolis.fr

Rationale

This initiative (2008-2013) implemented by the French Scientific Committee on Desertification (CSFD), in collaboration with DNI scientists, civil society organizations and UNCCD CST. It aimed at developing a minimum set of indicators to enable:

- decision makers to assess implementation of the UNCCD strategy after 10 years and the progress achieved on meeting its objectives
- multiscale assessment of land degradation and desertification trends progress achieved through local projects.
- Assessment of impacts of SLM projects.

Methods used and partnership set up

Existing usable indicators have been extracted from several hundred scientific references (in-depth literature review) and databases available on line from websites (FAO, WB, GEF, UNEP, etc.). A survey has been made as well through a questionnaire sent international networks (civil society organization, scientists, etc.). A selection has been made on about 300 indicators. As a result, 70 selected local impacts indicators for combating desertification operations have been characterized.

Partnership set up

- CSFD, French Scientific Committee on Desertification
- DNI, DesertNet International
- Civil society organizations: International Federation of Agricultural Producers (IFAP), Groupe de Travail Désertification (GTD)
- French Agency for Development (AFD)

Results

- Methodological elements for assessing impacts of projects to combat land degradation and desertification.
- An analysis of the assessment process complexity.
- Selection and characterization of 70 local impact indicators for projects to combat land degradation and desertification:
- Biophysical indicatorsare intended to qualify and quantify the state of natural capital: water, soil, vegetation…
- Quantitative production indicators are used to measure the results of project initiatives regarding agricultural production, forestry and livestock production.
- Economic and financial indicatorsaim at measuring investments, funding sources and rates of return.
- Institutional and societal indicators are intended to provide qualitative information on the nature and existence of local agreements and contracts between development stakeholders. They also generate quantitative and qualitative information on the organization of civil society and decentralization, and on poverty and wellbeing issues

Outcomes

- Several reports and publications
- Leaflets for UNCCD COP9 (Buenos Aires) and UNCCD CST 2013
- Local, national and global indicator Excel databases
- CSFD website on that topic : www.csf-desertification.org/recherche-developpement/item/mesure-des-impacts-des-politiques-programmes-et-projets-de-developpement

BUILDING INDICATORS TO MEASURE VULNERABILITY FACING DESERTIFICATION: Agua Prieta, Sonnora, Mexico, Case of Study

BERNAL, Sandra Maria

University of Arizona, United States of America

sbernal@email.arizona.edu

Environmental stressors identified in the border region between US-Mexico are: variability of the dry and wet seasons that suggests severity of events and a lack of capability to resist droughts and floods (Garfin et al., 2013). Heat waves that stress the more when preceded by a long period of drought, a side of the effects on human and natural environments, the connection between the compaction of soil after periods of drought, make an excellent path for floods and runoff speed during intense storms. Other impacts, also related to Climate Change, are those in land use and land cover.

The process presented considers the essential facts of a responsible design of indicators that represent the vulneran]bility of the community.

Following Bond and Mukherjee (2002) and Aldrich and Sayer (2007), the "Sustainable Livelihoods Framework" (Ellis 2000) in the method to define and organize indicators for natural, physical, human, financial and social capital, that together determine the living gained by the individual or household.

The livelihood analysis in table 1 shows that per each capital is an outcome that contributes to the availability to change the house. From the Human capital the strategies adopted by the community increase the participation of household members in the decision making process. It is also a reliable way to increase the availability of money.

The Human and Economic Capitals are tide since the more people at home, the more income opportunities. Within the Natural Capitals is only the land use change over the original farming use the one that will provide of more parcels for future development. This value applies to the Physical Capital too.

Social Capital is the source of possibilities for an organized development of participatory based projects. The partnership between state and social institutions is one of the most promising alternatives for adaptation.

The outcomes from the Sustainable Livelihood Assessment are a responsible decision tool to lead the distribution of the space within the houses and the management of the real adaptation capacities of the household. The ideal result is a set of indicators that support sustainable design that addresses people's capacity to sustain a household within an environment. An adaptation strategy design is a tool for poverty alleviation, improvement of livelihoods both key in this border region for its social and economic challenge.

Results

Human Capital: all the fields applied as meaningful due its contribution to the adaptation of the house.

The National Income Survey of Household Based Expenses and the National Advisory Board of Population published that on 2008 the extended families rate growth experienced an increment of 22% and the nature of this increment are organizational difficulties to manage the independent living of individual people, in special those who are over 65

I out of 10 Head of Household went back to their parents' house

28% of the households have the head's parents living in their houses

15% of the Head of Households have people with no blood relationship living on their property

Economic Capital: all the fields apply since the nature of this capital is based on money.

The more people at home, more economic activity and income chances, following the information cited on the Human Assets description indicate a relationship between population growth and economics.

The 38% of the people with economic activity earn less than $123.00 pesos = 9 dollars per day.

Natural Capital: Ranching (agriculture + livestock) is decreasing every year, the remaining activities are agriculture for local consumption, therefore the open space and surface water in not perceived as factor for housing adaptation anymore.

- 3,780 ha agriculture
- 356,682 ha livestock
- Río de Sonora, Río Bavispe, Punta De Agua y San Pedro.

Physical Capital: The criterion applies, land appropriation is the first step before the house.

Agua Prieta has 3617.66 km2 of territories from where 90% is ejido divided by 7 allotments managed by cooperatives.

Social Capital: every field applies.

There are two main social programs that provide people the possibility of having a house. The National Workers Housing Fund a small based saving account used to buy or build. The State program for improvement supported by the Federal Government and the State Commission of Housing is a 50-50 partnership with home owners that provide either material or labor. The more popular alternative is to save money at a household level to build a home as is possible.

IDENTIFYING COMMON INDICATORS ON AGRO-ECOSYSTEM RESILIENCE ACROSS THE RIO CONVENTIONS

COWIE, Annette (1); O'CONNELL, Deborah (2); GRIGG, Nicky (2); ABEL, Nick (2); WALKER, Brian (2)

1: Scientific and Technical Advisory Panel of the Global Environment Facility; 2: Commonwealth Scientific and Industrial Research Organisation

annette.cowie@une.edu.au

The Scientific and Technical Advisory Panel (STAP) to the GEF is leading an effort to identify indicators of agro-ecosystem resilience that complement the UNCCD progress indicators on land cover and productivity, and that can be shared with the UNFCCC as a measure of land-based adaptation, and the CBD as a measure of ecosystem resilience. To arrive at suitable indicators, there is a need to synthesize our understanding of resilience in interacting social-ecological systems. There is a growing emphasis on providing a solid scientific foundation to define the pre-requisite levels of ecosystem function to meet long-term social, or economic goals (O'Connell et al., 2013). The STAP is partnering with the Commonwealth Scientific and Industrial Research Organisation, the GEF, and the UNCCD and CBD to propose an approach to resilience assessment based on the resilience concepts described by Walker and Salt (2006, 2012).

The STAP commissioned a paper on resilience science and its application in agro-ecosystems for discussion at a workshop in November 2014. The paper synthesizes the scientific understanding of resilience in interacting social-ecological systems, with a focus on agro-ecosystems, and proposes an approach for defining indicators to assess social-ecological resilience of farming systems. The approach was reviewed and applied at the workshop using case studies and examples that are suitable for reporting by the Conventions and for application by the GEF.

The approach focuses on four elements: i) Element A: System description; ii) Element B: Assessing the system; iii) Element C: Adaptive governance and management; and, iv) Element D: Participatory process. The framework is intended to support the planning process based on a system-dynamic-based understanding of resilience. It is intended to be used across scales – from the project level to the regional level. The framework includes "Resilience Action Indicators" to guide action taken in response to the results of the application of the framework. These are in early stages of development and need further testing and development. STAP and CSIRO will host a side event at UNCCD's 3rd Scientific Conference where the framework will presented and discussed. The discussion will focus on the merits, challenges, potential application, and further development needs.

Indicators of agro-ecosystem resilience are expected to support common reporting on land-based adaptation between the Conventions. Through its focus on sustainable land management, as a measure to address desertification and land degradation, the UNCCD is well-placed to strengthen initiatives between the Conventions on monitoring and assessment of socio-ecological systems and their resilience to climate change. Food security and climate change adaption are two areas of the proposed Sustainable Development Goals for which strengthened resilience of agro-ecosystems is relevant. The outcomes will serve the goals of the Conventions in assessing progress in enhancing agro-ecosystem resilience to deliver global environmental benefits, and support the sustainable development agenda. An additional outcome is strengthening the links between UNCCD reporting, and monitoring of GEF-funded activities on land degradation to develop indicator sets that work together to assess progress in combating land degradation.

The authors are grateful to the Global Environment Facility for their technical contributions to, and funding of, this activity through its Scientific and Technical Advisory Panel.

LANDSCAPE CHANGE ANALYSIS, A TOOL FOR THE IDENTIFICATION OF LAND DEGRADATION MITIGATION PRIORITY AREAS IN MADAGASCAR

RATOVOSON, Arimino Aina Navale (1); RAKOTO RATSIMBA, Harifidy (1); RAKOTO, Percy Yvon (1); RABENILALANA, Mihajamanana (1); RANDRIANANTENAINA, Fenohery (2); RALALARIMANANA, Herivololona (2); RABENITANY, Yvannie (2); RAMAMONJISOA, Bruno (1)

1: Département des Eaux et Forêts de l'Ecole Supérieure des Sciences Agronomiques, Université d'Antananarivo, Madagascar; 2: Direction de la Planification, de la Programmation et du Suivi Evaluation, Ministère de l'Ecologie, de l'Environnement et des Forêts, Madagascar

rrharifidy@moov.mg

Rationale

Land degradation defined as long-term decline in ecosystem function and productivity (Bai et al. 2008) affects the economics of many countries related to its extent continuous increase and severity. The global assessment of land degradation, desertification and drought revealed the coverage of land degradation through the world while south of equator of Africa regions are considered as the most severe (Nkonya et al. 2010). Nonetheless, the lack of investment in the field limits the implementation of land degradation mitigation at national scale. Madagascar has involved to the ratification of the UNCCD and therefore has to establish and implement his national action plan for priority areas. Herein, baseline information of land degradation is still missing to define the appropriate strategies and policy. This study has been implemented in order to help to define priority areas of land degradation mitigation. With the improvement of technologies, remote sensing and GIS approaches is recently widespread and recommended to undertaken such study.

Materials and methods

MODIS Terra (MOD09A1) and MODIS Aqua (MYD09A1) images reflectance product, well known for its availability at no cost and its low spatial resolution of 250 m pixel size has coupled to MODIS Vegetation index (MOD13A1 and MYD1309A1), a 16-day composite from the previous daily reflectance in order to emphasize vegetation discrimination prior to the classifications. Normalized Difference Vegetation Index (NDVI) is although recognized and recently useful to assess land degradation such as GLADA project despite some authors advanced its weakness in this sense.

Based on UNCCD definition, climatic database was used to delineate the Madagascar's sub-regions through aridity index (Krugmann 1996). This index use rainfall and potential evapotranspiration as input variables and classify the regions following the severity of aridity. Database through permanent meteorology stations have been used for the calibration of the results.

Land cover and land use change and modelling are the main approaches for the delineation of the priority areas which was undertaken into two steps. Past experience of landscape change are conducted in the first step using times series data (2002 to 2007 and 2007 to 2013). Importance of transitions determines the priority areas using sub-basin delineation as map unit. Expected change has derived from the previous land cover modelling to 2024. Potential drivers incorporating previous disturbance, fire intensity and altitude have been used for the simulation. The priority area corresponds to the same sub-basin occurring high intensity of transitions.

Results and discussions

Aridity index for Madagascar shows the existence of aridity severity level range from sub-humid to arid regions. Drylands represent 30.4% of the country: sub-humid (19.45%), sub-arid (8.6%) and arid (2.7%) and have been characterized as land degradation and desertification area predilection. These areas are mainly distributed in the western and southern part of Madagascar with the concentration of arid and semi-arid regions in the south-western. The main pattern of the landscape in this area are shaped by deciduous dry forest, spiny dry forest in the south, mangrove forest following the coastline, croplands and rice field mostly represented within the basin of south western and of the south and unproductive area represented by grassland, savannah and

bare soil. This later shaped as the main matrix of the landscape studied.

Within the considered time-scale, human-induced land degradation and desertification are increasingly observed. Land cover changes from 2002 to 2007 and from 2007 to 2013 are very significant. Deforestation is one of the main components with a continuous degradation of deciduous forests related to its vulnerability to anthropogenic disturbance.

The priority area is defined through the frequency of transitions between the actual land cover and the predictive land cover for the next ten year and fire occurrence density. The past transitions of classes' shows that priority areas represent 28.76% (51,568 hectares) of the affected area previously defined. Comparison of land cover in 2013 and predictive land cover in 2024 shows a decrease of forest biomass and an increase of unproductive areas. The expected priority areas have moved to 73,119 hectares representing 40.79% of the drylands regions.

Outcomes

The study highlights the importance of landscape change for the definition of priority areas for land degradation and desertification mitigation with the help of remote sensing and GIS technologies which are recently known as key tools for policy definitions. Results shows significant difference of priority areas depending on the reference landscape change considered. However, update and periodic monitoring are needed for the adaptation of the strategies. Also, expected change is essential in order to analyze the impact of land degradation and its impact on human well-being and food security.

DESERTIFICATION RISK ASSESSMENT IN MEDITERRANEAN ECOSYSTEMS IN LATIN AMERICA

HUAICO MALHUE, Ana (1); ESPEJEL CARBAJAL, Ileana (1); DAESSLE HEUSER, Walter (1); ROVIRA SOTO, Jaime (2); LEYVA AGUILERA, Claudia (1); DÉSIGA ORENDAY, Aarón (3)

1: Universidad Autónoma de Baja California, México; 2: Departamento de Espacios Naturales y Biodiversidad, Ministerio del Medio Ambiente, Chile; 3: Mixbaal S.A. de C.v., México

anitahuaico@gmail.com

Rationale

The desertification problem in the Mediterranean ecosystems in Latin America has been poorly monitored at local scales. In these regions there is a great need to safeguard endemic species that have been experimented an exceptional loss of habitat (Myers et al., 2000). The present research was carried out with an objective to identify the areas under the risk of desertification at two different places: the rural locality called Maneadero in the northwest of Mexico, and drainage basin of the Puangue River in the Santiago Metropolitan Region, Chile.

This assessment is the first step for evaluation and monitoring to desertification in both zones. This investigation provides inputs to identify resolution of desertification problems and to propose prevention measures. This research suggests four steps a participatory evaluation model for monitoring the desertification.

Methods

We studied various models to assess the risk of desertification, and we chose a base model referred to as "Environmentally Sensitive Areas", or ESAS (Kosmas et al., 2005), for the development of a desertification risk index. Subsequently, we identified the causes and effects of desertification in the study areas and added various indicators to the initial model. This method involves 20 indicators, which are assigned to groups based on their variables, forming sub-indices. The risk index is based on six indicator groups. The environmental aspects to evaluate are the soil, vegetation management, climate, hydrology and socio-economic vulnerability. Finally, we identified areas at risk of desertification.

The scarcity or incompleteness of databases and the lack of standardized data are problems in Latin America; however, there is local knowledge regarding the causes of land degradation. The indicators were identified using the various established databases and were supplemented by interviewing local residents. We believe it necessary to include local residents in decision-making with regard to prevention, management and resolution of desertification problems. The model was developed to assess areas with the following characteristics: (a) a Mediterranean climate, (b) overexploitation of water resources, and (c) intense agricultural production.

Results

The risk of desertification in the drainage basin of the Puangue River in Chile is associated with the replacement of native forests by industrial crops. However, the basin contains two areas that have been well preserved: the headwater tributaries and certain remnant forests and areas of native vegetation on the valley floor. The study area contains 68,674.43 hectares, or 38.1% of the area, that is at high risk of desertification and contains another 68,563.65 hectares, i.e., 38.04%, that is at medium risk.

The risk of desertification in the area of Maneadero, Mexico, is associated with poor water quality and intense agricultural production, particularly in the central zone between the adjacent sea and piedmont. The area of medium desertification risk measures 7,857 hectares and comprises more than three-quarters of the study area (76.18%).

After the risks were identified, we analyzed the social indicators. Both areas are characterized by high levels of poverty and by levels of education (years of schooling) below regional/state averages, and thus, it is essential and urgent that actions are undertaken to increase the educational levels in these areas.

We developed a desertification risk assessment model with indicators and sub-indices for Mediterranean ecosystems in Latin America, because we do not think that it is necessary to generate more indicators but do believe that efforts should be directed at defining indices and defining a minimum set of indicators for each place or geographical zone.

We propose a participatory evaluation model for monitoring the desertification (Fig.1). This research suggests four steps: (1) identify areas at risk of desertification, (2) analyze the results from the first step in terms of the demographic characteristics and identify potential actions, (3) execute the recommended actions and (4) monitor and evaluate the actions with the participation of local residents. We think that indicators are important tools for evaluation and monitoring, but if indicators are not part of a larger process to achieve the sustainability of natural resources, there is a risk that the efforts on desertification will remain at the descriptive phase and will fail to achieve the developmental goals demanded by society.

Outcomes

This is the first study of two locations of Mediterranean regions in Latin America that are highly susceptibility to desertification and the methodology can be applied at different scales.

We propose certain preventative measures, such as studying local agricultural practices, identifying practices to conserve natural resources, protecting critical aquifer recharge areas, creating an environmental education program focusing on desertification, and generating a program for maintaining updated databases of local water and soil resources. We believe that this research presents the first steps in developing a participatory evaluation model to monitor for desertification in both locations.

AGRICULTURAL LANDSCAPE OF UKRAINE AND THEIR RECLAMATION PROPERTIES

DANYLENKO, Iuliia; LYUTNYTSKIY, Sergij

Institue of Water Problems and Land Reclamation, Ukraine

iuliia.danylenko@gmail.com

The territory of Ukraine is characterized by a great diversity of natural landscapes. And, unfortunately, because of the high plowed lands and their involvement in agricultural production most of landscapes are transformed into agricultural landscapes (agrolandscapes). These landscapes with modified cenosis are different from their former natural state through heterogeneity, which reduce the capacity of the territory to self-regulation and self-healing. The main factor that landscapes changes is an economic activity, including the use of different systems of agriculture, forestry, agronomic and other reclamation activities.

Any area should be considered as having a certain reclamation properties and has the ability to set up within their individual areas of landscapes that have a positive effect on close and distant environment. One of the regulatory elements key in the structure of agricultural landscapes are the shelter belts and forests. Particularly important role shelter belts and forest splay in forming of farmland microclimate.Through their influence reduced maximum daily surface air temperature, which positively affects the growing season crops.

Methods

Methods for determining the properties of the reclamation of agricultural landscapes combine the technology of remote sensing and ground-based observations. Ameliorative condition of rural areas can be considered satisfactory if it agrolandscape forms established climate that promotes plant growth, primarily due to the presence of a sufficient amount of moisture and heat.

The key indicator here is warm. What it is, the more water and carbohydrates plants consume to maintain your current life that harms the final harvest.Reduce surface air temperature can be due to shading area tree-and ground herbaceous vegetation, artificial moistening the ground and plants. Open, in our view, is the question of the optimal relation between the extents of reclamation activities in which surface air temperature will be minimal.

Results

We proved that the maximum daily surface air temperature in the case of Ukraine, which promotes biomass, varies between 20 - 30 °C. The maximum downward effect on this temperature is to give in clear and hot days shelterbelts. Lowering the temperature on the field with delicate forest belts is 1,4 - 2,1 °, and was blowing from forest belts - 0,7 - 1,6 ° C. In irrigated field even without belts temperature at least 3,1 - 3,3 °C in the protected shelter belts land - 2,7 - 2,8 °C.

Outcomes

These results are obtained by authors developed method. It checked in three regions of Ukraine, namely Kakhovskiy, Kamensky irrigated array (Southern and Northern Steppe), Kirovograd region (Southern Forest) Volodymyrets near Rivne region (Northern Forest). It was built specifically impact maps and maps that characterize available today deficits of shelter belts and irrigated lands.

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QUANTIFICATION OF LAND DEGRADATION AND PRODUCTIVITY OF AGRO-ECOSYSTEMS UNDER CHANGING CLIMATE AND LAND USE

BIRADAR, Chandrashekhar (1); XIAO, Xiangming (2,3); ZHANG, Geli (2); DONG, Jinwei (2); WAGLE, Pradeep (2); CONRAD, Christopher (4); DE BY, Rolf (5); STERK, Geert (6); ZIADAT, Feras (1); LOUHAICHI, Mounir (1); LOW, Fabian (4)

1: International Center for Agricultural Research in Dry Areas (ICARDA), Amman, Jordan; 2: Department of Microbiology and Plant Biology, University of Oklahoma, Norman, USA; 3: Institute of Biodiversity Science, Fudan University, Shanghai, China; 4: Institute of Geography and Geology, University of Würzburg, Germany; 5: Department of Geoinformation Processing, ITC, University of Twente, Enschede, The Netherlands; 6: Department of Physical Geography, Faculty of Geosciences, Utrecht University, The Netherlands

c.biradar@cgiar.org

Agro-ecosystems in dry areas are sensitive to changes in climate and land use. The gross and net primary productivities of these agro-ecosystems are highly variable in both spatial and temporal scales. Accurate and up-to-date information on grasslands and croplands along with extreme events are important for understanding the food security and sustainability of socio-ecological systems. In this research, we provide an overview of satellite and in-situ based observations and modeling of land use dynamics, coupled with edaphic and climatic factors in dryland production systems. Our efforts highlight recent advances in satellite-based mapping and in monitoring of croplands (cropping intensity, cropping calendar, crop types, crop rotation, water use, etc.) and grasslands (vegetation phenology and density) using time-series vegetation indices such as Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI) and Land Surface Water Index (LSWI). Secondly, the satellite-based Vegetation Photosynthesis Model (VPM) was used to estimate gross and net primary production of croplands, grasslands and tree-based systems. Thirdly, we introduce new methods in satellite-based mapping of grassland degradation and desertification from farm to landscape scales to identify prioritization hotspots for intervention and the design of improved adaptation strategy across the scales. Finally, paper discusses the role of community remote sensing and citizen science in the participatory monitoring of dry area grasslands and croplands. This is ongoing study, and initial results show the annual dynamics of the vegetation flux across the study region in response to climate and extreme events. The vegetation trend analysis seems to be a clear predictor of the productivity in response to degree of land degradation and LWSI is much more sensitive to productivity and droughts than does NDVI and EVI. We showcase the data products at the open access web portals (e.g., http://geoagro.icarda.org/) including smartphone apps, visualization kits and tools. The resultant data products are also adopted for the design of spatial decision support systems for rural advisory and policy analysis towards climate-smart villages and agriculture.

UNDERSTANDING LINKAGE OF CLIMATE CHANGE PATTERN AND DEVELOPMENT-POVERTY INDICES IN THE THAR DESERT – A CASE OF RAJASTHAN STATE, INDIA

SHARMA, Devesh

Central University of Rajasthan, India

devesh.water@gmail.com

The state of Rajasthan, situated in the western part of India, is the largest state in India, covering 10.5% of the country's geographical area, but it shares only 1.15% of the country's water resources. Geographically, the state encompasses a huge area of the Thar Desert. The region faces severe water scarcity and is classified as an arid/semi-arid region. Low and erratic rainfall, predominately deep dry sandy soil terrain with dune bodies, totally absent or irregular natural drainage in most parts, very deep and saline groundwater, very high evaporation and frequent dust storms make the region vulnerable. In Rajasthan, drought is a prominent feature of the climate with maximum probability of occurrence of drought, with recurring droughts in 3–4 years in a cycle of 5 years (Mall et al., 2006). The state is expected to be seriously affected by the impacts of climate change since the region's economy relies on agriculture and natural resources, i.e. water (GoI, 2004).

Rainfall, temperature and evapotranspiration change are analysed for the study area based on rainfall data of 35 years (1971-2005). Standardized Precipitation Index (SPI) is also estimated for drought analysis. To understand the linkage between climate change impacts and adaptation potential of human, Human Development Index (HDI) and Human Poverty Index (HPI) indicators are determined to develop the composite indices for multidimensional development and poverty status of Rajasthan State. MPI (Mazziotta-Pareto Index) method which introduced penalties for geographical areas with 'unbalanced' values of the indicators was used to calculate HDI and HPI.

From the analysis of rainfall indices, it is observed that few stations situated in east and south-eastern side in the state have shown high negative change for annual and monthly rainfall but not such negative change is observed in the case of average number of wet days for the same stations. Similarly from SPI drought analysis both short term and long term, higher tendency of mild droughts is observed than moderate and severe drought with a noticeable increase in occurrence of severe droughts on longer time scales. The study shows annual maximum temperature of Rajasthan is increasing in western part of Rajasthan and the annual minimum temperature of Rajasthan is increasing in north-east part of Rajasthan. The study provides a comprehensive knowledge of change in HDI and HPI over a period of years in Rajasthan. With both HDI and HPI, it was observed that northern part of state is in good position whereas western part of the state is below poverty line district. Eastern part districts are under critical zone. Results are very useful to researchers and policy makers as there is good results which represent the linkage between climatic change pattern and socio-economic status of the people.

CRITICAL AREAS OF LAND COVER CHANGE: AN INDICATOR IN THE FRAMEWORK OF INTEGRATED ASSESSMENT AND MONITORING OF DESERTIFICATION AT LOCAL SCALE. PROVINCE OF MENDOZA, ARGENTINA.

RUBIO, Maria Cecilia (1); RUBIO, Maria Clara (1); ABRAHAM, Elena Maria (1); SALOMON, Mario (2)

1: IADIZA, CONICET-Mendoza. Argentine Republic; 2: Facultad de Ingeniería. UNCuyo. Argentine Republic

crubio@mendoza-conicet.gov.ar

Rationale

The drylands in Mendoza province (Argentina) are fragile ecosystems, subjected to severe and complex processes of desertification (LADA/FAO, 2011), where physical-biological and socioeconomic subsystems interact. As an input to the integrated assessment and monitoring of desertification (Abraham *et al.*, 2006) in the non-irrigated area of the department of Lavalle, NE of Mendoza, we identified the "Critical areas of land cover change", an analysis infrequently conducted in desertification studies (Rubio, 2014). Although there is extensive background on assessing land cover and land use changes, most studies address productive humid areas, related to the advancement of soybean monoculture and cattle breeding. Consequently, we proposed to incorporate this indicator into the integrated assessment, in order to define areas susceptible to degradation from the land cover changes experienced in drylands. In these areas, land cover changes bring about strong modifications in the supply of ecosystem goods and services (Daily *et al.*, 1997) and influence the vulnerability of both places and people to climatic, economic or socio-political disturbances.

Methods used and partnership set up

With the aim to assess land cover changes, we worked with a global scale database, thus supplying the lack of data on land cover and land use layers in the study area for two different years. We used the GlobCover Land Cover product (2005-2006 and 2009), from the European Space Agency (ESA- http://due.esrin.esa.int/globcover/). The thematic legend is compatible with the FAO's land cover classification system -LCCS- (Di Gregorio and Jansen, 2005), which identifies 23 land-cover classes worldwide, at 300 m spatial resolution. This information can be fit and corroborated at local scale with data on the physiognomy and dominant plant species surveyed in the field (LADA/FAO, 2011).

Subsequently, in a GIS environment, we conducted an analysis of land cover changes between years 1 and 2, in the non-irrigated area of Lavalle department. Information layers were processed using the Land Change Modeler for Ecological Sustainability (LCM), integrated into IDRISI software. The LCM includes a set of broad tools to approach the complexity of land cover and land use change.

Determination of the areas susceptible to degradation through land cover changes was based on two criteria: type of land cover transition or change, considering those transformations caused by loss of ecosystem goods and services, and therefore having an impact on desertification processes, and the spatial extent of land cover change.

Results

Outstanding among the main results of the analysis of land cover change in the non-irrigated area of Lavalle department is the fact that the "Bare areas" class is the one showing the highest growth (67017 ha). In contrast, the "Forest or shrubland" and "Closed to open shrubland" classes have notably decreased their surface area (40948 ha and 38217 ha respectively).

We determined the critical areas susceptible to degradation from land cover changes. The following transitions between classes were selected: in the first place, the transition from "Sparse vegetation" to "Bare areas" (3920.92 ha), second, the transition from "Closed to open shrubland" to "Bare areas" (25756.69 ha), and finally, and with the largest transition area identified (35567.2 ha), the change from "Forest or shrubland" to "Bare areas".

The spatial trend of change from "Forest or shrubland" to "Bare areas" occurs across the eastern part along the Desaguadero river, in El Forzudo and Arroyito villages; and in the western part, in Asunción and San José villages. The spatial trend of change from "Closed to open shrubland" to "Bare areas" again occurs in nearby areas to San José and Asunción villages and to the south of "Lagunas del Rosario", which evidences a strong relationship between human pressure and land cover changes that leads to "Bare areas". Finally, the spatial trend of change from "Sparse vegetation" to "Bare areas" occurs near San José village and in the area corresponding to "Camino de los Huarpes" which exhibits critical soil and vegetation conditions.

Analysis of the spatial trend of change in critical areas within the framework of the integrated assessment of desertification allowed linking it to biophysical and socioeconomic indicators such as stocking rate, population density, aridity index, soil texture, water quality and poverty, among others.

Outcomes

The constructed indicator, "Critical areas of land cover change", is a contribution to strengthening the integrated system for assessing desertification. Applying this indicator in the non-irrigated area of Lavalle department, as a part of the integrated assessment, allowed identification of the major changes and transitions occurred in the area and determination of critical areas of change subjected to loss of related ecosystem services.

The newly produced knowledge contributes to territorial decision making for it represents an input to the establishment of sustainable land management practices (SLM), a design to monitor desertification processes and the formulation of measures and strategies for stopping and mitigating these processes. This information contributes to local land management in Mendoza through Law No. 8051/09.

MONITORING LAND DEGRADATION AND DESERTIFICATION IN A MEDITERRANEAN ISLAND USING A MULTIVARIATE STATISTICAL APPROACH

SYMEONAKIS, Elias; HARRIS, Edwin

Manchester Metropolitan University, United Kingdom

e.symeonakis@mmu.ac.uk

Land degradation and desertification (LDD) cause the loss of fertile soils globally, depriving more and more people of arable land. In a European context, the most affected areas are found in the Mediterranean zone. In this region, desertification, as an outcome of climatic and social driving forces, is not a recent phenomenon. According to the UNCCD (2004), the countries of Portugal, Spain, Italy, Greece and Turkey have a marked problem of desertification over large areas. Unfortunately, the breadth, complexity and dynamism of the desertification process has so far precluded the development of a comprehensive model and methods of assessment and monitoring have involved the use of indicators. The most frequently applied indicator-based system for assessing LDD in the Mediterranean is the Environmentally Sensitive Area Index (ESAI) framework (Kosmas et al 1999), mainly due to its simplicity in model building as well as its flexibility in the use of relevant variables as indicators. The aim of the present study is to modify and improve the standard ESAI method that can be used to monitor the dynamic nature of environmental sensitivity of Mediterranean environments to land degradation and desertification.

Environmental sensitivity is related to several biophysical and anthropogenic factors, whose characteristics and intensity contribute to the evolution of different levels of degradation. In this study, the criteria outlined by Basso et al. (2000) were used for selecting the different layers of information for mapping sensitive areas according to the MEDALUS ESAI methodology (Kosmas et al. 1999), namely: i) the relationship with the degradation phenomena; ii) the availability of data; iii) the ability of updating the datasets, and iv) the ability to refine, further develop or even remove existing layers of information in the future, if this is deemed important. Twenty-one layers belonging to five main environmental quality indices related with climate, vegetation, soil, groundwater and socio-economic characteristics of the land were estimated and their values standardized from 1 (least sensitive) to 2 (most sensitive) according to the ESAI scheme. Ten indicators employed in this study are used for the first time to appraise LDD sensitivity in Lesvos, namely soil water erosion, the groundwater quality-related indicators of sodium adsorption ratio, chloride concentration, electrical conductivity and water table height, and the socio-economic indicators of education level, old age index, population density, population growth, and sensitivity to grazing.

A criticism of the ESAI is that it can underestimate the importance of more important factors contributing to land vulnerability while inflating the importance of less important factors. This is because the ESAI assumes all indicators used in the system are equally important in contribution to LDD. Here, we accounted for relative variable importance to evaluate LDD using a multiway data analysis (MDA) approach (Salvati *et al.* 2009) and identified greater than one order of magnitude difference between the importance of individual variables.

The vast majority of the island appears to be fragile or critically sensitive, ~ 20% potentially sensitive and <5% not affected. The southwestern part of the island is the most sensitive part of the island, which was also identified by the Kosmas et al. (1999) study. This is due to the condition of the specific areas in parameters mainly related to the soils, vegetation, climatic and socio-economic quality and less so to the groundwater quality. Another area that this study identified as critically sensitive throughout the period of study is the area North of the capital city of Mytilene in the eastern coast of the island, due to human-related factors linked to groundwater quality as well as demographic pressure. This often uncontrolled and unplanned growth has put significant pressure on the natural resources, especially on the coastal rim where most of the tourist activities are focused but also due to the urban expansion towards the outskirts and the nearby towns of Mytilene. Moreover, by applying the modified ESAI in two epochs this study was

able to identify that, contrary to previous belief, sensitive areas are also found in the eastern side of the island mainly due to human-related factors. These areas, e.g. southeast and north of Mytilene, also warrant attention, not because of their currently critical state, but because their sensitivity is increasing rapidly, mainly due anthropogenic factors (Figure 1b). A significant correlation between our results and the original ESAI was observed for both epochs (Figure 1).

It is concluded that our integrated approach may better explore patterns and trends of the main factors affecting land degradation and desertification in Mediterranean environments by overcoming the methodological constraints of the ESAI framework, including the objectivity in the choice of the weighing of the indicators. The suggested methodology can be used for identifying sensitive areas where mitigation measures are required and thus provide a management tool for the prioritisation of such measures.

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INTEGRATED RIPARIAN MANAGEMENT BASED ON FUNCTIONAL ASSESSMENT WITH MONITORING FOR ADJUSTMENT

SWANSON, Sherman Roger; MCADOO, James Kent

University of Nevada, United States of America

sswanson@cabnr.unr.edu

Riparian areas with moist soil near flowing and standing water concentrate land uses, wildlife, and hydrologic processes. Without effective management, uses and actions can break the three legged stool of water, strongly rooted plants, and soil/landform needed to sustain water and life. Riparian proper functioning condition (PFC) assessment (Prichard et al 1993 and 1998, and Dickard et al. 2014) unites citizens, agencies, and disciplines so people agree about the risk level and needed fixes. On streams, each assessment is within a reach having a similar potential for landform, season and magnitude of water influences, and plant communities.

This focuses each PFC assessment on relevant observations. Different plants grow in different settings. Vegetation, especially strongly rooted water loving species that grow on streambanks, slow water flow and stabilize banks against the forces of flowing water. In some reaches, floodplains can spread the water and energy of floods, reducing erosion and increasing water storage. If streams erode into their bed, they incise deeply and then widen quickly because erosion increases greatly. Eventually a widened stream can support new vegetation that allows self-healing. Assessment informs management about needed changes in livestock movement, road or trail placement, water or sediment management, or other land use adjustments (Figure 1).

Assessment teams answer yes, no, or not applicable to seventeen items.

The first five address hydrology:

1. Floodplain is inundated in "relatively frequent" events;
2. Beaver dams are stable;
3. Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region);
4. Riparian area is expanding or has achieved potential extent; and
5. The watershed is not contributing to riparian impairment.

Items six through twelve address vegetation:

6. There is stabilizing riparian vegetation for recovery/maintenance;
7. There is recruitment of stabilizing riparian vegetation for recovery/maintenance;
8. Species present indicate maintenance of riparian soil-moisture characteristics;
9. Plant communities that have root masses capable of withstanding high streamflow events are present along the streambank;
10. Riparian plants exhibit high vigor;
11. Adequate stabilizing riparian vegetative cover is present to protect banks and dissipate energy during high flows; and
12. Plant communities are an adequate source of woody material for maintenance and recovery.

Items thirteen through seventeen address geomorphology:

13. Floodplain and channel characteristics (i.e., rocks, woody material, vegetation, floodplain size, overflow channels) are adequate to dissipate energy;
14. Point bars are revegetating with stabilizing riparian plants;
15. Stream banks are laterally stable;
16. Stream system is not incising;
17. Stream is in balance with the water and sediment that is being supplied by the drainage basin (i.e., no excessive erosion or deposition).

For grazing management, many tools allow plants to grow before and after grazing so they can be strong to resist soil erosion. It is most important to consider season of use, duration of use, rotation of use, and use intensity (Wyman et al. 2006). Long periods of excess grazing do not allow plants to grow and feed themselves. Then, streams fall apart and become drier.

After riparian assessment and management, monitoring change by measuring streamside vegetation teaches people to appreciate success and improve or adjust management when needed. Monitoring focuses on objectives that are:

S pecific about what is to be achieved,

M easurable with standard methods (e.g. Burton et al 2011),

A chievable for the setting and the management,

R elevant to management and processes of self-healing, and

T imely for the stage in succession and rate of response.

Riparian Multiple Indicator Monitoring (Burton et al. 2011) focuses vegetation measurements on the greenline, a linear grouping of live perennial vascular plants, embedded rock, or anchored wood above the waterline on or near the water's edge. Short-term indicators of annual use include the dates of use, stubble height or woody utilization and bank disturbance. Long-term indicators for meeting objectives include greenline stability and wetland rating, greenline to greenline width, bank stability, and woody vegetation height. By measuring cover of herbaceous and woody riparian colonizers and stabilizers, managers learn about the drivers of riparian recovery. When riparian areas function properly to capture, store and safely release water, riparian areas become more resilient and life becomes more and more abundant.

DESERTIFICATION AND FOREST DEGREDATION ISSUE IN KAZAKHYSTAN

SARSEKOVA, Dani (1); AYAN, Sezgin (2); KİTAİBEKOVA, Sara (3)

1: S.Seifullin Kazakh Agro Technical University, Agronomy Faculty, Department of Forest Resources and Management, KAZAKHYSTAN; 2: Kastamonu University, Faculty of Forestry, Silviculture Department, Kastamonu/TURKEY; 3: S.Seifullin Kazakh Agro Technical University, International Cooperation Department Astana/KAZAKHYSTAN

sezginayan@gmail.com

According to the definition of the United Nations Convention to Combat Desertification, desertification is "*land degradation in arid, semi-arid and dry sub-humid areas in result of various factors including climatic variations and human activities*". Both natural and anthropogenic factors are the causes of desertification in Kazakhstan. The main natural factor contributing to desertification processes in Kazakhstan is the intra continental state of the country, determining continental and arid climate, the scarcity and irregularity water resources distribution, causing widespread sand (up to 30 mln. ha) and saline lands (127 mln. ha). These natural features of Kazakhstan cause poor resistance of the environment to human impact. It is estimated that about 75% of the country are subject to high environmental risks. Anthropogenic factors that lead to the emergence and development of desertification processes in Kazakhstan are mainly associated with such economic activities such as: grazing; agriculture; development of mineral resources; construction and operation of industrial, military and civilian facilities, irrigation and linear structures. Desertification is also the result of illegal logging, uprooting shrubs and dwarf shrubs for fodder and fuel, forest and grassland fires, haphazard recreation organization dumps around settlements, pollution of soil and groundwater with toxic substances as well as the impact of transport. In addition, in Kazakhstan, each type of forest has its own set of factors causing forest degradation. The forests of forest steppe zone such as birch stands mixed with aspen and willow, suffer from reduction in area because of extensive agricultural cultivation of steppe land around woodland.

REMOTE SENSING FOR DESERTIFICATION AND LAND DEGRADATION MONITORING: ITALY CASE STUDY

SCIORTINO, Maurizio; DE CECCO, Luigi; MARTINI, Sandro; BORFECCHIA, Flavio

Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), Italy

maurizio.sciortino@enea.it

Rationale

International policy makers at the RIO+20 United Nation Conference on Sustainable Development recommended countries and the international community to identify urgent actions to achieve the goal of a Land Degradation Neutral word (LDN). The Normalized Difference Vegetation Index (NDVI), as derived from remotely sensed imagery, may be used as a proxy of Net Primary Productivity (NPP) and persistent deviations from the norm in ecosystems NPP can be taken as an indicator of land degradation or improvement. Long-term trends of NDVI have been proposed by global (Bai et al, 2008), regional (Cherlet M., et Al, 2014) studies as quantitative indicators for land productivity. These studies highlighted the powerfulness of remote sensing techniques for the monitoring and assessment of the impact of natural and anthropogenic processes that may affect land productivity.

Methods

NASA MODIS NDVI data available from March 2000 to present have been used, in this study, to check if their spatial (250x250m) and temporal (bi-weekly) MVC (maximum value composites) pixel resolution may be exploited for operational land degradation monitoring purposes at country scale. Annual sum of NDVI MVC for each pixel were generated for the Italian territory and normalized as indicator of annual accumulated greenness. The temporal trends parameters have been computed for the normalized NDVI sums, using linear least square regression over the 2000–2013 period. This technique represents a simple, yet robust, way to reveal long-term trends in the yearly sequence of land productivity. The slopes of the linear least square regression line of each pixel have been used to assess the land productivity trends for "forest and semi natural vegetation" and "agricultural" CORINE-2000 land cover classes.

Results

In Italy the forest and wooded areas are known to be expanding since 1990 as well as in the rest of Europe (Forest Europe, 2011). Within this greening trend, the present results show that, at national scale, the land productivity in "agricultural" areas is improving in 111271 km2 (7,4%) and declining in 3714 km2 (2,4%). "Forest and semi natural vegetation" are improving in 6737 km2 (5,1%) and declining in 4851 km2 (3,9%) (tab.1).

The geographic distribution of the changes is not at all uniform because northern Italian regions have higher negative trends and southern regions have higher positive trends. Although "forests and semi natural vegetation" areas are reported to be expanding nationally in terms of surface, NDVI trends highlight that in northern regions the area showing a productivity decline (5.9%) significantly exceed the areas of improvement (0,4%). Southern regions on the contrary show the highest productivity improvement both in natural (13,7%) and agricultural (14,3%) areas. The geographic distribution of positive and negative trends is highly correlated with the distribution of the precipitation trends over Italy but land abandonment and land use change are also contributing to the observed trends.

Outcomes

NDVI trends, as land productivity proxy, depend on several biophysical processes such as precipitation changes, soil erosion, salinization and soil organic matter content decrease. Anthropogenic processes such as land use changes, forest fires and biotic effects due to pathogens of natural and anthropic origin may also be relevant. The trend of the land productivity is the result of the combination of different possible causes that may also be inter-dependent and therefore hardly distinguishable. Nevertheless long-term NDVI negative trends may represent a warning signal, of land productivity change indicating ongoing degradation processes and the need of more in depth studies. The specific figures reported, referring to the Italy case study, are strongly dependent from the observational period but, keeping this in mind, the methodology proposed may improve countries ability to address land degradation and desertification monitoring and assessment using state of the art scientific data and tools providing a method to identify a country scale baseline for quantitative land degradation assessment.

EROSIVE LAND DEGRADATION IN UKRAINE ACCORING TO REMOTE SENSING

TARARIKO, Oleksandr; SYROTENKO, Oleksandr; ILIENKO, Tetyana; KUCHMA, Tetyana

Institute of Agroecology and Environmental Management, Ukraine

agrokosmos@gmail.com

Under climate changes the water erosion and deflation are strengthened. In Ukraine it is mainly connected to an increase in the shower nature of precipitation (Balabukh, 2008), significant expansion of the areas with such crops as corn, sunflower and soy. Erosive deterioration of soil negatively influences on the fertility of soils and yield of agroecosystem. The intensification of agrarian production manifested in increase of tiller crops areas, strengthens the risks of erosive processes in the territory of up to 15–16 million ha, the half of the arable lands in Ukraine. Thus the creation of up-to-date system for monitoring the degradation processes and desertification using the remote sensing data becomes urgent.

Methods

For identification of sheet and linear erosion the data of the Landsat-8 space survey and the materials of the Aster and RapidEye space surveys, also literal and map materials and data of ground observations, including three administrative regions with area of 100,000 ha each were used. Same time the test network of agricultural polygons with 5x5 km area within those regions was used for training data obtaining needed to develop the remote sensing data processing algorithms in the survey of large areas within homogeneous regions.

The erosive receptivity of soil was determined according to such properties as the agrophysical properties, humidity, moisture permeability, density, roughness and organic matter content. It is also considered that the spectral characteristic is caused by the humus content, the presence of moisture, oxides of iron and ground minerals (De Jong *et al.*, 1999).

In a complex terrain, one of the factors of agricultural landscapes degradation and desertification is the degree of the gully erosion development, which was determined according to the indices of gully rate within the territory, thickness, density and length of gullies. The gully rate was determined as the ratio of gullies area (ha) to the area of arable lands (1 km/km^2), density – as a quantity of gullies to 1 km^2; the gully rate is calculated for the total area, gullies length – for the overall length of gullies per unit of area (Tarariko *et al*, 2013).

Results

One the first the object-oriented classification was carried out based on the formalized expert knowledge concerning the signatures of signs (spectral, structural, textural and contextual) for identification of the agricultural land class (mask) differentiated to "plowed soil", "crop planted soil" and "wild planted soil". General approach to the determination of these signs (indicators) is obtaining the data directly at the test areas, based on the data of clay physical content in soil the homogeneous optical characteristics of soil classes were distinguished that enables to calculate the humus content using multiple regression method.

The negative values of the correlation between the spectral values and humus content were observed. Furthermore, it turned out that for each soil class high correlation coefficient has different combination of spectral channels. This confirms the expediency of soils subdivision.

The multiple regression equations were calculated and validated by the method of multiple regression for each sample. For the first soil class the total value of regression for the dependent variable composed 0.85391, for the second class – 0.799607. According to the results of validation absolute error for the first class was equal to 0.32 per cent, for the second one – 0.28 per cent, relative error – 9 per cent and 7.4 per cent respectively. At the following stage the humus content was estimated with the application of a scanning calculator basing on the output photograph within the separate uniform class and corresponding multiple linear regression equation (fig. 1).

For the differentiation of the erosiveness (washout) degree the data on the humus content in various genetic horizons of the soil profiles are used, which were allowed for various soil classes, and also for various sections of the researched area from the point of view of morphometry (slope angles). Thus, the appropriate gradations of the erosiveness classes are obtained for each uniform regio. The automated generalization (post-classification) of image is carried out after decoding, which consists in the removal of small outlines.

Application of remote sensing provides the opportunity of prompt obtaining information about the propagation of soil erosive deterioration in the agrolandscapes over the large territories and carrying out the reliable updating the information about the soil cover state both within the of separate agrarian farms and administrative units.

Basing on combined analysis of obtained data joined to the slope map, the risk degree of the erosive processes development was estimated in order to derive degraded areas for conservation, followed by natural or artificial meadow or afforestation, improving the agricultural landscapes structure.

The ability of the soil water erosion degree classification according to multispectral satellite images is proven. The automated classification models of this process according to remote sensing data are proposed.

MAPPING AND MONITORING LAND DEGRADATION IN SOUTHERN OMAN

AL-WARDY, Malik Mohamed (1); AL-RAWAS, Ghazi Ali (2); CHARABI, Yassine AbdulRahman (3)

1: Sultan Qaboos University, Oman; 2: Sultan Qaboos University, Oman; 3: Sultan Qaboos University, Oman

mwardy@squ.edu.om

Rationale

The southern of Oman is the habitat of 80% of biodiversity of the country. During the summer months (June to September), the southern part of Oman, is swept by Indian summer monsoon (Average seasonal rainfall is between zero and 20 mm for the overwhelming majority of the country and 20 to 60 mm in the southern mountains) (Charabi, 2009). In the last 2 decades this area has witnessed a spectacular socioeconomic development. This accompanied with the increase in the number of livestock by 104% from 1993 to 2014 (MAF, 2013) created a high pressure on the fragile ecosystems. Previous investigations have shown that the study area is already affected by different extent of land degradation due to the extensive overgrazing, touristic activities and urban sprawl (NAP/UNEP/ROWA, 2005). Another threat emerging at the same period is the appearance and spread of invasive plant species that would cause a significant damage to the natural biodiversity in the region. This study aims to delineate the areas affected and prone to degradation and identify the type of degradation.

Data sets and Methodology

Two SPOT scenes with a spatial resolution of 20m, obtained in April 4, 1994 and May 5, 2012, were used to study land degradation and retrieve affected area in the Governorate of Dhofar. Previous analysis using LANDSAT scenes, has shown, that April and May, are the months with the lowest Normalized Difference Vegetation Index (NDVI). For the purposes of the vegetation identification in SPOT images, NDVI value of 0.2 and above was considered to best represent the threshold for separating vegetation from barren land. This value was identified using various vegetation index models. Classified maps were produced using this NDVI threshold values, showing the following:

- Mesquite (Prosopis juliflora) invasion
- Urban sprawl
- Change in vegetation status

Results

Classified maps were produced using this NDVI threshold values, showing the following:

- The spatial extension of the invasive plant of Mesquite in the plain of Salalah between 1994 and 2012 has drastically increased from 1.3 km2 to around 7.1 Km2. It is important to note that this plant was found to crawl towards the valleys of the mountains endangering the natural biodiversity.
- The spatial extension of the urban area has increased from 13 Km2 to around 51 Km2. The most noticeable is the developments edging towards the mountain foothills.
- The changes in the vegetation status in Mountains region were classified into threecategories of changes (Figure 1):
  - Dense vegetation decreased in density (Area = 47 Km2)
  - Low density vegetation has become barren (Area = 85 Km²)
  - Extreme land degradation\land cleared for development (Area = 6.5 Km²)

Conclusion

The preliminary results show that the land degrading covers large areas under different aspects. For the three categories studied the total area affected by changes from 1994 to 2012 is equal to 182.4 Km2 dominated mainly by change in vegetation density in the mountainous region. These results highlight that there is an urgent need to develop mitigation strategy to reduce the pressure on natural vegetation caused by the increase of the number of livestock and urban sprawl and to control the expansion of the invasive plants species.

THE ASSESSMENT AND MAPPING OF DESERTIFICATION IN MONGOLIA

NYAMTSEREN, Mandakh (1); JAMSRAN, Tsogtbaatar (1); SODOV, Khudulmur (2)

1: The Institute of Geoecology, Mongolia; 2: Environmental information center

maaggi@yahoo.com

Rationale

In recent years, mankind has been challenged with a myriad of serious environmental issues. Many international institutions, governments and individual citizens are placing special emphasis and importance on the issues of desertification and land degradation.

In this current age, whereby climate change is inflicting ever increasing levels of desertification and negative pressure on Mongolian livelihoods, society and economy (Kharin., Natsag., 1992; Baasan, Dash, Sarantuya et al., 1992), it is important to reduce this process through broad activities that include people of all walks of life so that mitigation opportunities are applicable. Targets for mitigation activities include the most recent scientific breakthroughs and new technology, and address the sustainable management of water, land and forest resources. Thus, studying the indicators of and determining the causes of drought, desertification and land degradation, and further by measuring and visually depicting them and making a forecast on future conditions will be very important for reducing soil erosion, land degradation, and mitigation of desert expansion.

Methods and data

Desertification assessment was developed choosing indicator system based on whole country assessment and remote sensing method as well as eight indicators as the main criteria of desertification: drought intensity, drought frequency, water erosion, wind erosion, vegetation cover state change, vegetation cover change trend, livestock density, population density. The overall assessment procedure was made by dividing the above mentioned criteria into five main categories by its critical value, corresponding to the severity classes (slight, moderae, heavy, very heavy).

Results

The level of desertification and prevailing factors of land degradation for Mongolia was estimated and mapped in 2013, through analysis of indicators derived using various methods. As a result of this research it was reported that 77.8 per cents of the total territory affected by degradation, of which 35.3 per cents defined as slightly degraded, 25.9 per cents – moderately, 6.7 per cents severely and 9.9 per cents – extremely. Comparing this results with previous assessment (P.D.Gunin, 1990; P.D.Gunin, I.K.Michlyava, 2006; Dash, Mandakh, 2006; Dash, Mandakh, Khaunbek, 2008) it can be concluded that overall land degradation situation has a little changes; however, spatial distribution of lands heavily and extremely affected by degradation have changed significantly. Especially, there are many new places where extreme degradation situation newly formed.

Various factors that change over space and time determine the desertification process. Such factors include indirect factors such as population increase, socio-economic, political, and international trade, and direct factors such as land utilization method, and climate change. Today desertification issue stems from inappropriate usage of limited natural resources. Then the issue gets even crucial with climate change affect. Based on the numeric index of desertification map, a map of factors with major affect in the issue was developed. The map of factors shows that 10.4% has no affect from factors or with no sign of desertification, 1.9% is human action factor, 16.0% is natural factor, 13.8% is a climate factor, 20.8% is wind erosion factor, 0.1% with water erosion, 13.1% is combined factor of human action and climate, 23.9% is a combined factor of wind and human action. It means 10.4 % is no sign of desertification or no factor, 39% is human action prevailed or combined, 50.6% is natural factor prevailed or combined. In other words, natural factor plays 56% and human action factors in 44% in heavily or very heavily deserted areas. Researchers mentioned that an increase of degraded land may cause adverse effect on regional climate (Xue Y., Shukla, 1993; Xue, 1996; Gomboluudev, Natsagdorj, 2004). Gomboluudev and Natsagdorj (2004) pointed that large-scale changes occurring in land cover will subsequently impact moisture regime in regional climate. If degradation process will gradually develop and area of barren land will increase the amount of precipitation and evapotranspiration will decrease resulting intensive aridification of the climate. Researchers reported that increase in aridity may will significant in Central and Eastern parts of the country, which they proved by regional climate model outputs.

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A DIGITAL GEO-REFERENCING SYSTEM FOR MONITORING GROUND COVER IN DRY LAND ECOSYSTEMS

LOUHAICHI, Mounir (1,2); CLIFTON, Kathryn (1); JOHNSON, Douglas E. (2)

1: CGIAR/ICARDA, Jordan, Hashemite Kingdom; 2: Department of Animal and Rangeland Sciences, Oregon State University, Corvallis, Oregon 97331-5506, USA

M.Louhaichi@cgiar.org

Rationale

Rangelands are the most widespread land use type in the dry areas, and are home to most of its poorest inhabitants. Having low productivity and potential, the people they support remain largely marginalized. Over-grazing and the transformation to cropland are major causes of productivity loss, leading to widespread land degradation and desertification, compounded by climate change. The first step in any rangeland rehabilitation/restoration intervention should be to assess rangeland condition. Given the dynamic nature of plant community responses to climate fluctuations and man-made disturbances, there is a need for both short and long-term monitoring of rangelands.

Until recently, rangeland assessments have been more subjective than objective. Ground cover is a key indicator of rangeland condition and influences rangeland management decisions. Cover parameters are typically recorded by field personnel using field sampling techniques. Monitoring requires repeated observations, which are stretched over vast areas of land, requiring a lot of resources. Due to the cost and subjectivity, the result is a reduction in the frequency and confidence of traditional monitoring. Fortunately, with the advances in geo-spatial and electronic technologies new opportunities for vegetation and ecosystem monitoring have been created.

Methods used and partnership set up

Ground-level photography has been used for many years to document rangeland condition. However its broader application was limited without knowing exactly where photos were taken. The integration of GPS into digital cameras has expanded the possibilities for rangeland monitoring. Scientists at the International Center for Agricultural Research in the Dry Areas and in collaboration with Oregon State University have been developing digital tools and protocols for monitoring rangeland vegetation in dry areas.

The technique called digital vegetation charting technique employs an automated classification of digital images using VegMeasure®. VegMeasure® is a non-commercial software that allows accurate analysis of vegetative ground cover (Louhaichi et al., 2010). Field-based images can be taken using a digital camera with built in GPS mounted on a stand. Images can be batch processed rapidly. This approach is less labor intensive, less biased, provides a permanent record for future scrutiny, is non-destructive, more efficient, and is repeatable (Booth et al., 2005; Louhaichi et al., 2010). The digital camera with built in GPS capability must be held at a fixed height above the ground, pointing vertically downward in the same direction.

Results

This method reduces the time, cost, and subjectivity of traditional monitoring. Previously, hand charting of vegetation in quadrats, a very time consuming and tedious method, was used to collect cover estimates in the field. VegMeasure speeds-up this process and provides long term datasets than can be revisited. Furthermore, the protocol standardizes the measurement process so that results are more uniform and reflective of the condition of vegetation growing on a site. We compared technician estimates of plant cover (green leaf, litter, bare ground) between technicians and against the VegMeasure classified image. Result indicates that there was a high amount of variation between technicians in traditional monitoring, due to the fact that estimation of cover is highly subjective, VegMeasure reduces the variance between technicians. Monitored areas can be revisited each season or year to assess the spatial and temporal effect of natural and human induced factors. The images become a valuable data set that records and characterizes the condition of the range at a specific locations and time to document change and range trend.

Easily generated detailed time series maps are needed to measure the impact of management and policy decisions as well as contribute to agricultural information systems. Current methods of assessing change and differences in range trend and rangeland health rely heavily on professional interpretation. The addition of data quantification provides an important tool as land management agencies transition from collecting data primarily as a guide for internal management decisions to data sets that address both management and litigation concerns. This method is a continual work in process to achieve these ends. VegMeasure can also detect pant stress such as the deficiency of phosphate or herbicide application (Preuss *et al.*, 2012; Louhaichi et al., 2013).

Outcomes

More detailed rangeland condition maps help land managers, development projects, and migratory pastoralists monitor, assess and manage their natural resources in arid and semi-arid rangelands in an improved manner. The suggested protocols and tools provide valuable information for assessing the impact of climate change, livestock/wildlife grazing, spread of degradation/desertification rates and thus, improve rural community livelihoods. More detailed maps on greenness are just the first step. This method can be coupled with further field measurements that can provide detailed maps of biomass and palatability. This information is essential to inform carbon markets, livestock insurance schemes, and to assist pastoralists in their decision making.

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EVALUATION OF LAND DEGRADATION AND DESERTIFICATION: IMPLEMENTATION OF A NATIONAL SYSTEM OF MONITORING AND ASSESSMENT OF LAND DEGRADATION AND DESERTIFICATION IN ARGENTINA

ABRAHAM, Elena (1); ABRIL, Ernesto Guillermo (2); BRAN, Donaldo (3); CASTRO, Mora (4); CORSO, Maria Laura (5); CUEVA, José (5); MACCAGNO, Patricia (4); MACEIRA, Néstor (3); MAGGI, Alejandro (6); MASSOBRIO, Marcelo Juan (6); PIETRAGALLA, Vanina (5); RUBIO M.C.

1: National Research Institute of Drylands (IADIZA-CONICET); 2: Center for Surveying and Assessment of Agricultural and Natural Resources (CREAN), University of Córdoba; 3: National Institute of Agricultural Technology (INTA); 4: National Scientific and Technical Research Council (CONICET); 5: Secretariat of Environment and Sustainable Development, Argentine Republic; 6: School of Agriculture, University of Buenos Aires (FAUBA)

atherburg@mendoza-conicet.gob.ar

Rationale

Land degradation is a widespread phenomenon in almost all ecosystems in Argentina. It is mainly caused by overuse of rangelands, agricultural expansion, agriculturalization, and deforestation (LADA-FAO, 2011; Manuel-Navarrete et al., 2005). Several initiatives have successfully addressed this problem in various regions of Argentina (LADA-FAO, 2011; INTA-GTZ, 1995). These projects highlight the need for efforts toward coordinated assessment, monitoring, and mitigation strategies of land degradation and desertification at the national level. To this end, the Secretariat of Environment and Sustainable Development (SAyDS), the National Scientific and Technical Research Council (CONICET), the Argentina Institute for Arid Zone Research (IADIZA), the National Institute of Agricultural Technology (INTA), and two national universities founded the *National Observatory of Land Degradation and Desertification* (ONDTyD) in 2011. Its main objective is to establish a national network for permanent bio-physical and socio-economic monitoring and assessment of land degradation and desertification in order to better inform decision making and policy development in land-use planning and management (Pietragalla et al., 2013).

Methods used and partnership set up

The founding institutions of the ONDTyD presented the project and established its organization and the internal regulation. These institutions are all part of the steering committee and work together with other agencies on the advisory council. Several national workshops were launched to create networks linking the political, scientific, and technological sectors at regional and national levels as well as non-governmental organizations working on this issue.

In addition to building partnerships, members of the network designed the methodology for the national system of monitoring and assessment. The system is based on the experience of Land Degradation Assessment in Drylands in Argentina (LADA-FAO, 2011) and the system of integrated assessment of desertification (Abraham et al., 2006) as well as many other related projects, including ones in Patagonia (INTA-GTZ, 1995).

Figure 1 shows the methodology, which was agreed upon by ONDTyD's steering committee and the advisory council. It is characterized by a participatory and holistic approach that considers local, regional, and national levels. The scheme highlights the importance of pilot sites in generating local information that can be extrapolated to regional level. It also shows the role of the members of the steering committee and the advisory council, who are in charge of compiling and reporting data at the national level and directing work on specific topics. Together they are the primary actors in the ONDTyD.

Results

Currently, 17 pilot sites are working in coordination to monitor and assess bio-physical and socio-economic indicators of land degradation, which represent almost all of Argentina's ecosystems. In order to acquire comparable data, a minimum set of bio-physical and socio-economic indicators were selected through a local and national participatory process (fig. 1). Each study site

also monitors specific indicators to local degradation processes and socio-economic impacts.

The socio-economic indicators that the pilot sites must report are organized into the following categories of capital: human (e.g., education completion rates, illiteracy rates, local rates of principal illnesses), social (e.g., participation of herders and farmers in civil organizations, social programs), physical (housing quality, forms of land ownership, household access to water), and financial (household income, access to government subsidies or credits). A specific field survey was developed for collecting this data.

Bio-physical assessment and monitoring at the pilot sites is carried out at different levels. It consists of a field survey on the state of water and wind erosion, soils, and vegetation. It also involves establishing at least five monitoring plots at each pilot site, in which soil, vegetation, and water trends are monitored. Each site quantifies wind erosion with sediment samplers and will acquire a weather station. The bio-physical study is completed through the analysis of satellite images.

At the national scale, members of the ONDTyD deliver the two impact indicators required by the UNCCD: *land cover status* and *proportion of population living below the poverty line*. A current study shows the temporal trends in the normalized difference vegetation index (NDVI), based on MODIS sensor data for 2000-2014. Selected socio-economic indicators and indices are being developed.

These results are presented with general information, interactive maps, and an open-source server for sharing geospatial data on a website, http://www.desertificacion.gob.ar.

Outcomes

The *National Observatory of Land Degradation and Desertification* is a successful example of a partnership built across political, scientific, and technological sectors in Argentina. More than 30 institutions and 150 professionals all over Argentina are part of the network and create close links between sectors during assessment and monitoring, all of which produces knowledge that feeds directly into the policy process.

The activities of the ONDTyD are of particular interest in achieving UNCCD's mandates, especially in presenting required indicators. Notably, it has attracted great interest and financial support from non-governmental organizations.

IDENTIFYING AND MAPPING LAND DEGRADATION DUE TO WIND EROSION IN DRYLANDS: THE POTENTIAL OF SAR-BASED SATELLITE DATA

DEL VALLE, Hector Francisco (1); BLANCO, Paula Daniela (1); HARDTKE, Leonardo Andres (1); BOUZA, Pablo Jose (1); ROSTAGNO, Cesar Mario (1); METTERNICHT, Graciela I. (2); ZINCK, Joseph Alfred (3)

1: CENPAT (CONICET) Argentina; 2: Institute of Environmental Studies (IES) University of New South Wales (UNSW) Australia; 3: University of Twente, Faculty of Geo-Information Science and Earth Observation (ITC) Netherlands

delvalle@cenpat-conicet.gob.ar

Drylands land degradation is a major environmental issue of the 21st century because of its impact on food security and environmental quality (MEA, 2005). Remote sensing provides meaningful spatial data for mapping and monitoring drylands land degradation in. Synthetic Aperture Radars (SAR) offer a considerable potential to identify and map wind degradation features due to the impact wind-driven land degradation has on surface roughness.

This paper discusses the use of SAR data for detecting and interpreting attributes of terrain surfaces, including vegetation cover that can be used as proxy for mapping land degradation in drylands. We show the dependence of the radar backscatter upon four primary factors: surface roughness, soil moisture, local incidence angle, and vegetation cover.

Observations on wind-driven degradation processes were performed over a pilot area of northeastern Patagonia (Argentina). A set of 19 SAR images were used from: SIR-C (1), ERS (4), ENVISAT ASAR (2), RADARSAT-1 (4), COSMO-SKYMED (4), and ALOS PALSAR (4). Satellite data were converted to polarimetric imagery, georeferenced and co-registered to analyze the synergistic effect of various polarizations and incidence angles for detecting land degradation features. Gamma Map, Mean, and Lee polarimetric filters were used for speckle suppression. The relationships between backscatter (s^0) and biophysical properties were analyzed for the following land cover classes: scald-scabby deflation areas, cliff scarps (wind abrasion), discontinuous thin aeolian mantles in gravel plains, inter-dunes, closed scrubs, mosaic grass-scrub steppe with/without deflation areas, old track sand dune, and active sand dune megapatches. We used ANOVA and Tukey's multiple comparison tests to evaluate the significance of differences between means backscatter of the land cover classes.

A total of 200 field training sites were revisited and photographed to document degradation features. Past wind erosion was identified using visual field indicators such as bare soil surfaces, deflation hollows, desert pavements, wind scours between plants, etc.

The radar wavelengths and polarizations that improve the contrast among the dunefields and the surrounding sand mantle of the gravel plains are (in descent order): L-HV (SIR-C), L-HH (SIR-C and ALOS PALSAR), C-HH (RADARSAT-1), and X-HH (COSMO-SKYMED). Our findings show that L-band penetrates deeper in the soil mantle, and it is more sensitive to surface roughness. This may be because interdune areas are usually covered by a crust of fine particles and salts, and the terrain surface is modified by wind ripples (2–5 cm height), causing roughness that is well captured by the L-band.

Sand dune megapatches were better discriminated in C-bands from ERS-2, ENVISAT ASAR, and RADARSAT-1 images. Smaller look angles (≤35°) tend to enhance the discrimination of these areas. Indeed, ENVISAT ASAR images appeared to have higher radiometric dynamics that allows better discrimination.

Linear sand dunes are well delineated in C-band images. They have dark to intermediate gray tones in C-VV images likely due to the deposition of windblown material, which absorbs the radar signal and produces a lower digital number (Greeley et al., 1997). Comparatively, they appear slightly brighter in C-HH images.

Stabilized sand deposits have clearly defined edges on L-band from SIR-C and ALOS PALSAR radar images. Field observations indicate that they were deposited as sand sheets and large dunes. Thin white lines are bright reflections from steep sand ridge crests. The sand ridges, now

smoothed and partially reworked, seem to have derived from a mixture of active and inactive barchanoid ridges and parabolic dunes. This suggests that there is a transition between both dune types as the vegetation cover increases (Duran et al., 2008). That is a clear example of deactivation of migrating dunes under the influence of vegetation.

Analysis of COSMO-SKYMED data shows that co-polarized data (X-HH) are more responsive to surface roughness or volume scatterers on the scale of band's wavelength while cross-polarized data (X-HV) are most responsive to the geometry or texture of surface or volume scatterers. The sand surface is smooth relative to the surrounding gravel plains and calcareous soils and appears dark in radar image.

In this study, we have explored the potential of different SAR sensors for estimate degradation features. We used SAR SIR-C, ERS/SAR, ENVISAT ASAR, RADARSAT-1, COSMO-SKYMED and ALOS PALSAR data. Our findings suggest the use of multisensor radar data can provide complementary landscape information to enable accurate identification and mapping of land degradation caused by wind erosion (Figure 1). This additional information could improve current global maps of land degradation such as provided by the Land Degradation Assessment in Dryland (LADA) or Global Land Degradation Information System (GLADIS) projects, whereby proportion of degraded landscapes are reported, without identifying the 'causes' of land degradation. The latter is however a piece of information significant in the design and implementation of action plans and strategies to address land degradation. Furthermore, this research shows satellite-based SAR data could be used in monitoring and evaluation of land degradation action plans (e.g. re-vegetation of dunes; restoration of desert vegetation).

THE IMPACT OF LAND USE CHANGE ON THE 3-D STRUCTURE OF SHRUBLAND AND DRYLAND SAVANNA ECOSYSTEMS

WASHINGTON-ALLEN, Robert A. (1); LOUHAICHI, Mounir (2); MUDE, Andrew (3); LIAO, Chuan (4); CLIFTON, Kathryn M. (2); CLARK, Patrick E. (5)

1: Department of Geography, University of Tennessee, 304 Burchfiel Bldg, Knoxville, TN 37996,USA; 2: CGIAR/ICARDA, P.O. Box 950764, Amman,11195, Jordan; 3: CGIAR/ILRI, P.O. Box 30709, Nairobi, Kenya; 4: Department of Natural Resources, Cornell University, 309 Fernow Hall, Ithaca, NY 14853, USA; 5: United States Department of Agriculture, Agricultural Research Service, Northwest Watershed Research Center, 800 E. Park Blvd., Suite 105, Boise, ID 83712, USA

M.Louhaichi@cgiar.org

Rationale

Drylands cover 41% of the terrestrial land surface and provide $1 trillion in ecosystem goods and services to 36% of the global population. However the degree of Dryland degradation is largely unknown, particularly the impacts to carbon stocks such as livestock forage from droughts and land use practices. Subsistence pastoral societies are particularly vulnerable due to interactions between livestock and carbon stocks where drought induced reduction of carbon stocks may result in widespread livestock mortality, then famine, and thus human mortality. Newly implemented livestock insurance programs in northern Kenya and southern Ethiopia may provide avenues for stock replenishment and thus renewal of livelihoods in global Drylands. However, robust indicators of livestock mortality due to drought-induced forage loss are required. Terrestrial laser scanning (TLS) or ground light detection-and-ranging (LIDAR) is a remote sensing technology that has been successfully used in Dryland ecosystems to assess changes in the three-dimensional (3D) structure of soil and vegetation, including soil sediment loads and vegetation biomass (Olsoy et al., 2014a, b), that are diagnostic of impacts from grazing, drought, fire (Delgado et al. 2012), and wind and water erosion (Li et al. 2010). Consequently, local scale TLS linked to regional scale satellite imagery may provide an indicator of critical forage loss due to drought.

Methods used and partnership set up

The University of Tennessee's Dept. of Geography in collaboration with ICARDA, ILRI, USDA-ARS, and Cornell University's Dept. of Natural Resources collected TLS data in the cold desert shrub-steppe ecosystem of the East Bank Plateau of Amman, Jordan and in mixed *Acacia-Commiphora* woodlands of Borana Plateau in southern Ethiopia. ICARDA and ILRI maintain these research sites and conduct field studies in Jordan and Ethiopia, respectively. The study plots are the size of a Landsat pixel (30-m X 30-m) to link local scale TLS to regional scale satellite imagery. A paired-plot: shrubland restoration versus cropping, and livestock grazing was conducted in Jordan and 3-levels of livestock grazing, i.e., high, moderate, and no livestock grazing (a conservation fodder bank) were compared in 4 different villages in southern Ethiopia. We used a FARO Focus 3D X330 with built in GPS, a high resolution digital camera, and a 905-nm scanning laser at approximately 1 million points s^{-1} at 7-mm spacing per 10-m range over a 650-m radius through 360° in the horizontal plane and 300° in the vertical. This scan spacing resulted in 28 million total points per scan. Each scan has a range accuracy of ± 2-mm with a spot size of 4.5-mm diameter. Four cardinal direction and 1 plot center scan were taken per site for a total of 10 scans from the paired plots and 61 scans from the villages.. Vegetation structure, including height, volume, crown and basal area, diameter-at-breast height (dbh) ,canopy cover, leaf area index (LAI), & plant density and soil structure, including topography can be directly measured using TLS. Biomass and sediment loss, i.e., soil erosion are indirectly estimated using allometric equations that use height. A Kolmogorov–Smirnov (K-S) tests was conducted on the height diversity histograms of the vegetation point clouds at each site, which is representative of the foliage profile, to test the null hypothesis that different land uses do not impact land cover.

Results

Volumetrically, the cold desert shrub steppe of Jordan intercepted 14% of the 28 million points emitted. The mixed *Acacia-Commiphora* woodlands intercepted 36% of the points, suggesting that there is greater leaf area or biomass in the savanna ecosystems than in the shrublands. K-S tests indicated significant differences in vegetation height diversity between the study sites in Jordan (open access = one-level canopy and lower height compared to restored site = two-level canopy and greater height) and Ethiopia (fodder banks > height than moderate and high intensity grazing sites, Figure 1). Shrubs covered < 5% on the grazed/cropping open access site and < 30% on the restored site in Jordan. Additionally, the restored site showed greater surface roughness than the open access site that is indicative of the action of wind and water erosion.

Outcomes

This research has quantified the impact of different land uses on forage availability or changes in carbon stocks that are relevant to subsistence pastoralists. Such information can inform agro-ecological models and can be linked to broader implications for management decisions. The development of sound policy is dependent on improved information for management decisions. This research will also assist future work in arid lands by determining the best indicator and methods for vegetation measurements with ground and airborne LiDAR systems in Drylands. With this information other Dryland sites will be scanned and their ecological and degradation status will be determined.

Acknowledgements

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MAPPING SYSTEM FOR LAND DEGRADATION ASSESSMENT IN THE SAHEL COUNTRIES OF WEST AFRICA: CASE OF BURKINA FASO

SOULEY YERO, Kadidiatou (1); BOTONI, Edwige (2); SUBSOL, Sébastien (1); ALFARI, Issifou (1); BOUAFOU, Kouamé Guy Marcel (1)

1: Agrhymet Regional Centre, Niger; 2: Inter-State Committee to Fight against Drought in the Sahel

yero_kadidia@yahoo.fr

Rationale

This work is part of the problematic of implementing mapping system for monitoring and assessing the status of land degradation in CILSS/ECOWAS countries.

The Sahel region of West Africa and the northern part of Gulf of Guinea countries are increasingly confronted with the phenomenon of desertification and land degradation.

These phenomena result from climate change dynamics ongoing since the late 1960s. Anthropogenic factors also play a role in accelerating desertification. According Ruelland et al (2011), the Sudano-Sahelian regions are characterized for over 50 years by agricultural and pastoral activities that have led to increased pressure on natural resources, in line with the increase in population.

In this context of environmental and climate change several initiatives emerged. This work is one of the initiatives and is part of the Regional Program for Sustainable Land Management (RPSLM) of the Inter-State Committee to Fight against Drought in the Sahel. It favors earth observation data for the assessment of the status of land degradation in order to support the sustainable development policies of natural resources.

Methods used and partnership set up

The research aims to develop an interactive mapping system of land degradation in six CILSS / ECOWAS countries. This system is based on the model implemented by our colleagues of IGAD Climate Prediction and Applications Centre of Nairobi in East Africa (ICPAC). In this paper we present the case of Burkina Faso.

The data from Earth observation satellites are used to conduct the study of evaluation of the status of land degradation. They are combined with socio-economic data.

The system uses five types of input data: The Normalized Difference Vegetation Index (NDVI), land use land cover maps, rainfall data, a digital terrain model (slope percentages and slope lengths), soil texture, soil gravel content and soil water holding capacity, human population and livestock.

Input data are integrated into a GIS to calculate the intermediate products from which biophysical and socio-economic indicators are developed. These indicators are grouped into two categories: structural and conjunctural indicators. They are then used as elements of land degradation assessment.

The input layers and the indicators are weighted depending on the impact of these factors on land degradation according to the context of each country.

A partnership is established between the Agrhymet Regional Centre (CRA) and institutions within the ministries in charge of environment and sustainable development at country level. The system will be installed in these structures and be updated on an annual basis.

Results

This work led to the development of evaluation indicators of land degradation (figure 1). These indicators highlight the risk of land degradation and provide an estimate of degraded lands. These are socio-economic factors, soil erodibility, the topographic index, the index of vegetation and rainfall erosivity.

From these indicators two indices are elaborated: a potential land degradation index and a conjunctural index measuring annual factors contributing to land degradation.

The potential land degradation index map is made from the combination of physical and socio-economic factors. It highlights areas of structural risks of degradation. For the decision maker, it indicates where action can be taken to prevent or mitigate these phenomena.

The conjunctural land degradation index map results from the combination of the first index and two annual indicators: vegetation index and rainfall erosivity. It shows the areas most likely to be affected by land degradation for a given year.

The estimate of land condition for the year 2013 for the study area reveals that 8% of the area are not degraded, 14 % are very moderately degraded and 28% moderately degraded. Areas occupied by high or severe degradation represent 18% and 32% respectively, which means 50% of the total study area.

The results show that areas with less important degradation are associated with national parks and low population density. Areas with high degradation levels are mainly located in the north central densely populated area.

Outcomes

The implementation of the mapping model provides interesting information on the status of land degradation. The result shows across the country the rank of affected areas by land degradation from the lowest to the highest level. The products serve as tools for policy makers and financial partners to intervene in the areas affected by these phenomena in order to restore the land and take actions to protect areas at higher risk of degradation.

The annual update of the model will also allow assessing the impacts of policies and measures taken to reverse desertification and land degradation.

AN APPROACH TO THE ASSESSMENT OF HISTORIC TRENDS OF LAND DEGRADATION INDICATORS AT NATIONAL SCALES: USE OF MODIS AND AVHRR COARSE RESOLUTION VEGETATION PRODUCTS FOR MAPPING IN ETHIOPIA

PONCE-HERNANDEZ, Raul; AHMED, Oumer

Applied Geomatics Remote Sensing and Land Resource Laboratory, Environmental and Resource Science Program and Department of Geography, Trent University, Peterborough, Ontario, Canada

rponce@trentu.ca

Rationale

Significant concern about the ability to assess, map and monitor historic trends of land degradation and the onset of desertification at national scales with commonly-available data, particularly in non-data-rich environments, prompted the development of the methodology described in this paper. The methods are derived from those in Ponce-Hernandez and Koohafkan (2010) mofofied through a comprehensive analysis of historic trends from 22 years (1984 to 2006) of land degradation at national scale, integrating remote sensing-derived land degradation indicators, namely: normalized difference vegetation Index (NDVI), net primary productivity (NPP), rainfall use efficiency (RUE), energy use efficiency (EUE) and aridity index (AI) in Ethiopia. Both climatic data and coarse resolution satellite observations of vegetation activity at national scale were integrated. The trends revealed by the indicator variables serve as the baseline for future assessments of land degradation and desertification under climatechange. The advent and increase of satellite-based earth observation programs and of freely available data products of coarse resolution (e.g. MODIS and AVHRR) are utilized in the development of these procedures. Their validity is demonstrated with results from Ethiopia.

Methods

Land degradation is measured in terms of land productivity decline or improvement over time. The Global Inventory Modelling and Mapping Studies (GIMMS) 8 Km resolution Normalized Difference Vegetation Index (NDVI) data set for six periods every four years, between 1984 and 2006 for Ethiopia were used in this study. The GIMMS NDVI time series was translated to NPP using MODIS NPP data. NPP was estimated by computing an empirical linear regression model between MODIS annual NPP values and NDVI for the overlapping years of the GIMMS and MODIS data sets. The model fitted to this fairly large dataset consisting of 1,189,285 data points, was then employed to calculate NPP change for the entire country over the 22-year period. Raster maps of NPP spanning the 22 years (1984 to 2006) over the entire country were derived from the national coverage of NDVI images. Change in NPP in Ethiopia was identified and the areas of degradation and improvement in the country mapped. RUE was estimated from the ratio of the estimated annual NPP to the total annual rainfall (P) gridded to 0.5° lat / long. EUE is calculated from the annual NPP coverage to the mean monthly annual accumulated temperature (T). The Aridity Index (AI) was computed using gridded meteorological data. The computed RUE, EUE and AI over the years allowed the identification of areas of degradation, improvement and no change in the country. The outputs from all of NDVI, NPP, RUE, EUE and AI, were combined into one map to identify aggregate areas of degradation, no change and improvement, integrated for all indicators.

Results

The results show each of the land degradation indicators individually and combined and are shown in Figure 1. These results indicate that over the period from 1984-2006, NPP experienced a decreased trend overall in the country. High aridity trends are found in portions of the Awash watershed (north-eastern part of the country), the eastern and in parts of wester low lands. About 74% of areas of negative AI are also areas of negative RUE-adjusted NPP and negative EUE. This combination of negative trends in indicators, results in a slight increase in degrading areas in the country. The degrading areas based on AI are limited to a patch of areas in the eastern low lands. Integrating all indicators into one single map, aggregate areas of improvement and degradation

are obtained. Then, further expansion of degrading areas are accrued by adding those "new" areas of degradation contributed from the maps of RUE, EUE and AI indicators in order to get the final map of aggregate areas of degradation and improvement. Figure 1 shows the identified aggregate areas of degradation and improvement using all the combined indicators.

Degrading areas, showing decline in all indicators occupy 30 per cent of the country. These areas are located mostly in the south-eastern low lands and in the northern part of Awash watershed, suffering an average loss of NPP of 10.3 kg C ha^{-1} yr^{-1}. About 86% of the Ethiopian population (52.7 million out of 61.5 million) lives in these degrading areas. Land improvement, defined by the joint increase in all indicators, namely: NDVI, NPP, RUE, EUE and AI, was identified in 47% of the national territory, mainly in areas located in the western and central part of the country.

Outcomes

It was concluded that available archival coarse resolution vegetation products from the MODIS and AVHRR programs, proved quite useful in the analysis and mapping of historic trends of land degradation indicators in national scale assessments, when combined with relevant climatic data. This methodology and procedures are non-demanding in terms of data requirements, accessibility and availability, but intense in terms of data processing. However, they are transferable to other regions of the world.

MONITORING AND INTEGRATED EVALUATION OF CHANGING LAND PRODUCTIVITY DYNAMICS IN RELATION TO CRITICAL ISSUES FOR COMBATTING LAND DEGRADATION – THE WORLD ATLAS OF DESERTIFICATION APPROACH

CHERLET, Michael (1); IVITS, Eva (2); KUTNJAK, Hrvoje (1); SMID, Marek (1); SOMMER, Stefan (1)

1: European Commission, Italy; 2: European Environment Agency, Denmark

stefan.sommer@jrc.ec.europa.eu

Background and Rationale

The Joint Research Centre of the European Commission (JRC), jointly with UNEP and supported by a global network of international research institutions, are developing the new World Atlas of Desertification (WAD) in support to enhanced implementation of the UN Convention to Combat Desertification (UNCCD). WAD is considered to become a source of baseline information to improve the implementation of the new UNCCD progress indicator reporting as decided at the last UNCCD COP 11 held in September 2013 in Windhoek Namibia (UNCCD 2013, COP11 Decision 22/COP11). Further WAD is envisaged to contribute to designing solutions for the implementation of the post Rio +20 process on obtaining new global Sustainable Development Goals (SDGs), in particular a potential goal on 'striving towards a land degradation neutral world'.To address these complex global challenges, a monitoring and assessment capacity offering up-to-date information on the status and trends of land degradation and their causes and effects is under development as routes for possible solutions need to be offered.

Methodology used

Building on numerous studies that use time series of remotely sensed vegetation indices (e.g. NDVI, Fapar) as base layer, we expand this set of variables by calculating phenological metrics from time series of the vegetation index. De-convolution of the original time series into phenological metrics yields additional information on various aspects of vegetation/land cover functional composition in relation to dynamics of ecosystem functioning and land use (Ivits et al., 2012a). Using these vegetation phenological metrics can provide a quantitative basis to monitor such information on ecosystem dynamic equilibrium and change, envisaged to provide users with an independent measure on how ecosystems respond to external impacts, be it human induced or natural variability (Ivits et al., 2012b).

The resulting remote sensing derived spatial layers are then combined with ancillary bio-physical and socio-economic information in order to flag areas that actually show signals of actual land degradation. This includes attributions to different levels of intensity and probability of major causes, which will include major land degradation/desertification issues and the associated land use transitions as summarised and shown in table 1 below (Sommer et. al., 2011)

Overuse of agricultural land, intensification, inappropriate agricultural practices/non-SLM, increased soil erosion

Increase in intensive irrigation, overuse of water resources, salinization

Grazing mismanagement, overgrazing and decreasing NPP in rangelands, soil degradation, sand encroachment

Deforestation

Increased aridity or drought

Socio-economic issues, changes in population distribution and density, rural migration/land abandonment, urban sprawl

Uncontrolled expansion of mineral mining and industrial activities, extensive air and water pollution by waste materials, soil loss by contamination

Outcome and Conclusions

Analysis of long-term changes and current efficiency levels of vegetative or standing biomass are combined into land-productivity dynamics according to the scheme presented in figure 1. The work presented in this paper proceeds according to this scheme as follows:

Analysis of long-term changes and current efficiency levels of vegetative Standing Biomass are combined into land-productivity dynamics. Output from both the Long-Term Change Map was combined with start levels and state change of productivity and with the potential productivity map, based on the Local Net Scaling approach (Prince et al., 2009).

This processing chain has been applied at global levels and resulted 5 classes indicating areas of negative, positive change or stability of land productivity dynamics which is interpreted as indicator of change or stability of the land's apparent capacity to sustain the dynamic equilibrium of primary productivity in the given observation period, which is further analysed in relation to available information on land use and environmental change relevant to the issues listed above.

The dynamics of the Earth's covering biomass, or standing biomass, is a good expression of the general level of the potential to supply, or keep on supplying, ecosystem services. Assessing vegetative cover dynamics approximates a measure for general productivity levels of the land's human-environment system. Land-productivity reflects climatic constraints, the overall quality of the land, the efficiency of using the land and other resources and it indirectly indicates the level at which these resources are appropriated for human use, i.e. land used for intensive/extensive agriculture, grazing, forestry or urban areas. Hence, land-productivity dynamics might indicate levels of lost or sustained land-quality and may aid in land degradation assessments

MONITORING SHRUB ENCROACHMENT IN AN AFRICAN SAVANNAH USING A LANDSAT TIME-SERIES APPROACH.

HIGGINBOTTOM, Thomas P; SYMEONAKIS, Elias

Manchester Metropolitan Univeristy, United Kingdom

t.higginbottom@mmu.ac.uk

The encroachment and proliferation of woody shrub species into grassland or savannah ecosystems results in major carbon and ecosystem-service provision consequences (Eldridge *et al.*, 2011). It is therefore imperative that savannahs and grasslands are effectively monitored to prevent continued degradation. To date there have been relatively few attempts to map and monitor shrub encroachment on a large scale (Asner *et al.*, 2003). Consequently, the timings and magnitude of shrub encroachment in many localities is poorly understood. Satellite-based remote sensing offers a viable option for continued monitoring of large areas. However, progress in utilising satellite imagery has been hindered by the restrictive data policies and intensive computing demands of using the large volumes of data required. Since 2008, the freely available Landsat archive, combined with advances in computing technology and analysis techniques, has made spatial and temporally intensive environmental monitoring systems feasible (Kennedy *et al.*, 2014). Here we demonstrate a methodology for the monitoring of shrub encroachment using a Landsat-based time-series approach. We test this method in a heavily studied locality, the Kruger National Park (NP), South Africa, to ensure reliable validation is undertaken. It is envisaged that the procedure outlined here may be extended as a component of a wider desertification monitoring system across the region.

We generated annual composite mosaics of the entire Kruger NP using Landsat-derived Essential Climate Variable data. This data is provided by the USGS as Top-of-Canopy values corrected for atmospheric effects and clouds. A time-series of annual imageries was available from 1990-2008, using images obtained from January-March in order to capture the peak growth season. We used orthophotos obtained from the National Geo-spatial Information to train a predictive Random Forest model for shrub cover. Aerial photography is well established as a reliable method for quantifying shrub cover in dryland regions (Browning *et al.*, 2009). This predicative model was implemented on each annual mosaic, resulting in an 18-year time series of shrub cover estimates. These annual layers were then analysed using a time-series segmentation algorithm: Landsat-based Detection of Trends in Disturbance and Recovery (LandTrendr) (Kennedy *et al.*, 2010). This methodology dissects each pixel's time series into a succession of approximately linear subdivisions, each representing a directional shift in spectral index response. These segments can be classified as shifts in vegetation and land cover, with timings and magnitude of events automatically calculated. The calculated trends were compared with field data from the Vegetation Condition Assessment (VCA) undertaken by the South African National Parks Authority on an annual basis (since 1996, 113 sites have had shrub biomass levels sampled).

The Landsat-based shrub cover trends generally agreed with the magnitude and direction of trends obtained from the VCA field surveys, with a mean correlation co-efficient of 0.68 across the 113 sites. This high correlation gives confidence to our method for estimating shrub cover using Landsat data. Spatially, shrub encroachment was found to be most evident on the southern section of the Kruger NP, with the southern granite biome being the most affected. Comparatively, the northern section of the park was shown to have little-to-no shrub cover expansion. Shrub-cover appears to expand quickest in periods of high rainfall, which follow years with bellow average rainfall. There is clear spatial autocorrelation of shrub encroachment, which is in agreement with studies that propose a positive feedback between continued expansion of woody shrub species.

Desertification is acknowledged as a major environmental concern. However, the absence of reliable assessment and monitoring strategies hampers the co-ordination of remediation and preventative measures. Shrub encroachment results in major ecosystem Carbon shifts, in addition to ecosystem function modifications. Thus, the inclusion of shrub expansion in desertification monitoring systems is essential. Here we propose a spatial and temporally intensive methodology for the monitoring of environmental change in savannahs. For the Kruger NP, shrub encroachment was identified as being most prominent in specific ecological and geological zones (the Southern Basalt region). This highlights the importance of considering the environment characteristics of localities displaying land-cover changes. Temporally intensive observation systems, such as ours, also have the benefit of highlighting the precursory conditions that may influence the pattern observed. In this case, shrub cover expansion was identified as most dominant in high rainfall years that followed low rainfall periods. Our methodology utilises free data, which is now provided in a readily useable format. The applicability of this technique has been demonstrated in a heavily studied region where considerable ground truthing data is present. The high level of agreement between the remote sensing estimates and field analysis, for both annual estimates and temporal trends, in shrub cover makes the large-scale implementation of this method a possibility. It is envisaged that the methodology presented here may contribute to wider desertification monitoring systems in order to quantify the carbon implications of land use/land cover change in drylands, and how these are impacted by human actions.

THE USE OF REMOTE SENSING AND GIS TO DEVELOP SITE HISTORY FOR RESTORATION PLANNING AT DEGRADED ECOSYSTEMS IN AN ARID LANDSCAPE: UMM NIGGA, KUWAIT

ABDULLAH, Meshal M (1); FEAGIN, Rusty A (2); MUSAWI, Layla (3); WHISENANT, Steven (4); POPESCU, Sorin (5)

1: Texas A&M University, Dept. Ecosystem Science and Management, Texas A&M University, College Station, TX 77845, USA; 2: Texas A&M University, Dept. Ecosystem Science and Management, Texas A&M University, College Station, TX 77845, USA; 3: 3Kuwait Foundation for the Advancement of Science KFAS, Kuwait City, Kuwait; 4: Texas A&M University, Dept. Ecosystem Science and Management, Texas A&M University, College Station, TX 77845, USA; 5: Texas A&M University, Dept. Ecosystem Science and Management, Texas A&M University, College Station, TX 77845, USA

meshal80@live.com

Developing a site history and ecological site description is one of the critical steps in restoration planning. This study focuses on Umm Nigga, northeast of Kuwait, which, was damaged by various anthropogenic activities. The northern portion of Umm Nigga falls within the boundaries of the De-Militarized Zone (DMZ) adjacent to Iraq, and was fenced off to restrict public access since 1994. The central objective of this project was to utilize remote sensing, field assessment, and GIS spatial data to develop a site history for restoration planning of Umm Nigga. Field observation and GIS analysis indicated that the landscape could be divided into three units along a gradient ranging from the coast to inland locations, based on geology, soil properties, and dominant vegetation. Reference sites in the DMZ were also matched for each unit. Remote sensing was used to compare vegetation cover between damaged and reference sites at selected units. Results showed that vegetation cover increased in the unfenced damaged site after the 1991 Gulf War from 2% in 1988 to 37 % in 1998, but then it decreased to 23% in 2013. In the DMZ reference site, the vegetation cover also increased from 0% in 1988 to 40% in 1998, but it continued increasing through 2013 to 64%. We conclude that overgrazing and destructive camping are the major source of disturbance in the damaged areas.

THE ASSESSMENT OF FOREST DEGRADATION IN DRY FORESTED LANDS: MAPPING REGIONAL TREND INDICATORS OF DEGRADATION IN THE YUCATAN PENINSULA, MEXICO WITH SATELLITE DATA

ROMERO-SANCHEZ, Martin Enrique (1,2); PONCE-HERNANDEZ, Raul (1)

1: Applied Geomatics, Remote Sensing and Land Resources Laboratory (GEORESLAR), Environmental and Resource Science and Department of Geography, Trent University, Peterborough, Ontario, Canada; 2: National Institute of Forestry, Agriculture and Livestock Research. Mexico

mromerosanchez@trentu.ca

Rationale

Understanding the patterns of dry forest degradation over time and space is essential to determine condition and trends, and to design appropriate interventions and reversal of causative forces. Indicators of dry forest degradation that can be derived and from multispectral satellite data and field measurements can be computed and the trajectory of their changes over time mapped out in order to provide monitoring of forest condition and trends.

This paper shows how the free availability of satellite data from various platforms combined with a careful selection of forest degradation indicators and field measurements can be taken advantage of, to provide an accessible vehicle for regional monitoring of forest degradation in dry forests. The methods and procedures developed are transferable and can be used in similar forests in other regions of the world.

Methods

A paradigm for dry forest degradation assessment and monitoring is presented in this study. The methodological framework for Land Degradation Assessment in Drylands (Ponce-Hernandez and Koohafkan, 2010) is used as a basis for further methodological development, to assess and monitor degradation in dry tropical forests in the central part of Yucatan, Mexico. Freely available Remote Sensing imagery (Landsat TM and ETM+) are used as primary source of digital data to compute trajectories of Net Primary Productivity (NPP) and Canopy Cover (CC) over time (Kennedy et al, 2007) as primary indicators to show changes per pixel at 30 m resolution over 28 years (1986 to 2014), indicating changes in condition and trends of these forests and allowing for mapping the spatial patterns of these indicators over time, in order to identify priority areas for remedial interventions.

The MENDA-1 watershed and "Emiliano Zapata", Labna, Bombahaltun and 32-132-01-081 sub-watersheds as designated by (CONAFOR, 2013) in the Yucatan Peninsula, Mexico, were selected for this study. The areas sampled within each sub-watershed covers an average of 10 Km². The trajectory of NPP (g C m^2 y^{-1}) and CC of sample of pixels within each sub-watershed were analyzed in terms of the total values of the sample of pixels in each subwatershed. Both, NPP (g C m^2 y^{-1}) and CC (% cover) indicators were observed over time (Figure 1) to show condition and trends. The NPP computation followed a method based on a robust regression relationship (Ahmed, 2011) between existent MODIS NPP values for the area, and the Normalized Difference Vegetation Index (NDVI), computed from the imagery stack. Canopy cover is computed from the procedures suggested by Asner, et al (2009). Total values of sampled pixel areas for both indicators were then plotted against time to show graphically the trajectories, while the stacks of resulting images show their spatial patterns.

Results

The results from the trajectory analysis of forest degradation indicators (NPP and CC) show, over all timescales (28 years), a slight tendency towards forest degradation and decline, punctuated by cyclic oscillations of decline and recovery that indicates the cyclic nature of perturbations due to slash and burn agriculture. The long term trend as indicated by the slight downward trend of NPP (Figure 1) over the four sampled areas and over the 28 years is not significant, indicating the cyclic periods of disturbance (burn) and recovery (fallow) these dry forests are subjected to by the local populations. The cycle seems to take a 5 to 6 year return periods of slash and burn. These trends can be observed in Figure 1.

Outcomes

This study seeks to show a methodology for forest degradation assessment and monitoring, based on freely available multispectral satellite data (Landsat MS and ETM+) used for the computation of Net Primary Productivity (NPP) and Canopy Cover (CC) as the main indicators of forest degradation over time. The main feature of this methodology is its suitability for use in many regions of the developing world where more sophisticated and therefore data-rich and demanding procedures are not possible. The trajectories of these forest degradation indicators can be used as a tool for regional monitoring of forest condition and trends, enabling for the formulation of remedial action plans.

LAND COVER CHANGE DURING LAST DECADE IN MONGOLIA

SODOV, Khudulmur (2); NYAMTSEREN, Mandakh (1); NASANBAT, Elbegjargal (1); DOLJIN, Dash (2)

1: The Institute of Geoecology, Mongolia; 2: Environmental information center

maaggi@yahoo.com

Introduction

Nowadays land cover is a main criterion for determination of evolution in ecosystem over area and time within framework of global change. Therefore information about land cover widely used in agriculture, hydrology, forestry, land use planning and environmental impact assessment (Campbell J. B, 2002).

Due to changes in natural ecosystem land cover change study often used for research in environmental degradation, change trends. There are 2 methods such as "Seasonal land cover change", "Land cover change" for the study of land cover change. P. Coppin and others (2004) defined: Land cover change as one class interchanged completely to another, but Seasonal land cover change as change in quality not affecting in classification scheme. From this view point land cover change is a result of urbanization, expansion of cultivated area and wild fires, but seasonal change caused by climate change, pollution, annual and seasonal variations. Therefore in ecological research study those 2 changes in land cover might be used as consequences of some factors.

For the desertification assessment and monitoring study in Mongolia MODIS data based land cover map is a important source of information. For example, in the study of land cover change ecosystem condition can be assessed by shift of one class to the upper level class and will show implication of land degradation and desertification.

Methodology and data

Within framework of this study made land cover maps of year 2000 and 2010 using MODIS NDVI 250m resolution, 16 day composites of May to October and change detection analysis. The sequence of methodology includes: 1/ principal component analysis of 12 composites for each year, 2/ clustering using unsupervised classification of first component, 3/ supervised classification of clustered image to derive land cover classes. There are various methods of land cover change analysis and it shows that researchers are making different surveys in that direction. Change assessment methods divided like before and after classification, two different time periods, and long-term time series (Lunneta R. S., Elvidge C. D., 1999).

Land cover change assessment method for different time periods includes coincidence method, difference method, comparison method, linear analysis for 2 time periods, vector analysis, image regression, band combination analysis, vegetation indices difference method, principal component analysis, long-term classification method (Coppin P., Jonckheere I., Nackaerts K., Muys B., 2004).

Most studies considered one dimensional image difference method for change detection. This method based on subtracts between base year and target year, and in this case both images should be done by identical methodology, processing on same data. For the information derived from same source data by one methodology this method is most suitable, and positive, negative value presents changes, both null (zero) values presents unchanged pixels. In this study used one dimensional image difference method for land cover products of year 2000, 2010 in order to determine change directions. But for determination of level or extent of change at first, sorted out classes by its biophysical characteristics.

Results

Land covers change detection made by one dimensional image difference method between 2000 and 2010**.** Direction of changes assessed on change detection matrix. Comparison of year 2000 and 2010 shows up not so much changes and 56 percents of territory of Mongolia unchanged, But 21 percents of territory had positive changes, either improved by ecological order and has to keep this trend.

In spatial extent unchanged or positive changes happened in mountain steppe, forest steppe, and desert areas. In context of land degradation factor concludes: in those areas have only seasonal changes e.g. quality changes within classes, but not happened changes of classes to others.

Whereas negative changes, declination of ecological order happens on 23 percent of territory. Here during 10 year period is ongoing process of changing classes, and in context of desertification factor such processes are under influence of combined impacts of drought, wind and water.

In this study we made try to map land cover change by assessing quality and for this used sorted sequence of land cover classes by ecological characteristics. Land cover classes present natural zones and landscapes, therefore those were considered sorting classes by ecological significance. Result of this study presents about 28 percent of territory had more or less extent class declination. 24 percent had low, 2 percent had moderate, and 2 percent had strong very strong changes.

Conclusion

The land cover change analysis revealed that the changes or shifts from one land cover type to another appear speedily on the territory of the country. The most severe or rapidly changing type is grassland steppe ecoregions which considered as ecotone between mountain forests and desert landscapes. The quality of land is also a subject of degradation due to high pressure or livestock, variations in temperature and fluctuations in precipitation amount.

DISTRIBUTION OF MEXICAN POPULATION AND LAND DEGRADATION AND DESERTIFICATION

LECHUGA GAYOSSO, Lizeth Margarita (1); GÓMEZ DÍAZ, Jesus David (1); MONTERROSO RIVAS, Alejandro Ismael (1); GARCÍA, Jorge Luis (2); VILLEGAS, Joel (2)

1: Universidad Autónoma Chapingo, Mexico; 2: Comisión Nacional Forestal

al08117994@chapingo.mx

The land degradation and desertification decrease the life quality of the population mainly by the loss of enviromental services. In this study we determined the land affected by degradation and desertification of Mexico and then how the population is distributed in degraded or desertified areas.

The concept of land degradation is the loos of actual or potencial productivity or utility as a result of natural or anthropic factors (Eswaran et. Al., 2001) and desertification is the land degradation in dry lands with the UNEP criteria (1997) from the Aridity Index estimated with the Penman Method in Mexico (Gomez, et al., 2012),

To determinate the level of the land degradation and desertification we analyzed the conditions of the biotic, edaphic and hydric components using the criteria of the most limitative factor. The socioeconomic factor was also included in the study, considering the distribution of the population related to the different levels of land degradation and desertification. Also the different situations of the inhabitants were considered as: level of poverty, migration and human development.

The 90.7% of the country is affected by a certain level of land degradation where 47.8% of the total country surface is affected by a severe to extreme land degradation. The dry lands of Mexico represent 65.3% of the total surface and 59.2% of the total country surface is effected by desertification. Ninety eight percent of the total population (112.3 million of inhabitants) lives in areas with certain grade of land degradation while the 78.6% of the population lives in dry lands.

The population of urban areas represents 76.8% and only 23.2% lives in rural areas. Ninety seven percent of the population that lives in dry areas is under certain grade of desertification. Forty six percent the total population lives below the poverty line, and are distributed on the 71.5% of the severe and extreme land degradation areas. Only the 23.4% of the total population lives in areas affected by desertification. The migration from desertification affected areas is low, while the human development indices are high to medium high in 85.0% of the municipalities affected by desertification, that indicate that in the dry lands there are more opportunities of jobs and obtain a better income for the families. As expected, most of the population affected by land degradation and desertification lives in urban areas (villages with more than 2500 inhabitants).

PROMISES AND REALITIES OF SATELLITE DERIVED INFORMATION FOR DRYLANDS MANAGEMENT

ESCADAFAL, Richard (1); BEGNI, Gérard (2)

1: IRD / CSFD, France; 2: CNES, France

richard.escadafal@ird.fr

Images of drylands observed remotely, mainly from satellites, have been promoted as a unique source to assess and monitor the state and changes of this environment. Indeed, the number of images - more and more freely available- over those areas is growing almost exponentially. However the rate of their use does not seem to follow the same pace, at least for applications to drylands management. Taking some cases as examples, this communications aims at opening a discussion about this mismatch and at identifying ways to better tap into this large source of information.

Drylands most often cover wide underpopulated areas, with quite poor infrastructure. So, they are difficult and costly to survey and monitor by ground based techniques considering the revisit rate and means needed by environmental monitoring programs.

Satellites overfly those areas with clock regularity since the 70s and provide an ever-growing number of images. Long-time series observations begin to be available – a 'must' in desertification studies. Over those dry areas clouds are less frequent and thus the land surface is more often observed by the sensors that these satellites carry on.

A wide recent increase in the public use of RS and more generally spatial digital data can be observed. This present dramatic increase is largely due to free access through internet both to data and to some public domain geoprocessing software packages. Internet is bringing a technological breakthrough which is certainly critical in the use of RS derived products. Such innovative technologies, methods and systems are expected to develop quickly – indeed, this process already begun, often in a rather empirical way.

It should also be noted that low costs local remote sensing can now be achieved at the individual level by simple cameras mounted on small unmanned flying platforms becoming more and more affordable and popular.

Through several examples using various remote sensing (RS) data this communication illustrates the wide range of applications, from global survey (climate oriented), through regional drought monitoring (early warning oriented), to local trees mapping (project evaluation oriented). Welle established approaches using vegetation indices are presented, while the recent development of innovative instruments are discussed, for instance, SMOS satellite provides for the first time a direct and global access to the soil humidity, and thus to drought monitoring and essential information for drylands.

Despite their diversity this list of examples cannot be considered as an exhaustive review. Nevertheless, as of to-day, operational and scientific success stories are numerous enough to draw up a general picture of the various uses of RS products derived methodologies. It can be shown how methods using RS have in some cases reach maturity and are now used operationally by local or regional actors, delivering unique information to users and decision makers. In many other cases these data and methods have been fruitfully used in research projects, leading to scientific publications, however they remained confined to the academic circles.

The present availability and affordability of RS products plus the dramatic extension of Internet based technologies widely broadens the possibilities to take advantage of this source of information. Such a situation also increases the need to take benefit from lessons learned and from expertise and investments gradually accumulated in the last 40 years. In the discussion it is foreseen to collect feedback from various stakeholders: decision makers, operational users, new technology developers, scientific community, 'capacity building' actors, civil society representatives… These inputs and discussions shall be synthesized to draw up conditions necessary to a more successful use of spatial data in the near future for sustainable management of drylands and above all for the benefit of their inhabitants.

DROUGHT AS AN INTERNATIONAL DISASTER AND PLANT YIELD MODELS IN HUNGARY

MÁRTON, László

ISSAC CAR HAS, Budapest, Hungary

a13k45@aol.co.uk

Drought as an international disaster directly affects about 1.5 billion people who depend on arid and degraded lands for their subsistance. Land degradation can be prevented, degraded lands restored, drought mitigated through sustainable land, water use techniques supported by relevant institutional measures and policies. The implementation and effectiveness of prevention and mitigation measures of drought are limited by a range of barriers such as insufficient financing and resourcing, rather weak scientific basis and knowledge exchange in drought, insufficient advocacy and awareness inadequate legal basis. Solving problems posed by global environmental and climate change, requires coordinated researches for example as sustainable climate oriented crop production. For these reasons, long-term studies were developed in NorthEastern arid zone of Hungary from 1962-2001 in order to obtain relationships between Natural Water (NW) quantities, soil agrochemical properties and mineral fertilization on rye-, potato-, winter wheat and triticale yield. NW deviations (+/-) from averaged over many years's in the study years and during the phenological phases of rye had been -12% and -11%; potato -3% and -13%; winter wheat -13% and -10%; triticale -3% and 2%. During growing season relationships between NW quantities, plant nutrition (N, P, K, Ca, Mg), and yield could be characterized by models of "R^2" rye: 0.65-0.99, "R^2" potato: 0.95-0.98, "R^2" winter wheat: 0.54-0.76, "R^2" triticale: 0.28-0.67. Maximum yields for rye: 4.0 t · ha^{-1}, potato: 21.0 t · ha^{-1}, winter wheat: 3.4 t · ha^{-1}, and triticale: 5.5 t · ha^{-1} observed when respective NW amounts were in range of 430-500, 280-330, 449-495 and 550-600 mm. At NW amounts above and below these ranges, there had a corresponding dramatic reduction in yield.

PROPOSAL OF A HYDROLOGICAL-CLIMATIC METHOD OF IDENTIFICATION OF THE DESERTIFICATION BORDERS IN MOUNTAINOUS AREAS (ON THE EXAMPLE OF THE REPUBLIC OF ARMENIA)

KHOETSYAN, Ashot (1); KHACHATRYAN, Susanna (2)

1: Armenian State Pedagogical University; 2: Yerevan State University

akhoetsian@ysu.am

A certain deviation in the natural correlation of the climate and landscape under the influence of natural and anthropogenic factors was observed during the last century. This deviation impacts the factors intensifying desertification within the territory of the Republic of Armenia. As a natural phenomenon desertification is conditioned mainly by intensification of aridity and reduction of humidity.

Aridity and the level of atmospheric humidity, as well as heat capacity are determined by empiric methods which are based on calculation of the radiation balance, air temperature, humidity, precipitation regime, wind speed and other meteorological elements.

The study results show that the level of aridity and the possible limits of desertification of the areas that are closely related to it can also be determined by hydrological characteristics. In this case, it is necessary to determine the distribution limits of flow formation zones (dry and ephemeral flows). This is necessary since these areas are under the potential risk of desertification within such climatic-landscape complexes.

Thus, the determination of the upper limit of the zones forming dry or ephemeral flows in the mountainous conditions has a crucial importance in the identification of areas under the risk of desertification.

The upper limits of the zones forming no flows or ephemeral flows for the separate physical-geographic zones were determined by the correlation of the factors such as atmospheric precipitation, cumulatively evaporation, heat capacity and elevation of the area. The reliability of the obtained results was assessed by using the links in the result of correlation of atmospheric precipitation, cumulatively evaporation and heat capacity.

In hydrology the difference between precipitation and evaporation is considered to be climatic or complete flow. The areas with no flow expand to the elevations where the values of the cumulative evaporation are equal or greater than those of atmospheric precipitations. The upper limits of the areas of ephemeral flow are considered to be on the height where the curves of the atmospheric precipitations and evaporation intersect.

Possible borders of areas under the potential risk of desertification were determined using the links among terrain height and cumulative evaporation, heat capacity, precipitation, humidity and aridity coefficients [Khoetsyan A., Mnatsakanyan B., 2003].

The upper limits of the areas without flow are considered to be the elevations where the curves of the cumulative evaporation and precipitation permanently intersect.

The zones of formation of ephemeral flows where the risk of desertification is still present is considered to the elevation where the relation of the cumulative evaporation and precipitation is $K_{VII-VIII}$ equals to 1 (flow is dry during the summertime). The quantity of annual and seasonal precipitation exceeds the value of the cumulative evaporation in the higher areas. Since flows are formed in these areas the risk of desertification is excluded.

The elevations where the curves of atmospheric precipitations and evaporation intersect are considered to be areas with ephemeral flows and thus are the upper limit of the zones under the risk of desertification.

The upper limits of the areas with no flow or ephemeral flow change within the same region during one season. The highest limits are observed during July-August. These limits have lower marks as compared to the data for the vegetation period and year.

Because of the relief, especially the aspect and variety of the terrain types of the upper limits of the areas without flow or ephemeral flow of the Republic occur on different elevations within different physical-geographic zones.

Thus, about 16% of the Republic's area occurs to be flow-less during the year (without including the Lake Sevan and the reservoir of the lake Arpa) and is considered to be influenced by desertification according to the above description. The areas under the risk of desertification occupy 12564km^2 or 44% of the total.

During the vegetation period the desertification processes intensify and the desertified areas double and constitute 7529km^2 (26%), while the areas under the risk of desertification stay the same (42%).

During the summer period desertified areas occupy 15290km^2(54% of the total), the areas under the risk of desertification occupy 10938km^2 (38% of the total). The risk of desertification is absent only on 22511km^{2}area, which constitutes only about 8% of the terrestrial area of the Republic (Fig 1).

INCREASING ARIDITY CLIMATE OF THE SOUTHERN STEPPE OF UKRAINE, ITS EFFECTS AND REMEDIES

KOVALENKO, Anatoliy

Institute of irrigated farming, Ukraine

izpr_marketing@mail.ru

Rationale

South Ukraine Steppe covers the territory of 5.8 million, hectares of agricultural land are represented southern black earth, dark chestnut and chestnut soils. Annual revenues total radiation is 113-118 kcal / cm^2, of which 91-96 kcal comes during the growing season. Proceeds photosynthetic active radiation (FAR) during the growing period is 45-50 kcal/cm^2.

However, the possibility of effective use agro resource potential of the southern region is limited to low natural moisture. Hydrothermal coefficient during the growing period is 0,6-0,7, and in 2012-2013 generally declined to 0,3-0,45 that brings the region to the area of semi-desert where it is 0,5. In addition, in recent years there has been warming in the region. In this context, the aim of our study was to analyze climate change, determine their impact on farming and the development of measures to prevent these changes.

Methods used and partnership set up

For these studies, we used observations of meteorological stations located in the Southern Steppe, including one of the oldest in Ukraine Kherson weather station, which was founded in 1801.

In analyzing the impact of drought conditions on the growth and development of crops and yield formation of their being used for the author (Kovalenko, 2011) and the results of studies in this direction are presented in the literature (Vozhehova, 2013; Ivashchenko et al., 2011; Netis, 1994).

Results

Climate change in the Southern Steppe is already an objective reality. This is confirmed by analysis of observations of air temperature regime in the region. Thus, our data for the last 40 years the average temperature in Southern Steppe increased by 2°C.

In contrast, the entire territoryof Ukraine, where warming occurs mainly due to increase in air temperature in the cold season in the Southern Steppe, however, the greatest increase in air temperature is in the summer, especially in the second half. In July and August the temperature increased by 4.1 and 3.4°C, respectively (see Fig.). Quite noticeable as it was in September and October - by 2.0 and 2.5°C. It is somewhat lower in the spring.

Due to the increase in air temperature in the summer months have increased by almost 700 heat resources, while they do inUkraineamounted to only 100°C.

In addition, the clear focus of changes in rainfall during this period did not happen. However, due to higher air temperatures increased evaporation of moisture from the soil, leading to increased aridity climate and an increase in soil moisture deficit.

These climate changes very difficult farming in the region and need improvement, development and adaptation of farming and crop cultivation technology to new conditions.

In the system accumulation of moisture and drought in the Southern Steppe crucial role shelterbelts.

For long-term observational dataSyvashAgriculturalForestand Land Research Station in the fields of protected forest belts, the yield was significantly higher (grain - 17%, feed - 22% technical - 40%) than in the open. But in recent years when sharing land belts were tied, they were reduced, which could have very negative consequences: more frequent dust storms, droughts, desertification held territory. So you want to play spaces and restore program plantations.

Changes in thermal regime autumn period upwards its duration is generally favorable for winter crops. This expands the optimum sowing time and create good conditions for the normal development of plants to cease the autumn growing season.

For early spring crops increase in air temperature in March, April and May, on the contrary - a negative factor. This reduces the optimal sowing and inhibits the growth processes during rapid increase in temperature and thus the soil. Under such conditions it is necessary to create new varieties of crops that have had rapid growth as a ground biomass and root system that would allow them to avoid the negative impact of high temperatures in the early period of plant development.

It should be noted that the change of climatic conditions can get some benefits, not all effects of climate change can be negative in the region. It is therefore necessary to develop measures that will help to get benefit from climate change.

Outcomes

For this purpose it is necessary to carry out the following activities:

- creation of new varieties and hybrids with optimal parameters adaptation to hot dry conditions and rational use of water;
- to develop, improve and expand sustainable and efficient methods of irrigation to reduce dependence on rainfall;
- to develop new technologies and methods of cultivation of crops used to increase the accumulation and economic use of rain water and soil;
- reduce the risk of water and wind erosion on agricultural land by determining the optimal degree of tillage, the proportion of forage crops and shelter belts.

A CROSSROAD BETWEEN TRADITIONAL KNOWLEDGE AND SCIENCE: MANAGEMENT, WATER QUALITY AND FOREST RECOVERY IN THE HUAZUNTLAN BASIN, LOS TUXTLAS, VERACRUZ, MEXICO

AVILA-BELLO, Carlos (1); HERNÁNDEZ-ROMERO, Ángel Héctor (1); FRANCO-DUARTE, Santo (2); CERVANTES-CRUZ, Maribel (3); MARQUEZ-JUÁREZ, Benigno (4); DEMENEGHI-CALATAYUD, Ana Paulina (5)

1: Universidad Veracruzana, Mexico; 2: Universidad Veracruzana, Mexico; 3: Proyecto Sierra de Santa Marta; 4: Red de Mujeres de la Tierra Unidas por un Mundo y un Futuro Mejor; 5: Soteapan Municipality

carlosavilab2013@gmail.com

Traditional knowledge has been almost underrated even it has demonstrated strong empirical basis and substantial contributions to the sustainability. It is essential to find points of convergence between traditional and formal sciences to achieve sustainability. The present work has been developed since 2007 in the Santa Marta Mountain within the Los Tuxtlas Biosphere Reserve, Veracruz. The main agricultural activities are rustic shaded coffee, milpa and livestock. In this region is located the Huazuntlan-Calzadas basin, that covers 1,356 km^2 and provides 80% of the water for about 600 thousand inhabitants. Coffee production crisis and poverty has forced peasants to eliminate many coffee agroecosystems and forest areas, replacing them with livestock, which has had a negative impact on soil, diversity and production as well as on biogeochemical cycles (water, carbon and nitrogen) (Sánchez *et al.*, 2003; Bandeira *et al.*, 2005).

Methods used and partnership set up

The project is divided in two stages: the first one (2007-2011), a diagnostic was carried, and included participatory workshops with peasants from 10 communities and monitoring of water, soil and vegetation state at the main rivers, production systems and vegetation types. Selection of sampling sites for water and soil quality, soil erosion, and structure of vegetation was made based upon distribution on the main micro-watersheds, its accessibility and the activities taking place near the sampling point. The variables include the main physical and chemical properties of water and soil, in 12 sites. Soil erosion was measured (nails and washers method) and estimated (USLE) in 28 sites of 12 locations throughout the watershed (Anonymous, 1991). Quadrats of 400 m^2 and the point-centred quarter methods were used to studied vegetation and traditional coffee agroecosystems structure; Shannon-Wiener, Simpson and Fisher diversity indexes were used to evaluate richness and diversity trough Estimates 8.2.0 (Colwell, 2009).

The second stage was carried from 2011 to nowadays, includes presentation of results in different forums and to producers, non-governmental organizations, ejido authorities, mayors, deputies, government agencies, Watershed Councils and entrepreneurs in order to achieve funding resources. The aim is to increase the quality of agricultural matrices (Perfecto and Vandermeer, 2008), based upon the diversification of maize fields, coffee and pasture agroecosystems.

Results

Water quality is within the limits established by quality criteria. However, turbidity and faecal coliform (FC) draw attention. While the data reported for solids concentration and nutrients are within allowable limits, high levels of turbidity was observed, especially in the middle and lower municipalities of Soteapan and Soconusco, even above the permissible levels (10 NTU). Water quality indices (ICA) indicate that the parameters evaluated are acceptable (>70) at sites in the upper basin. In sites like Ocozotepec and those in the lower part of the basin lowest rates of quality (55-60) due to the impact of some pollutants, results show high levels for turbidity, BOD and FC. High values of FC in water are risk for humans; risk increases in the case of heavy rainfall, as well as other physical and chemical parameters such as herbicides and pesticides.

Soils in the sub-basin are young; pH ranges between 4.4 to 6.6. Agriculture and livestock areas have low organic matter (0.1 to 5.3%). Coffee agroecosystems have higher levels of organic matter (6.7 to 8.9%). All along the sub-basin, percentage of slope varies between 0 and 60%, although 35 to 55% are the dominant values. Figure 1 presents the main results of the assessment of soil erosion.

Structure of vegetation and traditional coffee agroecosystems had four strata. We have identified 323 species of vascular plants belonging to 98 different families. Plant diversity for tropical rain forest showed varied between 1.88 (Shannon-Wiener) and 0.79 (Simpson); tropical semideciduous forest presents values between 1.52 and 0.64, respectively. In contrast coffee agroecosystems showed values between 1.89 to 3.73 for Shannon-Wiener and 1 to 62 for the Simpson index, results that confirm the influential role of traditional peasants in preserving and even increasing diversity.

Outcomes

Results are relevant given the fast decline of natural resources at local and global level. The best way to conserve them is planning its sustainable use based upon watershed and landscapes approaches together with peasants. Model simulation shows a decrease in soil erosion of 6,285 tons ha^{-1} $year^{-1}$ to 628 tons ha^{-1} $year^{-1}$, combining different conservation practices. This type of scenario has been raised to the producers, whose experience in the use of agricultural matrix may be the basis for future practices of conservation and diversification. As a result of different negotiations with local stakeholders and funding instances, since 2013 in collaboration with Braskem-IDESA industrial consortium, and a group of consultants in Soteapan we begin a reforestation project. The goal is to cover 20 ha using native species, diversify agroecosystems together with landowners, students from the Universidad Veracruzana and to development local capacities. In the short-term it's expected to increase reforestation to 40 ha.

IMPACT OF USE AND WASTEWATER TREATED IN AGRICULTURAL SOILS IN THE MUNICIPALITY OF TORREON COAHUILA

GARCÍA, Mario; MADINAVEITIA, Hector; OGAZ, Alfredo; URBINA, Miguel; LÓPEZ, Isaias

Universidad Autonoma Agraria Antonio Narro, Mexico

isaius@hotmail.com

Rationale

In order to clean up 100% of the wastewater from the city of Torreon, there was a treatment plant based stabilization ponds built on land to the east of the city, whose effluents meet required quality built NOM-001-SEMARNAT-1996 at paragraph for irrigation in agricultural use, and it is currently being used by farmers in the region.

However, regardless of the plant receiving 97% of the wastewater generated in the city, there is still a percentage being diverted by farmers in the Ejido La Rosita from one manifold for crop irrigation.

That is why, we decided to do this study, this way we can determine the degree of impact residual and treated waters had on the ground for the past 10 years on the crops around the municipality's treatment plant as well as the quality of biosolids generated in some stabilizacion pond of the treatment plant, this with the goal of determining if the biosolids meet the parameters stablished in NOM-004-2002-SEMARNANT for handling and use of biosolids.

Partnership and methods used set up

The study was conducted on land adjacent to the water treatment plant located east of the city of Torreon Coahuila.

The sampling sites were:

1- Laguna Anaerobic A treatment plant.
2- Agricultural land irrigated with untreated wastewater
3- Agricultural land irrigated for 10 years with treated water.
4- Agricultural land irrigated with well water.

Laboratory measurements of the samples:

On the samples of dried and ground soil taken from 0-30 cm, 30-60 cm and 60-90 cm the following physical and chemical determinations were made: organic matter, texture, bulk density, cation exchange capacity, pH, electric conductivity, exchangeable sodium percentage, and heavy metals: Cadmium, Copper and Lead.

In addition to the soil samples water samples were taken in order to be able to analyze their quality according to the Mexican Standard NOM-001-1996-SEMARNAT the following points:

1- Raw residual water that enters the treatment plant.
2- Treated wastewater from the effluent from the municipal treatment plant.
3- Well water in the site where the agricultural land irrigated with this water is.

Results

In the three studied depths in the 4 sampling sites pollutant concentrations were higher in the horizon layer (30-60 cm), the concentration of the heavy metals lead, copper and cadmium but is significantly greater than that presented in the soil irrigated with water or well shot, those values are still within the criteria set out in the rules for land use, deep 30-60 cm and 60-90 cm the concentration of heavy metals was similar between the two layers, so the leaching thereof is inhibited by the pH of the soil, thus contributing to the metal encapsulation, avoiding deep layers filtration.

In the case of electrical conductivity in the soils studied it was found that the highest concentrations found in the upper layers, the content of salts indicate floors ranging from mildly saline to moderately saline, the above is because wastewater municipal Torreón plant contain an electrical conductivity on average 40% higher than the water from deep well.

Also biosolids, whose electrical conductivity is in the first layer of soil of about 19.6 mS / cm 2, which makes concentration strongly saline, should be carefully analyzed the potential agricultural uses for which it intends to use.

In irrigated with raw sewage soils, heavy metal concentrations were higher than those irrigated with treated wastewater, mainly because the majority of contaminants in sediment stabilization ponds, so the soils irrigated with treated wastewater are less contaminated, similar situation in the case of electrical conductivity.

Among the positive aspects of using wastewater and treated water were observed in the study is the significant contribution of organic matter being the highest in the case of soils irrigated with wastewater which contain more than 30% compared with those irrigated with treated water.

Outcomes

Within the study it can be concluded that although the irrigation water use treated municipal has multiple benefits as it allows the reuse of water providing a significant saving of water as well as contributions of organic matter and nutrients that reduce the use of chemical fertilizers also contributes salts and heavy metals that while it is true at the time of discharge this water meets the parameters of ecological standards, these have a cumulative effect on the, so it should establish agricultural management systems that include the use of such water, and possible mitigation actions. Finally, it should also be special emphasis on the management of biosolids, since an improper use can lead to problems of soil salinity, especially in regions where rainfall is insufficient for continuous washing them.

IMPACT OF RAPID URBANIZATION ON WATER RESOURCES IN THE CONTEXT OF CLIMATE CHANGE USING REMOTE SENSING AND GIS : A POLICY PERSPECTIVE

JOSHI, Kamal Narain

Gram Bharti Samiti, India

joshi.knjoshi@gmail.com

Increasing pressure of population and industrialization has threatened the quality and quantity of water resources in and around urban areas. Protecting surface water resources like lakes, rivers, streams, and ponds etc in the vicinity of urban area has become a very difficult task for urban planner and administrators. The haphazard growth of colonies, slum squatters and unplanned land use has not only broken down the natural flow of hydrological net work but also deteriorate the quality of water that directly affects health of people. Space technology together with geographical information system has provided new opportunity to analyze the problem and provide appropriate solution in cost and time effective manner.

The present paper investigates that how the urbanization and industrialization has changed urban land use of Jaipur urban Agglomerate which ultimately affected the surface water bodies and reduced the recharge area of ground water. The changing rainfall pattern due to possible climate change has exaggerated the situation. The study has been carried out with the help of Indian remote sensing satellite data and GIS techniques. During the course of study a number of thematic maps covering hydro-geomorphology, geology, water bodies, land use, soil etc. have been prepared and analyzed. In addition various attributes on climatic parameters and anthropogenic activities have been put together with these maps in GIS environment for integration to depict the changes and its impact on water resources vis-à-vis land use.

It was found that increasing pressure of population and un-systematic anthropogenic activities have made negative impact on water resources. It encroached upon lakes, rivers, streams, and ponds etc in the vicinity of urban area. As a result, out of total 518 rivulets in urban area and surrounding, 13 first order , 37 second order and 10 are of third order stream are completely blocked by settlements (Total 60). Out of 2600 wells, 1116 well/tube wells have completely stopped recharging due to increase in pavement area between years 1986 to 2007. Seven fresh water reservoirs have dried-up which was supplying drinking water to Jaipur city. The surface drainage network of rain water has been converted into municipal sewerage. Local source of water supply from surface as well as ground is closed due to scarcity of water. Recharge of ground water has stopped due to increased pavement area for urban development like infrastructure development, industrial development and other urban development activities. On the other hand Average annual number of rainy days has been reduced from 35 to 28 days in last 25 years. *15 years out of 30 years (1080 - 2010) have received less than average (650 mm) rainfall. Average number of days having High temperature has increased

Suggestion s for policy makers

The natural drainage system should be kept intact and free from encroachments so that the area could be saved from flood.

Common property resources including pastures and water bodies should be kept reserve to recharge the ground water.

Natural drainage and low lying area and lineaments should be protected for ground water recharge.

Forest around urban area should be protected and keep free from encroachment.

QUANTITATIVE ASSESSMENT OF THE IMPACTS OF CLIMATE VARIABILITY AND HUMAN ACTIVITIES ON RUNOFF IN THE A ARID AND SEMI-ARID ECOSYSTEMS IN IRAN, JAZMURIAN BASIN

GHARECHAEI, Hamidreza (1); MOGHADDAMNIA, Alireza (1); MALEKIAN, Arash (1); AHMADI, Azadeh (2)

1: Faculty of Natural Resources, University of Tehran, Karaj, Iran; 2: Department of Civil Engineering, Isfahan University of Technology, Isfahan, Iran

gharechaei@ut.ac.ir

Arid and semi-arid ecosystems, as in jazmurian watershed in Iran, are highly sensitive to local hydrological changes. In these regions, climate variability and human activities are two mean drivers on reduction or increase runoff and these effected have in water yield. In order to quantitative assessment of the impacts of climate variability and human activities on runoff in the jazmurian watershed we used the statistical and hydrological sensitive methods. Our results indicated that the trends in precipitation and potential evapotranspiration are not obvious, while runoff significantly decreases. The results change point analysis illustrates that an abrupt change of runoff occurred in 2000. For jazmurian watershed, the absolute value of runoff sensitivity coefficients to precipitation is larger than that to PET, Indicating that a 10% increase in precipitation will cause a 23.9% increasing in runoff and 10% reduce in PET 6.2% increasing in runoff. Revealing that the change in runoff was more sensitive to change in precipitation than to change in PET in this region. The results from the hydrological sensitive method show that climate variability impacts contribute 54.33 % to the decrease in runoff, while human activities impacts contribute 46.67 %. This study quantitatively effects between climate variability and human activities on runoff in Semi-arid and arid region such as jazmurian watershed, which can be a reference for regional water resources planning and management.

STEMFLOW IN TWO XEROPHYTIC SHRUBS AND ITS SIGNIFICANCE TO SOIL WATER AND NUTRIENT ENRICHMENT

ZHANG, Yafeng; WANG, Xinping

Shapotou Desert Research Station, Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences, China, People's Republic of

xpwang@lzb.ac.cn

Rationale: Shrub canopy are expected to funnel substantial amounts of intercepted rainwater in the form of stemflow to shrub base in the desert ecosystems with limiting water and nutrients. However, lacking are quantitative studies on the water and nutrient enrichment of stemflow at the shrub basal area.

Methods used and partnership set up: In this study, stemflow were quantified for two xerophytic shrubs (*Caragana korshinskii* and *Artemisia ordosica*) in a revegetated desert ecosystem of Shapotou area in northwestern China. We also measured the ion concentrations of total nitrogen (TN), total phosphors (TP), NH_4^+-N, NO_3^--N, Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, SO_4^{2-} and the pH and electric conductivity (EC) in stemflow, throughfall and bulk precipitation.

Results: Results indicated that stemflow accounted for 8.8 and 2.8% of the gross rainfall for *C. korshinskii* and *A. ordosica*, respectively. Individual stemflow linearly increased with increasing rainfall depth. Stemflow increased with rainfall intensity when rainfall intensity was less than 2 mm h^{-1} but showed decreased tendency thereafter. An antecedent precipitation of 1.3 and 1.6 mm was necessary for stemflow initiation for *C. korshinskii* and *A. ordosica*, respectively. The mean (confidence intervals, α=0.05) funneling ratios were 82(17) for *C. korshinskii* and 26 (7) for *A. ordosica*. Ion concentrations in stemflow were higher than in throughfall, and the concentration of most of the ions measured were significantly higher ($P < 0.05$) in stemflow than in bulk precipitation, with a nutrient enrichment ratio ranged 122.8 –1677.0 for *C. korshinskii* and 12.6 – 1306.0 for *A. ordosica* among measured ions, respectively.

Outcomes: Overall, the larger funneling ratios and enrichment ratios for the two shrubs suggest that stemflow plays a significant positive role in soil water replenishment and nutrient enrichment at deeper soil profile of root zone in the revegetated ecosystems under arid desert conditions.

IMPROVING ASSESSMENT AND MONITORING OF DROUGHTS IN GRASSLANDS

XIAO, Xiangming (1); WAGLE, Pradeep (1); BAJGAIN, Rajen (1); ZHOU, Yuting (1); ZHANG, Yao (1); BIRADAR, Chandrashekhar (2); BASARA, Jeffrey (3)

1: Department of Microbilogy and Plant Biology, University of Oklahoma, United States of America; 2: International Center for Agricultural Research in the Dry Areas (ICARDA), Amman, Jordan; 3: School of Meteorology, University of Oklahoma, USA

xiangming.xiao@ou.edu

Grasslands in the Southern Great Plains of the United States have experienced various degrees of droughts over years, and substantial economic losses occurred to many ranchers under severe drought condition. Current assessment and monitoring of agricultural droughts in grassland rely heavily on the satellite-based Normalized Difference Vegetation Index (NDVI), which is a normalized ratio between near infrared (NIR) and red bands. NDVI is closely to plant area index (PAI) and leaf area index (LAI) of grasslands. Severe drought could result in a decline of NDVI. Recently we have investigated the sensitivity of water-related spectral bands and vegetation indices to drought, including the Land Surface Water Index (LSWI), which is a normalized ratio between near infrared (NIR) and shortwave infrared (SWIR). First, we used the carbon and water flux data from the CO2 eddy flux tower sites in grasslands, and the vegetation indices derived from images of the Moderate Resolution Imaging Spectroradiometer (MODIS) at 500-m spatial resolution. The results show that the LSWI is much more sensitive to severe drought than does NDVI (Wagle et al., 2014). Second, we assessed the sensitivity of LSWI to droughts over the period of 2000-2013 at individual flux tower sites, and proposed a scheme of LSWI-based drought assessment. The results show that the LSWI-based drought assessment scheme complements well the current drought assessment scheme used in the US Drought Monitor, but at much finer spatial resolution (500-m). Thirdly, we applied the LSWI-based scheme to the Southern Great Plains (Texas, Oklahoma and Kansas), and generated maps of drought dynamics (starting date, ending date, duration) and severity over the period of 2000-2013. The results from our studies across the scales from individual sites to the Southern Great Plains have clearly demonstrated the potential of the LSWI-based approach to improve assessment and monitoring of droughts in grasslands. As MODIS data are available at the global scale, there is a potential to expand the LSWI-based drought assessment and monitoring methods to other arid and semi-arid regions in the world.

DROUGHT ASSESSMENT AT A TRANSBOUNDARY BASIN. CASE OF STUDY: TIJUANA RIVER BASIN

PEREZ-GONZALEZ, Dennice; HALLACK-ALEGRÍA, Michelle; HERNANDEZ-RETANA, Ignacio; SALAZAR-BRIONES, Carlos

Universidad Autónoma de Baja California, Mexico

mhallack@uabc.edu.mx

Rationale

The Tijuana River Watershed Basin is located at the northwestern end of Mexico. It is a transboundary basin comprising both sides of the international border between Mexico and the United States of America. It is located in a semiarid region with a mean annual rainfall ranging from 150 mm to 650 mm (SDSU-COLEF, 2005). The TRW is a unique environmentally and socially area, with approximately one-third of the basin in the United States and two-thirds in Mexico involving the importance of dynamism, diversity and complexity of human and natural systems. The objective of this work is to characterize drought variability, its frequency, intensity and duration to determine conditions under which it is recommended to initiate actions set forth in mitigation plans by the institutions responsible of water management.

Methods

In order to determine temporal and severity drought variation within the Tijuana River Basin, the standardized precipitation index (SPI) and the Palmer Drought Severity Index (PDSI) were calculated. In this paper the implementation of SPI, based on precipitation data, constitutes an index of the temporal precipitation efficiency; it considered the meteorological component which largely defines the presence and characteristics of drought (McKee et al. 1993). The SPI is frequently calculated for different time scales depending on the purpose of the study. Since this work is focused on a transboundary basin, mostly an urban zone, three scales have been selected. In addition, the PDSI was calculated to monitor hydrological droughts. The PDSI considers precipitation deficit, evapotranspiration, and the supply and demand of water within an equation of water balance. It is a cumulative drought index that calculates the stored soil water by the equation of soil water balance driven by precipitation data. Monthly precipitation is used to determine the z-index (moisture anomaly index). The z indices were calculated for each month of the difference between the actual rainfall and climatically appropriate precipitation conditions existing. This accumulation for several months of drought, the z indices accumulate over time to form the PDSI using a recursive relationship. (Palmer, 1965).

Results

Rainfall and Evapotranspiration data used in this study were obtained from the Mexican Institute of Water Technology and the National Water Commission for the 1950-2008 period of time. The results of duration and intensity analysis presented using the SPI and the PDSI indices were expected to demonstrate drought conditions determining abnormal droughts and high humidity events along the Tijuana River Basin. Both analyses were applied for three time scales of 3, 6 and 12 months using 30 years of precipitation record (not the whole series 1950-2008, but selected years) and monthly average evapotranspiration data, in order to obtain the history of periods of water deficit or excess using the distributed network of rainfall measurement for the study area. The SPI and PDSI results for all time series provided meteorological and hydrological drought (rainfall deficit) scenarios, as well as excess water periods. Those results allowed us to identify the areas with excess moisture, pointing out a favorable water situation or a widespread drought depending on the period of interest. Usually 3 and 6-month time scales were related to agricultural droughts, while a 12-month time scale to meteorological drought (McKee et al. 1993). The drought occurrence scenarios were important to consider, for instance, for late proper water management in dams or other hydraulic systems, thus it is important to have a water condition forecast for preparedness for water availability in the coming months and years. Even with the simultaneous use of drought indices, the identification of the adverse effects of drought is difficult and complex (Wilhite et al., 2007). It is therefore necessary to develop systems that consider the vulnerability of socioeconomic sectors for future works. Monthly forecasts for

monitoring and assessment of water availability conditions can be made for an entire region or a particular basin using geographic information systems, drought indexes and regional frequency techniques.

Outcome

The SPI and PDSI indices were useful techniques to assess drought conditions in the Tijuana River Basin. The SPI enables the analysis of impacts related to the event of drought on different time scales. The method allows defining PDSI drought scenarios for a series of 30 years, defining start, end, duration and frequency. Thus, meteorological and hydrological droughts in areas where there is not an extensive network of rainfall records these indices allowed us to develop drought monitoring maps. Drought is a prolonged period during which a deficiency in the precipitation is observed. In many parts of the world, is a normal, recurrent feature of climate and is therefore inevitable.

NATIONAL DROUGHT MITIGATION STRATEGIES, COST-EFFECTIVE EVALUATION IN TURKEY

TÜRKER, Metin; ENGÜRÜLÜ, Bekir; ÜNAL, Mehmet; ERDOGAN, Hakki Emrah

Ministry of Food, Agriculture and Livestock, General Directorate of Agrarian Reform

hakki.emrah.erdogan@gmail.com

The agricultural drought, as one of the biggest problems on the global scale, will affect all levels of our lives, namely physical and natural environment, urban life, development and economy, technology, agriculture and food, clear water and health as of current situation. According to 2030 scenarios prepared by Intergovernmental Panel for Climate Change (IPCC), probable hazards that will increase are generally listed as heat waves, forest fires, drought, heavy rains, tropical storms, effects on agriculture and agro-culture. In Turkey, in order to mitigate possible effects of agricultural drought and to determine necessary measures to achieve this, a 5 year Strategy and Action Plan for Combatting Agricultural Drought for the period between 2008 and 2012 has been prepared according to conditions of Turkey under the coordination of our Ministry and it has been put into practice. Main objective in combatting agricultural drought is to take all necessary measures when there is no drought with sustainable agricultural water usage planning in terms of environment by taking supply – demand management into consideration through including all shareholders to the process and increasing public awareness; to ensure minimization of drought effects by applying an effective combatting program during crisis. Agricultural Drought Management Coordination Board has been established and also Monitoring Early Warning and Estimation Committee and Risk Assessment Committee that will Word under coordination board at the central level have been established and at the provincial level Agricultural Drought Provincial Crisis Centers under the leadership of Governors have been established. Strategy and Action Plan for Combatting Agricultural Drought will be prepared again for the period between 2013 and 2017 in accordance with current conditions in order to prevent interruption of activities of Agricultural Drought Management Coordination Board, committees and provincial crisis centers established under activities for combatting agricultural drought and so that combatting will continue effectively. In this paper, political background, national strategies for combating drought and cost-effective evaluation were briefly explained.

COMBATING DESERTIFICATION AND LAND DEGRADATION THROUGH SUSTAINABLE LAND AND ECOSYSTEM MANAGEMENT PROGRAMME IN INDIA: AN ASSESSMENT

KAUR, Navreet

Department of Public Administration, Panjab University, Chandigarh, India

navreet9@gmail.com

Land degradation and desertification directly affects the environment in general and agronomic productivity in particular which influence the livelihood of poor people. In India about 32.07 percent of the land is undergoing various forms of degradation and 25 percent of the geographical area is affected by desertification. Moreover 69 percent of the country's land are drylands and degradation of these lands has severe implications for the livelihood and food security of millions.1*

These facts and figures depicts the serious and volatile picture of vulnerable ecosystem and its impact on sustainable livelihood. In order to address the problem of Desertification and Land Degradation, the Government of India has formulated many policies and programmes at Union level and State level like National Rainfed Area Authority (2007), Integrated Watershed Management Programme (2008) and National Afforestation Programme and had also developed the institutional mechanism to translate the policy into implementation. It had also initiated the process to collaborate with international agencies to address the challenges of Environment.

Sustainable Land and Ecosystem Management Program is major step in this direction. The SLEM Programme is a joint initiative between Government of India and Global Environmental Facility (GEF) under Country Partnership Programme (CPP). The SLEM-CPP is representative of GEF's Programmatic Approach, which is based upon solving environment problems all over the globe through integrating international global environment objectives into national and regional strategies. The Plan of Action is formulated and implemented through Partnerships.2*

The overall objective of the SLEM Partnership is to contribute to poverty alleviation in India by promoting enhanced efficiency of natural resource use, improved land and ecosystem productivity and reduced vulnerability to extreme weather events. In SLEM Partnership, three states Rajasthan, Madhya Pradesh and Nagaland are selected and plan of action was formulated for every selected state on the basis of challenges of environment of particular state.

In Rajasthan Sustainable Participatory Management of Natural Resources (SPMNR) was initiated to control land degradation is led by UNDP where as Reversing Environment Degradation and Rural Poverty through Adaptation to Climate Change is led by FAO.SPMNR in Rajasthan had shown remarkable results as it had successfully mobilized Jal Sabhas (Community based organizations) to effectively manage and monitor the use of local resources. The Traditional water management practices are revived in 25 villages. The Technical institutes and Knowledge Centres are encouraged for partnerships for capacity building activities along with awareness campaigns on the impact of land degradation.3*

Integrated Land Ecosystem Management Programmes was launched in state of Madhya Pradesh to reverse unsustainable land management practice by providing range of livelihood options for the poor people. The major achievement of this project was that construction of "microchek" dams had improved the soil moisture. Furthermore community is involved in protection and management of forests and income of families had also increased.

SLEM in Nagaland had addressed the issue of land degradation in shifting cultivation locations through general awareness and supporting integrated farm development. 800 "jhum" practicing households have benefitted from introduction of integrated farm development practices. It has strengthened coordination and conversion mechanisms between line departments and Participatory Land Use Plans (PLUP).

This Paper is written by using secondary sources. The data is collected from Annual Reports of UNDP, GEF, FAO, Ministry of Environment, Government of India and Annual Reports of State Government of Rajasthan, Madhya Pradesh and Nagaland, books, journals, internet, websites of agencies who are involved in SLEM –CPP in India. SWOT is used to assess the implementation of SLEM-CCP in India.

The finding clearly reflects that community participation for sustainable development played major role in achieving the objectives of the programme. Active participation of women and small farmers in livelihood practices and protection of forests is the Strength of the Programme. There exit overlapping of functions among multiple institutions and agencies involved in combating desertification and there is lack of well managed awareness programmes at the village level. These are the major Weaknesses of the SLEM Programme. Building communication between people through exchange of information and including local self government bodies for dissemination of scientific knowledge for sustainable livelihood and protection of natural resources are the Opportunities in the SLEM Programme.

The assessment of SLEM Programme also highlighted that there is need to strenghten the coordination mechanism and improvement in training plans at the local level.

SUSTAINABLE LAND MANAGEMENT AND CLIMATE FRIENDLY AGRICULTURE IN KONYA CLOSED BASİN OF TURKEY

GÖRÜCÜ, Özden

Kahramanmaras Sutcu Imam University, Turkey

ogorucu@ksu.edu.tr

This reseach project focused on to solve the land management problems related to sustainability and land rahabilitation in the region.So, The main aim of the research was to make substantial proposals to comeover three barriers: Barrier 1: Minimal experience among key government and civil society stakeholders in developing and implementing SL&FM practices on the ground. Barrier 2: Famers under-exposed to new innovative low carbon technologies for farming and farm waste management. Barrier 3: Inadequate enabling environment (legal, regulatory and institutional framework) and capacity for sustainable land management.

Incremental some funding resources support the mainstreaming of SLM, climate change mitigation and biodiversity conservation objectives into production landscapes practices. The project are providing an opportunity for a major scaling up and strengthening of participatory and integrated land management techniques to address capacity constraints within the main sectors in charge of land management. In doing so, the study have been introducing participatory and integrated SLM, climate change mitigation and biodiversity conservation through three interlinked components: (i) rehabilitation of degraded lands (ii) climate friendly agriculture, and (iii) strengthening enabling environment for sustainable land management. These components are summarized in more detail below and elaborated fully under the case study applications.

The research was organized around three components and outcomes obtained as below:

Component 1. Capacities built to rehabilitate currently degraded forest and rangeland: The objective of this component is to catalyse the improvement of forest and rangeland management to deliver SLM, CC, and BD benefits. Governments and other partners's incremental investment will innovate more effective and sustainable rehabilitation of degraded forest and rangeland.

Component 2. Capacities built to apply climate friendly agriculture techniques across productive landscapes: This component's objective is to embed climate friendly agriculture within small and large-scale agricultural operations. The result will be an increase of 20.000 hectares of existing agricultural land delivering climate change, biodiversity conservation, and SLM benefits.

Component 3. Strengthening enabling environment for multiple benefits from sustainable land management. The study introduces a holistic approach to forests, rangelands/pastures and agricultural lands. With the funding support from various source, an enabling environment for a basic management strategy will be developed for sustainably managed landscapes that consider to conserving biodiversity, mitigate climate change and reduce land degradation. So, the proposals of this study operationalizes farmer field schools throughout the arid region in Turkey. Beside individual and institutional capacity building programmes among decision-makers, technical staff and local beneficiaries will increase their ability to move towards integrated approach.

LAND DEGRADATION NEUTRALITY: IDENTIFICATION OF PATHWAYS FOR THE CONCEPT DEVELOPMENT AND PRACTICAL APPLICATIONS

KUST, German; ANDREEVA, Olga

Moscow State University, Russian Federation

gkust@yandex.com

Rationale

The Outcome Document of the Open Working Group on Sustainable Development Goals has proposed the goal 15.3: "by 2020, combat desertification, and restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land-degradation neutral world"

The LDN concept grew up from the concept of Zero Net Land Degradation, which has already been promoted by the UNCCD (2012) and widely discussed in recent scientific literature (Chasek et al., 2014; Tal, 2014, Stavi&Lal, 2014; EU, 2014). The Zero net loss environmental strategies have been also practically realized for the sustainable land management (SLM) purposes in different countries.

Methods and basic approaches

Here we present the results of the study and understanding the concept of LDN for its scientific development and practical application, basing on our experience in the East Europe, Central Asia, work on the development of the Russian "Healthy Soil" initiative for the Group of Eight presented in 2014 (which unfortunately was not realized due to certain political circumstances), and also preliminary results of the discussion of this concept in the UNCCD Intergovernmental Working Group on the follow-up to Rio+20 (IWG) which is working on the elaboration of the internationally recognized science-based definition of the land degradation neutrality (LDN).

The scientific basis for the development of the concept was discovered earlier and can rely on the ideas of the homeostasis of soil cover in desertification affected areas (Kust, 1999) and of the invariants of soil cover changes (Goryachkin, 2006).

In practical terms the concept is clear enough: SLM actions should not allow reducing the existing balance between "not yet degraded" and "already degraded" lands with persistent desire for the restoration of the last. Thus, the LDN can be considered as a practical tool to balance processes of land degradation and restoration/rehabilitation/recovering at global, regional, national and local levels.

Taking this into account, the IWG recommended the LDN concept might be based on the UNCCD land degradation (LD) definition, which means the reduction or loss of the biological or economic productivity and complexity of lands in arid, semi-arid and dry sub-humid areas. The most of IWG supported the idea the LDN concept is related not only to drylands, but should be considered as a scientific principle and main condition for the functioning of modern civilization, and in this case can be applied for other areas affected by LD. Such approach fully corresponds to the DLDD (desertification, land degradation and droughts) related topics of the UNCCD and promotes the close collaboration of a set of international organizations working on the LD focal area: GEF, UN system, World Bank, IFAD, GSP, IPBES, and many others.

Results

The LDN concept has three main constituents and can be defined:

- as a concept of land use/land management contributing/favouring to sustainable development at global/regional/national/local levels to meet the needs of future generations,
- as a phenomenon of equilibrium/homeostasis/constancy of land system in terms of the balance between deterioration and improvement of terrestrial ecosystems' qualities, functions and services; LDN occurs when ecosystem services are balanced artificially or naturally;

- as an SLM target to be adopted at national, sub-national or local level to sustain and improve natural resources for economic, social and environmental benefits, and food security
- A number of additional bedrocks were discovered for further scientific development and practical application of the concept:
- changes in the LDN state has two co-linked dimensions: positive and negative changes in land quantity and land quality;
- consequently LDN promotes an ecosystem-based approach with two umbrella pathways of action: (i) addressing current and future LD (avoiding/ preventing/minimizing LD): e.g. transition to SLM; (ii) recovering LD occurred in the past;
- the LDN concept considers spatial and temporal scales of changes pari-passu with increase and mitigation of DLDD risks;
- land quality is a multilateral term, which could mean productivity, functions, ecosystem services soil and ecosystem health, or their combinations
- LDN recognizes various approaches and methods to achieve the LDN target,
- the LDN should address links to biodiversity and deforestation, carbon fluxes and climate change adaptation, water stress, ecosystem services, poverty, migration, and food security issues

Outcomes and practical recommendations

LDN is not a global target which requires a new protocol or international agreement. Every country should declare its own level of ambition.

The LDN principle can be used for management purposes at different levels and scales, and requires spatial and temporal limits to be monitored and evaluated.

The areal assessments will be a priority at the first steps of the LDN practical application, but further development for a qualitative assessment, and here the concept of soil health, ecosystem services, food security, social stress, water stress, etc will be essential.

Acknowledgements

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HYDROPONIC GREEN FODDER AS AN ALTERNATIVE TO MITIGATE THE IMPACT OF GRAZING ON REFORESTATION

ZAVALETA ARAGÓN, Regina; QUINTERO ROMERO, José Manuel

Biosustentabilidad y Forraje Verde en Oaxaca, Mexico

rellis_16@hotmail.com

Theoretical contribution in the area of **climate change and the environment**: forests and changes in land use.

INTRODUCTION

Climate change how result of changing land use and deforestation, involves significant challenges and contemplate drastic measures such as the vetoing of small and large ruminants that are operated under grazing conditions in some communities in the state of Oaxaca, Mexico. But as clear cut solutions do not represent the complete solution of the problem, so it is important to contemplate alternatives how hydroponic green fodder is presented by FAO in 2001 as a means of animal feed.

MATERIALS AND METHODS

This theoretical contribution, took place as a result of preventive measures adopted in some communities in the state of Oaxaca, Mexico, which prohibits the possession of livestock animals are fed under grazing conditions, based on the impact that grazing reforestation and in view of reforestation have a high impact on tackling climate change.

While the measure is justified, but not the magnitude of the scope that this decision since possession of livestock animals represents half of a local family consumption and income.

So in the search for a more viable alternative, it was first necessary to develop a representation of the main points that allows for a bigger and clearer what we are talking picture. These are:

P = Banned or prohibiting animals fed livestock grazing conditions.

Q = Shortage and inaccessibility to another type of food for livestock animals.

R = Protection of reforestation.

In this regard the search for information to provide a more adequate and satisfactory to solve the problem context starts.

Results

As somehow P and R are already given, we focus on Q that represents the scarcity and inaccessibility or other means of supply for livestock animals, other than grazing.

Among the results of the investigation are various types of grasses that are generally used for animal feed, but for the special situation of the communities would not be feasible considering that it would be necessary to make a change in land use or as the establishment of agro-forestry-pastoral system but that implies an extended period of allowing the development of forest species time.

By continuing to search a managed by FAO (2001) called "Green Forage Hydroponic" program, which according to their content their advantages and disadvantages are met:

Advantages: Save Water; Efficiency In space usage; Efficiency In production time; Quality fodder for animals; Safety, Costs Production; Diversification and intensification of production activities; Partnerships and commercial approach.

Disadvantages: Misinformation and overvaluation of technology; Cost High installation; Special case of the advantages, meets many of which other types of balanced food, fodder silos and not guaranteed.

Therefore the Green Forage Hydroponic represents a viable option for mitigating the impact of grazing on reforestation alternative, given that food is produced in a small space and without removing the animals from their pens (which results in less time calves), thus maintaining protected reforestation, family economy.

SOIL FERTILITY RECOVERY AND ADAPTATION OF UKRAINIAN SOUTH STEPPE TO NEGATIVE CONSEQUENCES OF CLIMATE CHANGE: CONTRIBUTION OF SCIENCE AND PRACTICAL EXPERIENCE

VOZHEGOVA, Raisa (1); GRANOVSKA, Liudmyla (2); GOLOBORODKO, Stanislav (1)

1: Institute of Irrigation Farming of the National Academy of Agrarian Sciences of Ukraine, Kherson, Ukraine; 2: Kherson State Agricultural University, Ukraine

hranovska08@mail.ru

Aim

Creation of the ecologically balanced agricultural landscapes through soil fertility recovery of irrigated lands and adaptation of the agriculture systems to the negative consequences of climate change in order to obtain ecologically safe products for population and creation of feed base for animal husbandry.

Methods and collaboration

Methodological basis of scientific investigation is made up of the modern methods of research: historical; systematic; statistical analysis.

The informative basis of research – Law of Ukraine «On the Environment Protection» (1991), Resolution of Cabinet of Ministers of Ukraine «Standards of Optimal Crops Correlation in Rotations in Different Naturally-Agricultural Regions of Ukraine» (2010).

Partners

Institute of Irrigation Farming of the National Academy of Agrarian Sciences of Ukraine, Kherson State Agricultural University, State Enterprise "Research Farm "Askaniyske".

Results

Today, under the conditions of South of Ukraine, where irrigated lands were used during the protracted period of time, there is an active process of irrigated lands fertility decline, the processes of soil degradation and desertification are observed. Application of out-of-date and scientifically not reasonable technologies of crop growing, intensive bringing in of mineral fertilizers and complete absence of organic fertilizers, non-fulfillment of Resolution of Cabinet of Ministers of Ukraine about the standards of optimal crops correlation in rotations, and also ineffective use of lands lead to worsening of fertility and ecological indices of soil, that negatively influences quality of agricultural produce.

The example of front-rank practice is State Enterprise "Research Farm "Askaniyske" of Askaniya State Agricultural Research Station of Institute of Irrigation Farming of the National Academy of Agrarian Sciences of Ukraine, located in South Steppe of Ukraine, in Kakhovka district, Kherson Region. The area of agricultural lands of the farm makes 9,534 ha, including: arable land – 9,220 ha (4,974 ha of irrigated lands).

For the climate of these territories summer dry hot winds (high winds up to 19-24 m/s alongside with relative air humidity – less than 30% and high air temperature – higher 25 °C) are characteristic. Annual amount of fallouts changes from 310 to 430 mm, with a change on years from 140-160 to 450-560 mm. Most of precipitations falls out in June – 35-60 mm; March is very dry – 20-29 mm. During a year only 100-120 days of precipitations is observed. Basic part of precipitations (60-70%) falls out as thundershowers in May-July.

Fig. Temperature, relative air humidity, evaporating capacity, precipitations and deficit of water consumption in 2013 *(data of Askaniya meteorological station)*

During the period from 1986 to 2000 fluctuations of humus content in soil of irrigated lands are observed in the farm; this influences the productivity of crops. The change of humus content over years is conditioned by the system of fertilization at crop growing and correlation brought in mineral and organic fertilizers. Optimal correlation is 1 kg mineral fertilizers to 15 tons of organic fertilizers. Maintenance of stock-raising allowed the farm to get sufficient amount of organic fertilizers. The observance of standards of optimal crops correlation in rotations provided an increase of humus content in soils of irrigated lands during the last 10 by 2.99%.

Basic requirements for providing of self-supporting balance of humus and its content at the level of 2.5-3.5% under the conditions of irrigation is: observance of standards of optimal crops correlation in rotation (grain and leguminous crops – 40-82%, industrial crops – 5-35%, vegetable and water-melon cultures – up to 20% forage crops – up to 60%, permanent grasses – 17-44%), maintenance of stock-raising; bringing of manure in with amount 3-7 tons per hectare, introduction of the resource-saving irrigation schedules and use of modern overhead irrigation technique with optimal intensity of sprinkling.

Front-rank practice gives following results:

1. Prevents contamination of irrigated lands with heavy metals and toxic substances by diminishing of norms of mineral fertilizers application and replacement of them with organic ones.
2. Assists maintenance of soil fertility through the observance of standards of optimal crops correlation in rotations.
3. Averts violations of agricultural landscapes balance and assists increase of their ecological stability.
4. Creates conditions for ecologically safe products of agriculture obtaining.
5. Provides high yields of crops.
6. Allows promoting the profits of population, solving social problems and providing food security.

Possibilities

Agricultural enterprises meeting these requirements can get the stable and high enough yields of crops, high quality agricultural produce, preserve soil fertility and self-supporting balance of humus, to scale up the wages of workers and specialists, provide high social level of population, create modern infrastructure, solve any problems related to education and employment of young people.

Experience of State Enterprise "Research Farm "Askaniyske" gives evidence of upgrading of quality of employed population's life, improvement of condition of agricultural landscapes. This experience allows fulfillment of major state objective – providing of food security, as part of national security of country.

3. Monitoring and assessment

Session 3.4: Sustainable land management / Land degradation neutrality

ECOLOGICAL RESTORATION AND RECOVERY IN SANDY DESERT REGIONS OF CHINA

LI, Xinrong

Cold and Arid Regions Environmental and Engineering Research Institute, CAS, China, People's Republic of

lxinrong@lzb.ac.cn

Wind erosion and sand burial were the main cause of ecological degradation in the transitional zones between desert and oasis, desert and desert steppe to the west of the Helan Mountain, northern China, where annual precipitation is less than 200 mm. The planting of sand-binding vegetation is one of the most effective approaches available for ecological restoration in those regions. However, the vital issue for ecological restoration and recovery is how to maintain the stability and sustainable development of artificial vegetation ecosystem. In this study, based on a 50-year long-term study in the southeast edge of the Tengger Desert by the Shapotou Desert Research and Experimental Station of Chinese Academy of Sciences, our results showed that sand-binding vegetation succession was driven by the soil hydrological processes, meanwhile, the changes in the composition, structure and functional traits of vegetation had feedback influences on the evolution of hydrological processes and soil properties. Revegetation markedly enhanced surface dune soil alteration, such as increasing in the water-holding capacity and the entrapment of dew deposition of shallow soils (0-40cm) due to accumulation of dust deposition, the formation and development of BSCs, and propagation of massive herbs on the fixed dunes. These changes result in spatiotemporal variation and redistribution of soil water, further prolonged the residence time of rain water in the shallow layer of soil and decreased water replenishment of the deeper soil layers due to decreasing infiltration. Hence, we believe that changes in properties of surface soil led to increased interception of water, favoring shallow rooted grasses and forbs over perennial planted shrubs. Finally, initial planted xerophytic shrub communities will be replaced by herbaceous dominated communities. However, the monitoring for recovery of topsoil physicochemical properties in sand-binding vegetation system suggested that soil recovery was a slow process in an extremely arid desert environment, and how to conserve soil habitat will be a challenge for land managers. In addition, the characteristics of native vegetation patterns and the maintenance mechanism of biodiversity in the sandy areas were also discussed, in the right of stability analysis of the typical artificial vegetation, the spatial configuration models for revegetation at different bio-climatic zones of Chinese sandy deserts were proposed, which provided a new understanding for future ecological restoration and recovery.

GLOBAL ENVIRONMENTAL BENEFITS FROM REDUCING POVERTY? GHG MITIGATION FROM IFAD PROJECTS WITH AND WITHOUT CLIMATE/ENVIRONMENT FINANCE

MATTOS, Juan de Dios Roger (1); PATRICK, Eric (1); COMTE, Irina (2)

1: IFAD, Italy; 2: Institut de Recherche pour le Developpement

j.mattos@ifad.org

Rationale

Governments and development institutions aim to reduce poverty, increase food security and improve the living conditions of rural communities by investing in agricultural development. However, there are many co – benefits of these investments that go by unnoticed (Franks and Hadingham, 2012). One of them, climate change mitigation, could be optimized through GHG-aware design if data were available. By reviewing design documents of 30 investment projects from around the world financed by the International Fund for Agricultural Development (IFAD), Governments and other institutions, it is possible to calculate the contribution of these investments to global targets of climate change mitigation through reduction of emissions of greenhouse gases (GHG). These results underscore the importance of land-based adaptation as a development option which satisfies multiple objectives. Furthermore, if projects contribute to climate change mitigation, and at the same time achieve their targets of poverty reduction and local climate change adaption, it will be possible to evaluate the contribution of local actions by small farmers to global public goods (Glenk and Colombo, 2011).

Methods

This paper uses design documents (including working papers and consultancies reports) of 30 projects approved by IFAD between 2012 and 2013. The projects were not selected randomly but on the basis of data availability. Data from these documents (collected in each country during the design phase) was introduced in the EX-Ante Carbon-balance Tool (EX-ACT) developed by the Food and Agriculture Organization (FAO) and others as a way of rapidly but reliably estimating carbon pools and GHG emissions, based on IPCC 2006. EX - ACT provides ex-ante measurements of the impact of agriculture (and forestry and other land use) development projects on changes in the net C balance and of GHGs, which are taken to represent the mitigation potential of the project (Branca and Gorin, 2010). EX-ACT can be used in the context of ex – ante project formulation and it is capable of covering the range of projects relevant for the land use, land use change and forestry (LULUCF) sector. It can compute the C-balance by comparing two scenarios: "without project" (i.e. the "Business As Usual" or "Baseline") and "with project" (Bernoux et al. 2010). In this paper the '''with'' and ''without'' project values are compared between two sets of projects, each group with the same number of projects; one group where projects do not benefit from climate and/or environment finance and one where they do. Furthermore, any calculated difference between these groups is expressed both per hectare as well as per beneficiary, together with project cost data to assess the cost effectiveness of mitigation co-benefits between these two groups.

Results

Table 1 summarizes the results of the study. Only two of the projects which *do not* benefit from climate/environment finance had negative values (meaning mitigation of GHG) in the without project scenario; the other project areas can be anticipated to generate net emissions. On the other hand, six of the projects in that group have positive values for the with project scenario; in other words, even projects which do not have an explicit mitigation objective or climate/environment finance can generate mitigation co-benefits. However, amongst the project group which benefit from co-financing from environmental or climate change funds, 13 have a positive balance, as well as greater mitigation per hectare.

Conclusions and Recommendations

In conclusion, it appears that explicitly including climate and environment objectives together with budgeting for it influences project design in ways which generate important benefits towards global public environmental goods in addition to both local poverty reduction and environmental benefits. In the case of the IFAD 'with climate/environment finance' group of projects, the climate objectives are primarily related to adaptation, reflecting the source of funding – IFAD's Adaptation to Smallholder Agriculture Program – but which also generate mitigation co-benefits which become visible when a suitable methodology is applied. Such tools should be widely used and mainstreamed into development project assessment and design in order to have an empirical basis on which to optimize trade-offs and maximize cost effectiveness.

Outcomes

On average, projects that have climate or environment co – financing (ASAP or GEF) have higher mitigation numbers both per hectare and in total.

EFFECTS OF VEGETATION COVER ON SOIL MOISTURE AS AN IMPORTANT FACTOR FOR RESTORATION OF DEGRADED TEMPERATE FOREST ECOSYSTEMS.

SOSA, Fermín

Universidad de Guanajuato, Mexico

shoobilatzi@gmail.com

This work is about a study in the La Esperanza watershed, in the municipality of Guanajuato, México, to determine the behavior of soil moisture with different plant covers. Random sampling was performed considering four canopies depending on vegetation, with six replicas each. Two types of native vegetation were considered, sities with *Quercus sp* as arboreal stratum and sites where *Dodonea Viscosa*, *Mimosa sp* and *Pingüica sp* are associated as stratum of shrubs; sites with *Eucalyptus sp*, these species of trees were introduced for restoration of areas in process of degradation some years ago, and they are wooded areas now; and sites without vegetation. Soil samples were collected from March to September to determine moisture and analyze the differences between each site and each canopy, correlating moisture with variables such as altitude, slope, orientation, soil texture, number of trees on the site, leaves on soil and litter thickness of soil horizons "O" and "A". These study showed that during the dry season, humidity was lower for sites with shrubs (8.3 %) and *Quercus sp* (8.7%) and greater for sites with *eucalyptus sp* (10.6%) and with no vegetation (9.9%); moisture loss was greater for sites with no vegetation (3.4%) and lower for sites with *eucalyptus* (-0.8%). During the rainy season, humidity was higher for sites with *Quercus sp* (16.6%) and lower for sites with *eucalyptus sp* (15.4%); sites with *Quercus sp* (7.9%) and shrubs (7.2%) had increased humidity. A review was performed with the loss and increase of humidity; sites with *Quercus sp* (6.2%) and shrubs (4.2%) had greater humidity. The percentage of moisture in places with *Quercus sp* (7.9%),shrubs (7.2%), and with no vegetation (6.1%) had significant differences between the dry and rainy season, which did not occur at sites with *eucaliptus,* (4.8%) where differences were minimal. The analysis of these results can be considered in the moment to take desitions about restoration of degraded temperate forest ecosystems.

DECISION-SUPPORT TOOLS FOR ASSESSING LAND DEGRADATION AND REALISING SUSTAINABLE LAND MANAGEMENT IN TUNISIA

JENDOUBI, Donia (1); SCHWILCH, Gudrun (1); LINIGER, Hanspeter (1); HURNI, Hans (1); OUESSAR, Mohamed (2); HAMROUNI, Hedi (3)

1: University of Bern, Switzerland; 2: Institut des Régions Arides, Tunisie; 3: Executive Directorate of Development and Conservation of Agricultural Land. Ministry of Agriculture. Tunisia.

jendoubi.donia@yahoo.com

This work focuses on the use of the most relevant indicators for measuring impacts of different degradation processes in El Mkhachbiya catchment, situated in Northwest of Tunisia and those actions taken to deal with them based on the analysis of operating modes and issues degradation in different agricultural landscapes (farming systems).

The main objective of this research was to provide a database for surveillance and monitoring of land degradation in order to support stakeholders in making appropriate choices and judge guidelines and possible recommendations to remedy the situation in order to promote sustainable development.

This study investigated the application of the *WOCAT* (World Overview of Conservation Approaches and Technologies)assessment and mapping tools in El Mkhachbiya catchment (representative area) in Northwest of Tunisia.

The elaborated data and maps based on the *WOCAT* tools have been found useful and including effective information on land degradation and conservation status. Consequently, this methodology would provide an important background for decision-making in order to launch rehabilitation/remediation actions in the study area and then reducing degradation processes, scaling up restoration activities and sustainable land management *SLM.*

SOIL CARBON IN DRYLANDS SOILS: MULTIPLE FUNCTIONS BENEFITING SOCIETIES AND THE ENVIRONMENT

BERNOUX, Martial (1,2,5); CHEVALLIER, Tiphaine (1,5); RAZAFIMBELO, Tantely (3,5); GALLALI, Tahar (4,5)

1: IRD, France; 2: CSFD, France; 3: LRI, Madagascar; 4: FST-Tunis, Tunisia; 5: CaSA network

martial.bernoux@ird.fr

Soil organic matter (SOM)—and thus organic carbon which accounts for over 50% of its mass—has a key role in the overall behaviour of soils and the agroecosystems they support: soil physical qualities, stimulation of soil biological activity, water and nutrient storage and availability for plants and pollutant regulation. The soil organic carbon content is generally considered to be the prime soil quality indicator, with respect to its agricultural and environmental functions.

Loss of organic carbon or SOM inevitably results in soil quality degradation and alteration of the soil's associated functions, creating a vicious circle whereby soil degradation prompts a reduction in agricultural productivity and an increase in food insecurity, malnutrition and famine, etc. Conversely, increasing the SOM directly enhances soil quality and fertility, thus contributing to agricultural resilience and sustainability and, in turn, food security of societies and carbon sequestration.

The impact of forestry and agricultural activities on carbon sequestration has been overlooked, with agriculture and soil carbon being poorly treated in international negotiations. It was not until the 2008 and 2009 food price crises and food riots in Africa that international debates began to be focused on the soil topic. Soil carbon is now a global environmental issue, especially in the framework of the three multilateral environmental agreements (MEAs): the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD) and the United Nations Convention to Combat Desertification (UNCCD). If, the objectives of these conventions differ, they are nevertheless interrelated, especially with respect to dryland terrestrial ecosystems: desertifi cation, climate change and biodiversity loss interact.

Thus we advocated that soil carbon should be recognized as a valuable indicator usefull for the 3 conventions.

TOWARDS LAND DEGRADATION NEUTRALITY: VALUING TRADITIONAL KNOWLEDGE PRACTICES

BOGGIA, Antonio (1); CANDELORI, Massimo (2); CIANI, Adriano (1); LAUREANO, Pietro (3); TEI, Francesco (1); TORRES, Leslie (4)

1: University of Perugia; 2: Individual, Agrometeorology; 3: IPOGEA; 4: Indipendent consultant, Environmental Economics

letatkent@hotmail.com

Rationale

The validity of Traditional Knowledge (TK) has been asserted for many years. Nonetheless, the application and innovative disseminations of these sustainable land management techniques appear still below their real potential: the reasons range from limited awareness of the non-marketed values created through TK techniques, to non-exhaustive TK-inventories and complementary technologies.

The 2012 Rio+20 Summit set a high level of ambition, calling for a "land-degradation neutral world" (LDNW). The target "By 2030, achieve a LDNW and restore degraded land including land affected by desertification and drought" has been already proposed in the ongoing consultations for the Sustainable Development Goas that will guide the post-2015 development agenda. However, the concept and the approach to Land Degradation Neutrality (LDN) are the object of current debates within the desertification community (Welton et al., 2014).

Assessing the value of TK practices and their positive effect to support ecosystem services will then produce insights relevant to their "neutrality" and LDN approaches and policies.

This Paper builds on the concept of LDN and applies suited methodologies to measure short- and long-term effects of preserving/upscaling among the most recurrent TK practices in the Mediterranean: terraces, dry stone wall, water gallery and soil control plants.

Methods used and partnership set up

Policy makers need to be informed of the real potential of TK and the non-marketed values latent in these practices, as they are confronted with the decisions of: (i) abandoning; (ii) maintaining; (iii) expanding the use of such practices; or (iv) replacing them with a different technology.

LDN cannot be achieved through offsetting strategy. Although compensation is a very effective tool in economics, it is difficult to apply to environmental goods - particularly to land - since each ecosystem has its own innate equilibrium levels, its intrinsic value and its form of tenure. Hence, the approach followed in this Paper focuses on "how" to best secure LDN, rather than on the "where".

The multi-criteria analysis (MCA) tool is proposed as the instrument for a multidimensional representation and sustainability assessment across the policy-making scenarios. Moreover, the integration between MCA and Geographical Information System (GIS) will provide a spatial multi-criteria assessment of alternatives against a set of criteria often difficult to quantify.

We select two approaches within the MCA framework: Choice Modelling (DeFRA, 2007) to effectively capture respondents' attitudes and willingness to pay; and Dominance-based Rough set approach (DRSA)(Greco et al., 2004) to discover knowledge from inconsistent or ambiguous data, where weight assignment in MCA is excluded for the first time in MCA methods. Consideration will be given to the recently developed Institutional Analysis and Development Framework (IAD) (Ostrom, 2011), to better understand the conditions under which local communities can self-manage and maintain their common resources. IPOGEA, a non-profit research organization recognized by the European Union, will contribute the experience of the Iconographic System of Traditional and Innovative Techniques (SITTI) and its readily accessible archives and database (Traditional Knowledge World Bank - TKWB).The Department of Agricultural, Food and Environmental Sciences, University of Perugia will provide scientific and technical expertise, conduct the economic valuation and develop the MCA methodology, based on DRSA.

The long-standing experience of IPOGEA together with the expertise of the University of Perugia, ensure that complex parameters, such as: (i) interdependence of ecosystems; (ii) spatial and temporal issues in analysis on how ecosystems services develop over time to enable economic valuations; and (iii) environmental limits and thresholds; are analyzed over representative samples of TK, ecosystems and landscapes.

Finally, relevant insiders' knowledge will ensure that this study systematically builds upon and is aligned with the UNCCD intergovernmental process and its milestones.

Results

The following results are expected:

- Economic, environmental and social analysis of selected TK practices in the Mediterranean, finding concise classification patterns for the simulation of future situations;
- Parameters and indicators to identify and map out TK losses through identification of "hot spots";
- Innovative approaches to valuing TK practices based on the methodological approaches described above;
- Proposals for the project's continuity and assessment of its large-scale replicability in a LDN context.

Outcomes

The Paper will document a knowledge-discovery paradigm for multi-attribute and multi-criteria decision making, with regards to sustaining ecosystem services through land-degradation neutral TK practices:

The design of a flexible, holistic methodological approach will support policy makers in their territorial and environmental planning towards achieving LDN national targets.

In discovering knowledge from the data generated in this study, this Paper also concurs in verifying the relevance of the current UNCCD progress indicators to a LDN assessments of TK practices.

The methodological framework design may also enable the development of UNCCD policy guidelines to recognize and assess TK values, in support of the LDN approach which was recently assumed at the intergovernmental level.

GROUNDING THE COMPREHENSIVE ANTI-DEGRADATION PROTECTION OF IRRIGATED LANDS FOR THEIR SUSTAINABLE USE

SHEVCHENKO, Anatoliy

Institute of water problems and land reclamation, Ukraine

Lagunova@ukr.net

In the context of growing the frequency of droughts in different climatic zones of Ukraine as a result of global climate change a sustainable development of agriculture is impossible without using irrigation. Today, in the country within the total area of 2.2 million hectares of irrigated land it is actually irrigated only about 0.6 million hectares. In this regard, the restoration of irrigated land potential is a top priority of the agricultural sector of Ukraine.

As is well known irrigated lands are prone under certain conditions to the increased risk of degradation processes development. The most common of them are: floods, irrigation erosions, resalinization, alkalinization, soil consolidation, soil dehumification, pollution with heavy metals and others (Scientific basis, 2009; System of anti-degradation measures, 2013). Therefore, the sustainable use of irrigated land is largely determined by the degree of their natural or artificially formed safety against degradation processes primarily related to water hazard.

Grounding the environmentally sustainable and efficient use and comprehensive protection of irrigated lands against degradation requires proper tools for their differentiation into spatially separate areas with the certain conditions of processes formation and development along with the necessary adaptation to them typical farming, reclamative, nature-conservative and other protective measures.

Development of a methodology for area separation with different conditions of crop cultivation, risks and degrees of adverse soil processes was based on field and analytical studies of a long-term impact of irrigation on the processes of environment transformation, effectiveness of measures to protect and improve soil fertility and state of the existing systems of engineering protection against flooding in the irrigated areas of Kherson region. For the spatial differentiation of the territory by its stability to the development of negative processes under irrigation, the methods of special zoning and comprehensive evaluation of environmental and reclamative conditions as well as sustainability of irrigated lands were used (estimation, 2002).

The developed methodology for grounding the differentiated target measures to prevent irrigated lands degradation is based on using monitoring data, land zoning, a specialized diagnostic system of water hazard and soil degradation, predictive information modeling of ecological situations, environmental and reclamative land qualification, adaptive algorithms of the typical schemes of measures with the formation of situational models of comprehensive protection from degradation (Figure).

The proposed integrated multi-level functional diagnostics system of land conditions and soil degradation includes the direct and indirect indices of preconditions for flooding development and soil degradation processes as well as the criteria for their evaluation, mainly by determining the sustainability of natural and agro-reclamative geosystems to the certain types of land degradation at different hierarchical levels: regional, local and detailed.

The methodology of map predictive information modeling of ecological situations provides a consistent assessment and representation of a mechanism of environmental conditions transformation at different hierarchical levels of planning measures.

Predictive information model is a set of map materials and attribute information to them on spatial and temporal variability of natural and reclamative conditions of a specific area. A system of multi-level predictive and information models based on zoning is made by using GIS and monitoring data (Shevchenko, 2009).

Environmental and technological limitations and regulations relative to the use of lands with different risk degree of degradation developments are set by the environmental and reclamative land qualification (Scientific Basis, 2009).

According to the qualification as to the degradation processes development three categories of land are specified: potentially stable; potentially unstable; actually unstable. Depending on the potential sustainability, environmental and reclamative state of the lands and actual degree of degradation, the following ecological risk zones are determined: a risk-free zone, a zone of acceptable risk, a zone of increased risk and a zone of sustainable risk with the development of crisis ecological situations.

Making the situational models of comprehensive anti-degradation protection is proposed to fulfill using the results of land qualification based on relevant predictive and information models which describe actual or predicted state of lands at a particular time, taking into account the target measures to protect and enhance soil fertility, prevent or minimize the negative effects of flooding and soil degradation processes.

Conclusions

As the tools for grounding differentiated anti-degradation protection under irrigation a spatial decision support system has to be used, built on the principles of adaptation and exact binding of measures to the conditions of a certain object, using monitoring and GIS data. Effective method for selecting the areas with different natural and reclamative conditions and their grouping according to the degree of environmental risk against the background of irrigated land use and the need to protect them from degradation processes is a multi-level spatial diagnostics system of soil degradation, predictive information modeling of the conditions of anti-degradation sustainability and environmental and reclamative land qualification. The proposed methodical approaches enable to make appropriate eco-technological regulations, limitations and recommendations concerning safe farming on the irrigated lands.

POTENTIALS OF WISE LAND USE CHOICES IN CURTAILING IMPACTS OF EXTREME WEATHER, REDUCING LAND DEGRADATION AND ENHANCING AGRICULTURAL PRODUCTIVITY IN AFRICA

SHITTU, Adebayo Musediku (1); VIDAL, Déa de Lima (2)

1: Federal University of Agriculture, Abeokuta, Nigeria, Nigeria; 2: State University of Ceará, Fortaleza, Ceará, Brasil

shittuam@funaab.edu.ng

Unwise land use choices viz-a-viz reliance on inappropriate farming systems, cultivation of marginal lands, overgrazing of grassland, unsustainable exploitation of forest ecosystem and too rapid urbanization have been linked to rapid deforestation leading to land degradation and desertification in Africa (MEA, 2005). The consequence has been drastic reduction in the productive capacity of agricultural land in the region, leading to stagnating or declining yields, loss of potential income and increased poverty, hunger and food insecurity (World Bank 2007). Clear understanding of the multidimensional impacts of land use choices on African agriculture is therefore crucial to inform sustainable livelihood and environmental policy in Africa. A study is therefore, being conducted to examine the link between land use pattern on one hand and land degradation, severity/impact of drought and rising aridity on the other, and the combined impacts in explaining the relatively low cum wide differences in agricultural productivity among Africa countries. It is part of an ongoing collaborative and interdisciplinary research between Scientists with expertise in semi-arid agricultural research in Brazil and some Nigerian Scientists working on how to combat rising desertification and land degradation in Africa. The proposed paper is the report of an ongoing study that is based on a panel data on land use patterns, agricultural production and resource use, and relevant climate/environmental data on 47 African countries between 1990 and 2010. The study hopes to provide quanitative evidences on the link between land use choices, land degradation and agricultural productivity. Three measures of agricultural productivity were employed, including grain yield, labour productivity (GDP per economically active worker in agriculture) and Total Factor Productivity (TFP). The index of TFP used, is the Hicks-Mooresteen TFP index, constructed following O'Dornell (2008, 2011) using DPIN program, version 3.0. A combination of descriptive, correlation and multivariate regression methods are being employed in the data analysis. Preliminary evidences revealed substantial variation exists in agricultural productivity among African countries. Cereal yield ranged from as low as 0.34 tonnes/ha to as high as 7.8 tonnes/ha. Similarly, the range of agricultural LP and TFP were $244.11 - 12,095.81 in 2005 prices and 0.04 - 0.40 respectively.The mean grain yield, LP and TFP were respectively 1.42 tonnes/ha, $1, 378.10 and 0.17. Preliminary evidences based on correlation analysis revealed that land degradation, aridity and proportion of the population affected by draought is significantly reduced with increase in the relative size of protected terrestial land, forest cover and reduction in area subjected to bush burning. The various measures of agricultural productivity area significantly enhanced by access to basic infrastructure, increased intenstity of livestock population, among other.

ECONOMIC POTENTIAL OF LAND-USE CHANGE FOR SUSTAINABLE MANAGEMENT OF AGROFORESTRY PARKLAND RESOURCES AND IMPROVING LIVELIHOODS IN THE DRYLANDS OF WEST AFRICA SAHEL

BINAM, Joachim Nyemeck (1); PLACE, Frank (2); ADEMONLA, Arinloye (1); ANTOINE, Kalinganire (1)

1: World Agroforestry Centre (ICRAF), Mali; 2: International Food Policy Research Institute (IFPRI)

j.binam@cgiar.org

Interest in African drylands development has increased in recent years. This has been driven mainly by recognition that while they have been the target of significant humanitarian aid over the last three decades, comparatively little effort has been put into development that would increase people's resilience and reduce their dependency on aid.

In-spite of being exposed to the relatively unfavorable dryland climate, dryland people and communities have acquired through the millennia resilience to these conditions, which enable both land and human well-being to regularly recover following droughts and other nature-induced shocks like floods and fires. However, the relatively recent high human population growth rate and increasing frequencies and intensities of droughts in the drylands are undermining the resilience of both lands and people. This eroded resilience is a result of a vicious cycle of land users driven to reduce the capacity of the land that supports them, which further exacerbates their well-being (Safriel et al 2005).

The main objective of this study is to provide information about the economic profitability of switching land use to a tree-based system through farmer-managed natural regeneration (FMNR) practices and, reviews the evidence that these systems are currently important and will play a pivotal role in achieving resilient and sustainable drylands development.

As a first analysis of the returns to investment in FMNR, a model was constructed to analyze costs and benefit streams per hectare over a different year time frame. Two benefit streams were captured: value of direct tree products (wood and non-wood) and value of improved crop yields. The data on benefits is from Place et al., (2013) for the Sahel.

the results indicate that the lowest estimates for the returns, for the 20 year period at a 20% discount, are $29.9 for net present value (NPV) and 1.5 for the benefit-cost ratio (BCR) for one hectare of FMNR. The highest calculations are for a 30 year period at a 10% discount rate and are $178.11 and 2.66 respectively for the NPV and BCR. The breakeven point comes in year 11 with a 20% discount rate and year 10 and 9 for discount rates of 15% and 10% respectively. The benefit streams per hectare from crops and tree products are virtually the same in the case of Mali. However, note that when scaling up to the households level, the benefits from tree products will increase relative to crops as not all the farm area will be under crops, while the value of tree products was drawn from a farm level enumeration.

In Niger, the lowest estimates for the returns, for the 20 year period at a 20% discount, are $149.2 for the NPV and 4.19 for the BCR. As in Mali, the highest calculations are for a 30 year at 10% discount rate and are $569 and 7.47 for the NPV and BCR respectively. The same calculations can be done for the five, ten, and fifteen year period at a different discount rate levels.

These results also indicate that the lower and upper limits of private economic returns in the selected year periods in Niger are three to four times greater than that estimated in Mali. This is probably the results of the well-known institutional and policy reforms that have been pro-agroforestry in Niger (Place et al., 2013). Indeed there have been some recent policy and institutional reform that have directly targeted and benefited the expansion of agroforestry in Niger thus complemented education on farmer managed natural regeneration with investments in advocacy and the creation of local rules and institutions to privatize rights to trees. This thereby promoted improved environmental management. These informal reforms—developed through consensus and with the support from village and district chiefs helped communities resolve resource conflicts, sanctioned uncontrolled tree cutting and livestock grazing, and reinforced local efforts to regenerate on-farm trees.

Despite the adverse effects of the Sahelian forest codes long time being recognized, there have been many dialogues in the region to try and move forward. In the other hands, markets for tree products are other factors that impacts on incentives to manage trees. The development of tree product markets will have a positive effect on TBS in general. For FMNR in particular, market development may have different effects. In general, as tree product markets develop, there is more incentive to maintain trees on farms. There may be further incentives concerning the selection of species to retain based on market signals, but only if market signals persist for a long period of time since changes in tree species composition is a long term operation in the drylands. Furthermore, in the semi-arid and dry sub-humid zones where tree planting opportunities are greater, certain types of market development may favor tree planting by farmers and, as a result, may also reduce interest in FMNR.

Remarks on Land Degradation Neutrality (LDN), the Case of the Terrestrial Environment of Kuwait

MEISAK, Raafat Fahmi

Kuwait Institute for Scientific Research, Kuwait

rmisak@kisr.edu.kw

Rationale

Kuwait covers about 17,800 km^2. It consists of two main ecosystems. These are the terrestrial (about 85%) and the coastal and marine (15%). Some 72% of the terrestrial environment of Kuwait is degraded terrains. Three classes of land degradation are identified (Misak R., J. M. Al-Awadhi & M. Al-Sudairawi 1999 and Al-Awadhi, et al. 2005). These are slight (15%), moderate (75%) and intensive (10%). Biophysical, land use and socioeconomic indicators of land degradation are reported in Kuwait (Misak 2014). The most significant land degradation indicators are deterioration of vegetation cover and loss of biodiversity, loss of topsoil through water and wind erosion, soil sealing and compaction and soil salinization (in several farms of Wafra Agricultural Area). The extent of these disturbances is not well documented.

In Kuwait the following classes of drought are recorded: (Misak R. & Al-Dousari A. 2013.)

- Very severe: Total annual rain fall, less than 25 mm (seasons 1963/1964 and 1993/1994).
- Severe: Total annual rain fall, from 25-50 mm (seasons 1972/1973, 1976/1977 and 2007/2008).
- Moderate: Total annual rain fall, from 50-75 mm (seasons 1966/1967, 1991/1992, 2008/2009).
- Slight: Total annual rain fall, 75-100 mm (seasons 1964/1965, 1996/1997 and others).

Categories of desertification/land degradation in Kuwait include:

- Land use related (socio-economic). This category is caused by overgrazing, deforestation, quarrying & mining, over-exploitation of resources (especially irrigation water in some agricultural areas) as well as camping and recreation over fragile desert surface.
- Military operations related. This category is caused by maneuvers & troops transport, establishment of ground fortifications, landmines plantation, demining activities, etc.(August 1990-February 1991).
- Natural. This category is caused by prolonged drought, flash floods and strong winds.

In Kuwait, sustainable action plan to control land degradation is actually not in practice. Land degradation neutrality (LDN) in arid, semi-arid and dry sub-humid areas is a state whereby the amount of healthy land resources remains stable or increases within specified temporal and spatial scales (UNCCD, 2014). After the UN Convention to Combat Desertification has entered into force for the State of Kuwait (22 June 1997), the need to assess land degradation/desertification in Kuwait has substantially increased. While standard and traditional methods for undertaking such an assessment and measurements are inaccurate, time consuming and expensive, it has been demonstrated that satellite-based and airborne remote sensing offer a considerable potential.

Methods

This study discusses the feasibility of reducing land degradation from about 72% in the year 2015 to 0-5% in the year 2030. For this purpose, a 15- year LDN scheme is proposed. It consists of several programs. These include: 1) Land degradation monitoring, mapping and assessment (ground and remote sensing investigations), 2) GIS based knowledge support system 3) Restoration/rehabilitation (soil, vegetation and water supplies), 4) Sustainable land use and 5) Public awareness and human development. Under the umbrella of this study land degradation monitoring, mapping and assessment will be tackled. Based on recent field surveys (March 2014) and updated remote sensing information, the approximate areas of degraded and non-degraded terrains of the main land use types of the terrestrial environment were estimated.

In addition, monitoring and assessment of land degradation in 21 pilot sites represent open areas of terrestrial ecosystem of Kuwait were conducted. Each site covers 25km^2. Land use, vegetation type and land degradation severity (very severe, severe, moderate and slight) were identified. Based on field measurements and surveys, degraded terrain in five pilot sites were mapped using recent IKONOS images.

Results

About 11330 km^2 of the terrestrial environment of Kuwait representing 72% of the country are degraded. For agricultural areas which cover 470 km^2 (2.6% of Kuwait) about 80 km^2(17%) are degraded, while the rest (390 km^2)is non-degraded. Land degradation in agricultural areas is represented by soil salinization and loss of agricultural production. For abandoned gravel quarries which cover 383 km^2 (2.6% of Kuwait) about 203 km^2 (53%) are degraded. Land degradation in the abandoned gravel quarries is represented by surface deformation, hydrologic disruption, soil compaction, vegetation deterioration and loss of biodiversity. With respect to protected areas which cover about 3242 km^2 (18% of Kuwait) about 1679 km^2 (52%) are degraded terrains as real protection is still in progress. For areas used for rangelands grazing which cover about 9123 km^2 (51% of Kuwait) are highly degraded. Loss of biodiversity, vegetation degradation, loss of top soil (by both wind and water), soil compaction and sealing are the prevailing land degradation processes.

Outcomes

Recent statistics on percentages of degraded terrain by land use type (agriculture, quarrying, protected areas, military, oil and rangelands).

Land degradation information system including basic information on the magnitude, mechanisms and trends of land degradation processes in pilot sites.

Set of recent land degradation maps (through remote sensing and ground truth).

LAND DEGRADATION-DESERTIFICATION PROCESS: A KEY STUDY FORM CORUH BASIN IN TURKEY

ATALAY, Ibrahim

Mehmet Akif Ersoy University, Turkey

ibrahim.atalay@deu.edu.tr

Çoruh basin covering an area of 20 000 kilometres square and locating in the NE part of Anatolia is one of the land degradation-desertification basin of Turkey. In this basin the Eastern Black Sea Mountains rising more than 3000 m have been deeply dissected by Çoruh River and its main tributaries. The relative elevation between the Çoruh valley and the summit part of encircling mountains is more than 2500 m in the middle part of basin. Slope inclination of the basin is more than 40 %.

Main livelihood of rural people living in the mountainous areas and along valley depends on animal husbandry and agricultural activities. These economic activities lead to the misuse of land in the sloppy areas, deforestation and overgrazing and heavy grazing in the rangelands and forests. Because rural people opened agricultural fields in the forest lands to obtain cereals, over utilized the forest for the construction of dwellings and fuel materials and engaged in animal husbandry to obtain meat requirements. New scattered and temporary settlements were established along the valley, and upland areas with the increase of rural population.

For these reasons, the steep slopes of valley and the mountains were subjected to intense soil and parent material erosion. The torrents originate from the upland areas destroyed agricultural fields that are found along the valleys. Presently the steep slopes of the valley are converted into bare lands like deserted area. The evaporitic sediments preventing the growth of vegetation are being dissected by the gullies as the result of mostly chemical erosion. On the other hand, the gullies are also seen on soft flysch and volcanic tuff and sand outcropped along the Çoruh valley. Rocky areas are formed on the granitic rocks where natural vegetation, especially forest has been completely destroyed. Destruction of natural vegetation on the steep slopes of valleys is the main responsible for the land degradation and desertification.

The importance of the Çoruh basin is to suit for the dam construction. Four big dams construction are planned, currently two dams construction named Borçka and Deriner were completed. The mean annual suspended sediment yield of Çoruh basin is about 286 ton/ km square, transported suspended sediment is nearly 5.8 million ton, the bed load is c. 2.8 million ton and the amount of total erosion is estimated to be 31.3 million ton. For this reason the erosion control measurements in the basin is the vitality importance. Up to now, many erosion control workings have been carried out, and watershed management project was made for Oltu basin. But these projects that applied the basin are not enough in the preventing of erosion control and land degradation due to financial shortage and scattered settlement patterns.

In order to lessen or mitigate land degradation process and to rehabilitation in Çoruh basin following measurements should be carried out:

1. Scattered or dispersed rural settlements should be converted into cluster settlements.
2. Local and micro land classification should be made according to natural properties of the basin. The flat land in the forest area can be classified as agricultural field or meadow in order to obtain agricultural production and grazing area for animal breeding purpose.
3. The agricultural land on the sloppy area should be abandoned and reforestation activities should be applied according to ecological conditions of this basin. Dry forests on the semiarid areas should be regenerated and rehabilitated.
4. Additional revenues for rural people should be provided to lessen the livelihood depending on limited land resources. For example, walnut, cherry, green houses and fruits gardens should be established in suitable places along the valley. Present walnut gardens should be enlarged and the new agricultural techniques can be applied for the increase of its productivity. Ecotourism potentials of the basin should be planned in

order to pull tourists, because Coruh basin has important touristic potentials such as hiking, trekking, rafting sports and glacial topographic forms like cirques and cirques lakes, glacial valleys, and deep and wide canyon valley, waterfall like Tortum. Rich plant communities belonging to relict and endemic plant species are seen. For instance, one can see both Mediterranean and Euro-Siberian plants in the vicinity of Artvin town, in Coruh valley.

5. Reforestation, erosion control activities should be enlarged according to ecological conditions.
6. Range management should be planned and applied in the mountainous areas upon the natural timberline. Because the rangelands of the Coruh basin mountains have important potential to the develop animal husbandry.
7. Best way for reforestation is to natural regeneration of forests. Forest regeneration occurs rapidly in the protected forest areas and abandoned fields in the forests. For example, the scots pine forests naturally enlarge toward the lower level in the western upland areas of Oltu basin.

DESERTIFICATION PROCESSES IN THE MARINE COASTAL ZONE OF UKRAINE

ALEKSANDROV, Borys

Odessa Branch, Institute Of Biology Of Southern Seas National Academy Of Sciences Of Ukraine, Ukraine

obibss@paco.net

Because of water level dropping, two lacks located in densely populated coastal areas of the Black Sea and the Sea of Azov became nuclei of desertification and land degradation processes around it. Some ways of improvement of the ecological situation are proposed.

It is scientifically proved, that the major hotspots and main "pain points" in the biosphere are connected with interface areas (Zaitsev, 2012). The cases of two saline coastal lakes (local names limans) in the Black Sea (Kuyalnik) and the Sea of Azov (Molochny) are examples of this. Both of them are located in dendely populated recreational, agricultural and industrial areas (Rozengurt, 1974). The Kuyalnik lake, is isolated from the Odessa Gulf by a narrow sandy bar, for many years was famous as an internationally recognized source of medicinal mud. During the second half of the XXth century the water salinity fluctuated between 38 ppm and 120 ppm. But since the 2000, as a result of human activities (interruption of incoming river and habitat continuity, disconnection of adjacent wetlands and hydrological alterations) and climate change the water salinity increased about fourfold, in 2013-2014 reaching 317 ppm. The water level has significantly dropped and a bottom area of 26 km2 drained and turned into a sandy-muddy sedert covered by a thick layer of salt.

In the same time, the water salinity of the Molochny lake, formerly important as a fishing wetland, increased from 30 ppm to 82 ppm. As a result of water level decreasing, 70 km2 of bottom drained and turned into a sandy-muddy saline desert. In consequence of this, commercial fisheries suffered heavy losses.

Both cases are a confirmation of general conclusions concerning climate change and its impacts on water resources made by Economic Comission for Europe (New York and Geneva, 2011)

Integrated investigations by experts from the Institute of Marine Biologe of the National Academy of Sciences of Ukraine (Odessa) were organized, including hydrology, chemistry and biology. As a result, data concerning the progressive reduction of water surface and appearance of desert strips around, increasing of water salinity, changes in biodiversity and number of species of algae, fungi, invertebrates and fish in the water, decline of recreational potential and commercial fish stocks were obtained.

Ways of improvement of aquatic ecosystems by increasing the river and marine waters inflow in impacted lakes were proposed.

ADVANCEMENT AND RISKS OF SALINIZATION AND DESERTIFICATION IN THE BRAZILIAN SEMIARID

VIEIRA, Marcelo Feitosa (1); VIEIRA, Clarissa Telles (2); DOS SANTOS, Gleydson Ribeiro (3); ALBUQUERQUE, José Alfredo (1)

1: Departamento Nacuional de Obras Contra as Secas - DNOCS, Brazil; 2: Universidade Federal do Ceará; 3: Empresa de Assistencia Técnica e Extenção Rural do Ceará

marcelojafv@yahoo.com.br

This study aimed to assess the progress in salinization and desertification in the Brazilian semiarid and policies of irrigation and drainage, as one of the causes of these phenomena rush in agriculture. Climate is undoubtedly one of the elements that influence the physical changes in the environment, the associated high temperatures and high evaporation rates make the region vulnerable to desertification of semiarid, Filho, et al., 2012. Aciole claims, 2014 in the case of soil degradation resulting from natural process that may be catalyzed or induced by man. The process of land degradation produces the deterioration of vegetation, soil and water resources. Through a series of physical, chemical and hydrological processes that deterioration causes the destruction of both the biological potential of the land as of their capacity to sustain the population attached to it. In Brazil, the National Plan to Combat Desertification (NPDC) found that the vast majority of the land is susceptible to desertification in semi-arid and sub-humid areas of the Northeast. The quantification of these areas shows that about 181,000 km2 (corresponding to approximately 20% of the semiarid area in northeastern region), are in the process of desertification. In this context, semi-arid areas of Brazil pose challenge for increased productivity and improvement of natural resources.

The Brazilian semiarid region, also known as wilderness, is the most populated semiarid region of the world. It is a region of high temperatures where the rainfall patterns are highly irregular, with long dry periods and occasional rains concentrated in a few months. In such a region is observed a great drought, since the amount of falling rain is three times less than the amount of water that evaporates from the surface. The drought is part of the history of the region and there are records of droughts since the days of the Empire (MDS, 2014). Because of its environmental limitations, semiarid're more likely to suffer from environmental degradation processes mainly for their socioeconomic situation and their soil and climate characteristics. Despite the state of Ceará have been advances in the realm of public policy to combat this problem, still lacks effective actions according to Gomes 2011 (Formiga et al., 2012). Observed that 55.25% of the northeastern semi-arid lands are affected by desertification and 62.6% of the affected northeastern municipalities have higher degradation percentage of 80%. This shows the degree of fragility in which lie the northeastern counties. The present state of Ceará in this context has 10% of its land classified as degraded, mainly divided into three major regions, they are: Irauçuba/North Central, and Inhamuns Jaguaribe. In these areas the native biome, the savanna is largely devastated and their eroded soils, mainly because of lack of knowledge and proper soil management. It is inferred, from the results obtained, that municipalities with high levels of desertification have deficiencies on the part of facing the use and conservation of soil and a combat action in this sense public policies will be essential to ease this process. We conclude that there is a policy directed towards short and medium term modify the actions of man in this region, will be impossible to live with the region in coming decades it is concluded. worsens because increasingly the lack of water that kills entire herds of cattle, goats and sheep, leaving farmers with no alternative to bail out their flocks and with severe economic and financial problems.

THE DESERTIFICATION IN HUMID REGION OF CHINA

YE, Wei; YANG, Lihui

People's Republic of China

lihuipost@gmail.com

Desertification is a global environmental problem (Yang, 2005). According to the UNCCD, desertification is due to climate change and the unreasonable activities of human being and other factors, make arid and semiarid and with drought disaster in semi-humid region of land degradation happened. In fact that desertification is not only in arid, semi-arid and semi-humid region but also in humid region such as Southern Chinaand the harm is far greater than in arid, semi-arid region. It is a pity that the study on desertification in humid region is relatively limited. The desertification types in Southern Chinaare mainly water erosion desertification and eolian erosion desertification (Longjun, 1998).

Water erosion desertification usually distribute in Chiang-nan Hilly Region which refers to the majority of the hilly area of the southernYangtze Riverregion. There are lots of hills which without the cover of vegetation were called "red baldhead", because of what they look like. The common characteristics of soil in this region are barren, poor water holding capacity and weak anti-erosion ability. The rainfall in this region is seasonal maldistribution and abundance of rainstorm. Once the vegetation is damaged by human, addition to the steep terrain, soil will be eroded quickly with the washing of rainstorm. Deteriorated soil nutrient and moisture status make it more difficult for the vegetation to survival in this region. At last, the hills get bald and the desertification appeared.

Eolian erosion desertification usually distribute in the sandy shore side and the river bank. There are many sandy desertification lands on the coastal sandy plain in Fujian, Taiwan, Guangdong, Guangxi andHainanprovinces. The desertification generally presented as shrub dunes, sand ridges, dunes chain. On the sandy lakeside or sandy alluvial plain, the desert presented as sand ridge or dunes chain. Such as Poyang Lake and Gan Riverbank in Jiangxi province. On the sandy terraces slope, because of the water erosion, the sand layer is exposed to the surface. With the action of wind in winter and spring, the sand was blown up and formed desert on the sandy slope.

Human is considered as an important factor which should be responsible for the land deterioration. In this region, a large population with relatively little arable, notable contradictions between human and land, low quality of the population and the lack of guidance and policy support counteracted sustainable development in the regions. In addition to poor management and other policy failures, cultivation on steep slopes, barren grazing and even the phenomenon of deforestation are very normal in this region (Zhu, 1993). Meanwhile extensive farming, misuse of fertilizer and pesticides, are artificially triggered and accelerated soil erosion and land degradation.

The research on the mechanism of desertification and its management measures in humid region of China is very important. It can help the local people and government to restore and reconstruct the ecological environment, alleviate the current contradictions between human and land, make the regional economy and eco-environment develop in a sustainable way.

TURING INSTABILITY AND BIFURCATION POINTS: AN APPROACH TO FORECAST DESERTIFICATION

SEPEHR, Adel

Ferdowsi University of Mashhad (FUM), Iran, Islamic Republic of

adelsepehr@aol.com

Desertification could be described catastrophic responses of an ecosystem to environmental perturbations including internal and outgoing pressures (Fig 1). Desertification is a catastrophic and irreversible with collapse in vegetation patterns at a fast time scale, for instance as a consequence of a slow decrease of yearly rainfall, or through an increased grazing pressure (Fig 1). Arid and semi-arid ecosystems have been characterized by regular patterns (periodic); we can find a predictable sequence of self-organized patterns based on "Turing instability". Initially stable steady-state of a dynamical system can become unstable if we additionally consider diffusion in the system. It is surprising and unexpected phenomenon because diffusion usually makes things more smooth and uniform. Loss of stability due to diffusion is called Turing instability, after Alan Turing who proposed this idea in his work in 1952. Turing instability can occur in reaction-diffusion systems with self organization and pattern dynamics which can be considered a sign to forecast system behaviors. In areas with no preferred orientation of the pattern, the form of patterns shifts from gaps to labyrinths and to spots as the system becomes more degraded. In this article, has been explained desertification process into mathematical terms and relation of pattern formation with desertification and ecosystem collapse. It will be shown that the process of desertification poses fundamental mathematical questions and we are able to forecast this process by study of pattern shifts base on PDEs models. So in this paper have been introduced differential equations to estimate vegetation pattern dynamics.

The results showed that vegetation patterns collapse into the desert state like Turing bifurcations. Also pattern dynamics is a sign for estimation equilibrium state of ecosystem to forecast desertification. The finding indicated that spotted vegetation patterns can be an early warning signal of imminent desertification in dry-lands. Also the process of desertification can be modeled by systems of reaction-diffusion equations. PDEs/ODEs models introduced in this article show that as a critical transition to a barren state is neared, the vegetation becomes characterized by regular patterns because of Turing instability. These patterns change implying that this may be interpreted as early warning signal for a catastrophic bifurcation of desertification. The results recommend applications of the pattern-formation approach to water limited landscapes to predict the possible emergence of spatial heterogeneity as a self-organization phenomenon. Also this article shows that the predicted spatial patterns can be periodic (spots, stripes and gaps), irregular with a characteristic length scale, or scale free. Results indicated that the pattern formation approach provides clear criteria for the realizations of these different pattern types in terms of environmental hazards considering land degradation and desertification. In addition to early-warning signals for desertification, there are particular spatial patterns that can arise before a critical transition.

PROCESSES AND RATES OF ECOLOGICAL RECOVERY IN GRASSLANDS TYPICAL FOR DESERTIFICATION IN NORTH CHINA

ZHAO, Wenzhi (1,2)

1: Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences, Lanzhou 730000, China; 2: Linze Inland River Basin Research Station, Chinese Ecosystem Research Network, Lanzhou 730000, China

zhaowzh@lzb.ac.cn

Soil desertification (including soil and water losses) is a significant ecological and environmental problem in North China, and currently more than 2 x 107 km2 of desertifying land in this region needs to be treated to prevent further degradation in the environment. Ecological recovery aims to repair a degraded ecosystem back towards a historical reference or a certain condition through natural and artificial development and vegetation recovery is one of the priority issues needing to be addressed to rebuild those degrading ecosystem. Extensive recovery of vegetation requires multi-agency approaches to initiate the processes, i.e. returning cultivated land to forestland or grassland, fence application, and aerial seeding, while the natural restoration after fencing application is an important step in the ecological recovery of the degraded soil system.

The complex ecological recovery process is affected or even directly controlled by natural factors, i.e. meteorological factors (for example, the patterns in precipitation and temperature), and global climate changes. Degrading grasslands distributed in many decertified areas in China, spanning from the arid and semi-arid regions, to semi-humid regions in northern China, those drought-prone area accounts for 28% of the total area of the country. In those regions with very different water and energy signatures, below issues should be taken into account in order to make the ecological recovery successful: 1) In what kind of conditions of heat and water an ecological recovery can be realized through natural development? 2) What are the suitable vegetation and soil conditions for a successful application of ecological recovery? 3) How about the rate of ecological recovery? 4) Is artificial development useful or not to the ecological recovery? In the presented study, three representative research cases (Horqin sandy land, Bashang area in Hebei Province, and Alashan Plateau semi-desert) with long-term monitoring data are involved to investigate the natural ecological recovery processes in soil and vegetation in north China.

Through the analysis, we try to extract some general principles for the design of successful ecological recovery project, and it is concluded that: 1) In regions where annual precipitation ranging between 100-400mm, natural restoration with fence application can be adopted to well restore the degrading grassland, however, the restoration ability could be different for varying systems, i.e. the natural recovery processes of the system rely on both soil seed banks and capacities of sexual reproduction, and for the serious degraded grassland, replenish the soil seed banks and rebuilt the seed islands are necessary for effective natural recovery; 2) Ecological recovery rate of vegetation and soil is a function of grassland types and environmental climate conditions. For instance, the natural recovery time for vegetation could be 8-15 years in the semiarid to semi humid regions, while the soil C and N can only be restored to 60-80% of the zonal vegetation during the same period; In the arid regions like Hexi Corridle and nearby desert regions, vegetation recovery usually costs 10-20 years, however, the restoration of the surface soil C and N takes at least 100 years.

In the presented study, three representative research cases (Horqin sandy land, Bashang area in Hebei Province, and Alashan Plateau semi-desert) with long-term monitoring data are involved to investigate the natural ecological recovery processes in soil and vegetation in north China. Through the analysis, we try to extract some general principles for the design of successful ecological recovery project, and it is concluded that: 1) In regions where annual precipitation ranging between 100-400mm, natural restoration with fence application can be adopted to well restore the degrading grassland, however, the restoration ability could be different for varying systems, i.e. the natural recovery processes of the system rely on both soil seed banks and capacities of sexual reproduction, and for the serious degraded grassland, replenish the soil seed banks and rebuilt the seed islands are necessary for effective natural recovery; 2) Ecological recovery rate of vegetation and soil is a function of grassland types and environmental climate conditions. For instance, the natural recovery time for vegetation could be 8-15 years in the semiarid to semi humid regions, while the soil C and N can only be restored to 60-80% of the zonal vegetation during the same period; In the arid regions like Hexi Corridle and nearby desert regions, vegetation recovery usually costs 10-20 years, however, the restoration of the surface soil C and N takes at least 100 years.

EXAMINING THE CAUSES OF US DRYLAND "GREENING" AND THEIR RELATIONSHIP TO COMMERCIAL LIVESTOCK GRAZING USING TIME SERIES OF LST AND NPP SATELLITE DATA

WASHINGTON-ALLEN, Robert A. (1); MARCH, Rosaleen G. (2); MCNELIS, John J. (1); ROBERTS, Joseph R. (1); SEIDEN, Zachariah T. (3); KULAWARDHANA, Ranjani W. (4); REEVES, Matthew C. (5); MITCHELL, John E. (6)

1: Department of Geography, University of Tennessee, United States of America; 2: Department of Ecosystem Science and Management, Texas A&M University, United States of America; 3: Department of Civil and Environmental Engineering, University of Tennessee, United States of America; 4: Department of Biology, Jackson State University, United States of America; 5: USDA-Forest Service Rocky Mountain Research Station, Forestry Sciences Laboratory, United States of America; 6: USDA-Forest Service Rocky Mountain Research Station, United States of America

washingtonra@utk.edu

Rationale

Dryland degradation can be defined as a decreasing trend in net primary productivity (NPP), accelerated soil erosion, a decline in soil quality, e.g., nitrogen loss, a change in plant physiognomic structure that is contrary to management goals, and detrimental changes in spatial structure and configuration that lead to declines in ecosystem function (Washington-Allen et al., 2006). The amount of quantitatively estimated land degradation in US Drylands at the national–level is largely unknown. This is because few studies have been conducted at this scale and Dryland ecosystems exhibit dynamics that are diagnostic of a complex system including catastrophic behavior, multiple dynamic regimes, and self-organization particularly in response to fire, herbivory, and major climatic events such as the El Nino-Southern Oscillation. Additionally, Dryland ecosystems have demonstrated the greatest instabilities in the face of climate change, particularly the fastest range velocities (Loarie et al. 2010). Understanding of Dryland dynamics at the national spatial scale requires time series of at least 10-years to separate the impact of climatic regimes from land management practices. Ecological indicators that measure each of the characteristics of land degradation, e.g., NPP can be derived from satellite-based remote sensing data (Washington-Allen et al., 2006).

Methods

The University of Tennessee's Department of Geography in collaboration with Texas A&M University and the US Forest Service developed time series of above-ground NPP from MODIS NPP, and acquired time series of Leaf Area index (LAI), and land surface temperature (LST) from 2000 – 2012 for US Drylands. We used peak annual LAI to determine the growing season LST. We observed a trend of increased carbon gain from 2000 to 2009 and found that this trend was related to the national livestock's stocking rate (NPP decreased with increasing stocking rate) and climate [NPP increased with increased Palmer Drought Severity Index (PDSI)]. To test the hypothesis that Dryland "greening" is a function of a physiognomic change from grassland to woodland we examined LST for a declining trend towards an evapotranspirative cooling threshold of ≤ 37° C (Nemani & Running 1997, Mildrexler et al. 2011). We tested the hypotheses that:

National Park System (NPS) ANPP > Rangeland ANPP

and the grazing optimization scenario where

NPS NPP < Rangeland NPP

to determine how much of ANPP is being appropriated by commercial livestock.

Results

We found that LST had a decreasing trend towards the evapotranspirative cooling threshold of ≤37° C (Figure 1). We found a mean appropriation of 49 % of ANPP from US rangelands, i.e., NPS rangeland ANPP (mean of 10.0 kg m-1 yr-1) > rangeland ANPP (mean of 5.1 kg m^{-1} yr^{-1}). After ecoregion stratification, we found a mean appropriation of 58% where NPS rangeland ecoregion's ANPP was greater than the surrounding rangeland ecoregion's ANPP.

Outcomes

The trend towards the evapotranspirative cooling threshold of£37° C, suggests that the “greening” of US Drylands is due to woody encroachment. Commercial livestock grazing, including sheep, goats, and cattle, is excluded from the US National Park System. Assuming the magnitude of wildlife grazing and wildfires is the same inside and outside the parks an appropriation level of 50% of forage is consistent with best, recommended, and historical conservation practices of grazing utilization of “take half and leave half.

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INTERRELATIONSHIPS BETWEEN CHROMIUM AND SOIL PROPERTIES TO EVALUATE THE PHYTOEXTRACION POTENTIAL IN A DRY RIVERBED FROM SOUTHEAST SPAIN

FAZ CANO, Angel

Universidad Politecnica de Cartagena, Spain

angel.fazcano@upct.es

Sediments from a dry riverbed affected by former spills by the tannery industry have been collected, with the aim of assessing the degree of Cr pollution, mobility and the interaction with soil properties to define a phytoextraction strategy. A detailed sampling to carry out the biogeochemical characterization of the sediments is crucial to identify patches or areas with different degree of pollution and interaction with soil properties, so that tailor-made strategies for decontamination are selected. Phytoextraction is an emergent and promising technology which uses the capacity of plants to uptake and accumulate metals in their tissues. Plants are later uprooted or cut, favoring the decontamination of the soil. This technique requires long periods of time in comparison with traditional physico-chemical methods, but it is quite inexpensive and technically feasible for communities with economic issues, being environmentally friendly and long-term sustainable.

Outcomes

Results reflect high concentration of Cr in the sediments of the studied dry riverbed owing to former direct spills by the tannery industry. However, although the sediment is polluted (the total concentration surpasses the generic levels of reference), its mobility is quite low, maybe due to the predominance of Cr^{3+}. This indicates low risk of transfer of Cr under the current conditions. Nonetheless, since the sediments are located in a riverbed, they can be transported by runoff after torrential rainfall events and contaminate downflow areas. Since the risk is not high and the need for rehabilitation is not urgent, the technique of phytoextraction for Cr decontamination is suitable in this scenario, so that plants can uptake and accumulate Cr to reduce its concentration in the sediment. Owing to the characteristics of the sediments, plants to be used for phytoextraction must be salinity adapted and with low nutritional requirements. Since the available fraction of Cr is low, some chelating agents should be added to the sediments to facilitate Cr mobility and enhance plant uptake

EVOLUTION OF SOIL QUALITY,AVAILABILITY OF HEAVY METALS AND VEGETATION IN A TAILING POND IN CARTAGENA LA UNIÓN MINING DISTRICT,AFTER REHABILITATION BY ASSISTED PHYTOSTABILIZATION

FAZ CANO, Angel

Universidad Politecnica de Cartagena, Spain

angel.fazcano@upct.es

Mining has been carried out for more than 2500 years in SE of Spain, due to its richness in metals, like lead and zinc, constituting one of the most important mining areas in Europe.

From 1991, these mines and its tailing ponds are abandoned, what implicates a high environmental risk *(spreading of the pollutants by wind and water erosion).*

Numerous researches have demonstrated the efficiency and profitability of phytoremediation as a technique to solve this matter.

Aided phytostabilization technique consists of using both plants and organic/inorganic amendmetns. The plants chosen should carry out the translocation of metals from roots to shoots as low as possible and thereby limiting the propagation of metals into the food chain. Further, the plant cover in mine tailings enhances microbial community, which promotes plant growth and takes part in metal stabilization. The application of amendments can decrease the bioavailability of metals and improve soil development and vegetation establishment.The aim of this research was to evaluate the efficiency of aided phytostabilization technique in Santa Antonieta tailing pond (SE Spain) after 30 months of carry out the first amendment application (July 2011).

PROTECTIVE EFFECT OF GRAVEL LAID ON THE PLATEAU OF THE MOGAO GROTTOES

WANG, Wanfu (1,2,3); ZHANG, Weimin (1)

1: Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences; 2: Conservation Institution of Dunhuang Academy; 3: National Research Center for Conservation of Ancient Wall Paintings and Earthen Ruins

wwanfu@hotmail.com

The Mogao Grottoes is one of the world class arts and cultural treasures. Windblown sand has been one of the main environmental related problems for the mural paintings at the Grottoes. The Grottoes is located at multi-wind directions area that make the energy exchanging and sand transporting back and forth repeatedly between the gravelly Gobi and the Mingsha Mountains. The Gobi naturally can prevent part of sand drift carried by the northwestern wind to the grotto zone and help the east wind to blow a large part of accumulated sand back to the Mingsha Mountains. The sandy Gobi at the top of the Grottoes has a limited capacity of preventing sand movement; therefore, rationally laying different size of gravels to cover certain area of sandy surface can be a key for controlling of the windblown sand. In order for the grotto-top Gobi to become a natural barrier for controlling windblown sand the Conservation Institute of Dunhuang Academy implemented "Conservation and Utilization Engineering Projects at the Dunhuang Mogao Grottoes — Windblown Sand Control Project" sponsored by the China Development and Reform Committee to construct vertical sand control zone, vegetative wind fence watered by the drip irrigation system, chessboard typed straw stabilization zone, and grave laying zone to protect sandy surface. Grave laying zone is one of the major components of the comprehensive sand control system playing a key role in the system. Gravel laying is one of the new approaches for windblown sand control and has been firstly applied at the Dunhuang Mogao Grottoes, a world heritage site.

To study the patterns of sand movement on the surface of gravel layer and sand carrying capacity, especially under the easterlies can be used to evaluate the effect and significance of gravel layer on sand control. Study showed that (1) Sand source plays an important role in the transportation of sand on the gravel bed. When there is enough sand source from the gravel layer, sand carrying capacity near the ground surface increases as wind speed increases and it follows a relationship of V-0.22*(V-Vt). With further advanced of dust storm, sand source from the gravel layer decreased the relationship between wind speed and its sand carrying capacity follows a power function law. To be noted that when sand supply is low, especially when wind speed is >11m.s-1, sand carrying capacity increases multiply and forms long transport of sand drift that in favor of developing a transporting sand bed from accumulating sand bed. When wind speed is 9m.s-1 that has a great impact to the Grottoes. It showed that if there was enough sand source yearly sand carrying capacity of easterly and westerly atop of the grotto was 672 and 409 kg.m-1 respectively and the yearly carrying capacity of easterly was 1.6 times of that of westerly. When the wind speed was >11m.s-1, westerly could transport 78kg.m-1 of sand to the Grottoes. However, easterly could blow 49% of accumulated sand (202kg.m-1) back to the Mingsha Mountains. However, if there was not enough sand source, yearly carrying capacity of easterly and westerly atop of the Grottoes was 655 and 383 kg.m-1 respectively and the yearly sand carrying capacity of easterly was 1.7 times of that of westerly. If wind speed was >11m.s-1, westerly could transport 99kg.m-1 of sand to the Grottoes and easterly could blow 67% of accumulated sand (256kg.m-1) back to the Mingsha Mountains. (3) According to the collected data that at the top of the Grottoes 30% of the area laid with 3-4cm in diameter of gravel could trap and transport sand satisfactory. One should take the full advantage of multi-wind directions, characteristics of different sand sources, and natural forces to minimize the impacts of windblown sand to the Mogao Grottoes.

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ABOUT THE CONFERENCE

http://3sc.unccd.int

The 3rd UNCCD international scientific conference on "Combating desertification/land degradation and drought for poverty reduction and sustainable development: the contribution of science, technology, traditional knowledge and practices" is held from 9 to 12 March 2015 in Cancún (Mexico), during the 4th special session of the Committee on Science and Technology (CST S-4) of the United Nations Convention to Combat Desertification (UNCCD).

The conference aims to attract the widest possible range of scientific, local and traditional knowledge that can be harnessed to achieve poverty reduction and sustainable development in areas susceptible to desertification, land degradation and drought.

One of the major challenges facing delegates to the conference is the development of new scientific insights and recommendations to policy makers with regards to the assessment of vulnerability of socio-ecosystems to climate change and current and future capacities to adapt.

The conference addresses three major challenges:

- **Diagnosis of constraints:** How to best characterize and understand the vulnerability and adaptive capacities of ecosystems (in particular agro-ecosystems) and populations in affected regions, including regions newly susceptible to the consequences of climate change?
- **Responses:** How to build efficiently on available knowledge, success stories and lessons learnt to promote implementation of better adapted, knowledge-based practices and technologies?
- **Monitoring and assessment:** What are the new monitoring and assessment methods available to evaluate the effectiveness of these practices and technologies that provide improved insights on whether or how their implementation should be scaled up?

The conference is expected to contribute to the combat against desertification and land degradation and to addressing the impact of drought, through delivering the following outcomes:

- Better anticipation and prevention of the impact of climate change on land degradation and desertification through capacity building;
- Identification and promotion of sustainable and adaptive methods of using ecosystems to reduce poverty and environmental degradation while achieving sustainable development;
- Identification of pathways towards land-degradation neutrality: by way of reducing degradation processes and scaling up restoration activities, the objective is to maintain and improve the quantity and quality of productive land.