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Report of the fifth meeting of the Group of Experts of the Committee on Science and Technology

Note by the secretariat*

Addendum

Guidelines for updating the *World Atlas of Desertification*

Summary

This document gives a review of the present *World Atlas of Desertification* and of its weaknesses. The needs for mapping and/or illustrating desertification and drought are presented; the main aspects of a more detailed and complex mapping methodology and the process of desertification are introduced. The relevant statements of the Millennium Ecosystem Assessment and the Land Degradation Assessment in Drylands project are summarized, and the main elements of assessing drought and desertification are quoted as basic important ingredients in the compilation and editing of a new atlas. Dealing with some aspects of the mapping process and referring to the detailed explanations in the report, thematically ordered main conclusions and recommendations for updating or revision of the *World Atlas of Desertification* are given. Research needs on the topic are summarized as well.

* The submission of this document was delayed due to the short time available between the fifth session of the Committee for the Review of the Implementation of the Convention and the eighth session of the Conference of the Parties.

CONTENTS

I. Introduction

1. During the first meeting of the Group of Experts (GoE) of the Committee on Science and Technology (CST), held in Hamburg, Germany, in 2002, the task to evaluate guidelines to update the *World Atlas of Desertification* was clearly outlined. The work foreseen was to review the current status of mapping and of the atlas itself, to determine the criteria on which the production of the new atlas can be accomplished, and to prepare recommendations for the terms of reference for revising the atlas.

2. The first progress report on the task was presented at the second meeting of the GoE, held in Bonn, Germany, in 2003. The report reviewed the current status of the atlas and of the mapping problems, and summarized the conclusions for the most important steps in the development of the new *World Atlas of Desertification*.

3. By its decision 15/COP.6, the Conference of the Parties (COP) adopted a framework of a two-year work plan for the GoE, which included the task of evaluating guidelines to update the atlas in consultation and interaction with other related ongoing efforts, such as the Millennium Ecosystem Assessment (MA) and the Land Degradation Assessment in Drylands (LADA) project.

4. Contacts were established with the MA and the LADA, which provided important information to the GoE. For instance, the MA chapter on drylands contains important information relevant for establishing guidelines for updating the atlas. Consultations with the MA process yielded a strong recommendation that more political and financial support is urgently needed for improving information on the status of drylands as well as for developing a common, unified, worldwide usable methodology on assessment and mapping of desertification and drought.

5. The aims of the LADA project include making a global assessment of the status, causes, trends and impacts of land degradation. It is envisaged that the project outcomes will have some important information that can be useful for updating the atlas, because any kind of mapping needs a special and careful assessment, and the final step of any assessments is always some kind of mapping.

II. The present *World Atlas of Desertification*

A. Background

6. The first world map of desertification was produced in 1977 jointly by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the World Meteorological Organization (WMO) in time for the United Nations Conference on Desertification, held in Nairobi, Kenya. Most of the subsequent national, regional and global assessments of desertification undertaken by the United Nations Environment Programme (UNEP) and others were based on the FAO/UNEP/UNESCO “provisional methodology”, elaborated in 1987, for the assessment and mapping of desertification. This provisional methodology was later used by UNEP and its partners in the 1987–1990 period to produce the first global assessment of human-induced soil

degradation (GLASOD). This provided considerable information for the database of the first version of the atlas.

7. After long discussions and development work on the concept and definition of the term desertification in the 1980s and early 1990s, the first edition of the *World Atlas of Desertification* was published in 1992, to coincide with the Earth Summit held during the United Nations Conference on Environment and Development in Rio de Janeiro, Brazil. The atlas displayed the existing state of knowledge of desertification and of its extent, and possible solutions. It demonstrated that desertification is a major economic, social and environmental problem, affecting more than 110 countries in all regions of the world.

8. Since the entry into force of the United Nations Convention to Combat Desertification (UNCCD), efforts to improve the assessment and monitoring of desertification have continued, mainly in the framework of the implementation of the Convention. More than 110 countries prepared reports and made studies on the different problems of desertification, drought and land degradation. These reports and documents described the extent of desertification in most of the countries, and the continued worsening of the situation in many of them. Although much of this information is of too general a nature to be incorporated into the atlas database, there has been continued encouragement and support for the gathering and presentation of new and improved data on the drylands.

B. Objectives of the atlas

9. The objective or aim of the atlas does not seem to have been defined clearly in the publication. The preface mentioned only that "the atlas is designed for those working on desertification at the global, regional and national levels", and "it is intended to facilitate the work of governments at the Conference of the Parties of the Convention to Combat Desertification, and it is also aimed at a wider audience to be accessible through libraries, universities and schools. It provides a blend of data, images and text that enables the reader to gain a more comprehensive view of the global problem of desertification".

10. Perhaps the last few words: "the global problem of desertification" can be the key to understanding the objective of the atlas. Giving a global view on the global problem was presumably the main aim of the authors, and this is the virtue and at the same time the shortcoming of the atlas itself.

C. Content of the atlas

11. The second – and present – edition of the atlas, issued by UNEP in 1997, has a technical introduction and four sections. The introduction provides the background and information needed to explain the technical basis of the atlas, and the contents of the four sections are as follows:

(a) *Section 1* presents the best available global assessment of desertification and related issues. The text which accompanies each map has been completely revised and updated with many new references reflecting work done since the first edition was published. A large

part of the section is devoted to the relationships between climatic factors and desertification, particularly the variability of rainfall, which is important aspect of dryland climates.

(b) *Section 2* presents the higher resolution GLASOD survey of human-induced soil degradation in Africa and related issues such as vegetation distribution. The revised text accompanying each map provides examples of the issues under consideration and the complexities of the interrelationships between the causes and effects of land degradation.

(c) *Section 3,* which is totally new, incorporates a number of methodological developments. In the Soil Degradation in South and Southeast Asia (ASSOD) assessment of Asia, greater emphasis is given to generating assessments at country level rather than at regional level. Emphasis is also given to trends in land degradation and to the impact of desertification on agricultural productivity.

(d) *Section 4* highlights, together with national and local databases and assessments, the links between desertification and other global environmental problems such as soil salination, climate change, carbon sequestration and biological diversity. The description of the social dimensions of desertification, showing links between land degradation, human population and migration, and socio-economics, is an important part of this section. The text also highlights success stories in combating desertification, ranging from soil rehabilitation in north-west China to overcoming waterlogging and salinity in Western Australia and the continuing challenges of the Sahel. A new global initiative called the World Overview of Conservation Approaches and Technologies (WOCAT) is described here, giving Eastern and Southern Africa as examples. The WOCAT case studies give information on severity of erosion, dominant soil and water conservation techniques, and the impact of the conservation technologies on cropland and grazing areas.

12. The bibliography contains a long list of relevant publications from most parts of the world, and an index helps the reader to find the different key-words or countries.

III. Weaknesses of the *World Atlas of Desertification*

13. One of the weak points of the atlas – admitted by the authors – relates to the database on which the compilation was based. This shortcoming is pointed out in the introduction: " . . . unfortunately, accurate and reliable data on the extent and severity of desertification and the rate of its progress, based on actual ground surveys, are very scarce. The existing data are often controversial and open to doubts and criticism". Available data are uneven in scale and accuracy, so is difficult to create a proper map.

14. The second problem comes from inconsistencies in the concept and the definition used "and the perception that desertification threatens all the world's drylands". In spite of the long previous discussion to reach a consensus on how to define desertification, the definition is complex and simplistic at the same time, equating desertification and 'human-induced land degradation' in drylands, and considering only broad classifications of climatic zones – arid, semiarid and dry sub-humid.

15. Although the title of the publication is 'World' atlas", the content did not cover and represent the whole world: there are few examples from Europe, and none from the whole American continent.

16. It was also conceded in the text that "there may be grounds for criticizing a global approach to the problem. The complex nature of desertification means that adequate assessment and consequent plans to counteract the problem can only be usefully carried out at the local scale, a central reason for the involvement of local populations and non-governmental organizations in approaches adopted by the CCD". Nevertheless the global perspective has some advantages: it allows desertification to be evaluated relative to other global environmental problems, such as global warming, climate change and threatened biological diversity. Furthermore it was useful to develop a worldwide picture to identify 'hotspots' at the continental, national and local scales. For this reason the atlas was organized to start from a global perspective (in sections 2 and 3), and tried to give some examples to analyse in greater detail – and at smaller scales – specific issues of particular importance (in section 4).

17. However, the scale itself can be a source of error. Because a global map is, of necessity, on a large scale, it is difficult to differentiate small areas with different degrees of land degradation or desertification. Hence although a given area on a map may be coloured to indicate a particular characteristic, this does not necessarily mean that all the land within that area possesses that characteristic.

18. Although desertification is a complex phenomenon, the world map of desertification shown in the atlas – and even in other publications based on the atlas – is only a simplified illustration of the spatial distribution of desertification or its contributing factors. The atlas gives global maps of the distribution of aridity, soil degradation and soil erosion, but not a combined and integrated presentation of these. These maps do not show the real vulnerability to desertification in the world, but they are sometimes are presented as such. A similar mistake can be found in the 10th anniversary publication of the UNCCD; a map entitled "Desertification in the world" is in fact showing only the distribution of some climatic zones in the world based on aridity, which is very different from desertification. This is the main problem with all presently known maps that try to represent desertification.

19. Another problem is that – the atlas does not deal with drought mapping problems at all, however drought is mentioned sometimes in the text. Drought affects great areas all over the world, and can be a precursor to desertification, not only in the so-called susceptible drylands. It is clear that drought events can be assessed and mapped effectively only at local or regional scales, but there is need for some description and illustration of the spatial distribution of drought-prone areas with higher risk of starting desertification there as well.

IV. Needs for mapping and/or illustrating drought and desertification

20. A world atlas of desertification and/or drought has to consist of and contain written texts, descriptions of the situation, the problems and the concepts, expositions of the conditions, evaluations of the processes, relevant data in tables and figures, and maps illustrating the spatial distribution of the phenomena all over the world and at different scales. Therefore the

presentation of such content and developing the methodology of mapping are among the most important tasks to be undertaken before starting with the compilation and editing of a new atlas.

21. It seems necessary to make a distinction between the mapping of desertification and of drought. The first step in the desertification process is that the area becomes constantly dry, and droughts occur more frequently. Drought is one of the main factors in the development of desertification, but it cannot be equated with desertification. However, the spatial distribution of both phenomena is interesting and should be addressed, because there are considerable differences between the two either in the needs for mapping or in the methods to be used.

22. The reasons for assessing and mapping the spatial distribution of desertified and threatened areas can be summarized – in order of importance – as:

(a) Providing general information on desertification to the public;

(b) Giving (general) information for research activities;

(c) Giving (general) information for education purposes;

(d) Affording some basic (general) information for decision makers and organizers interested in preparedness and mitigation actions.

23. Desertification should be mapped at different scales, taking into account the real objective of mapping at each scale, the available databases and the aims of the map. The maps and evaluations drawn on global data and assessments should be broken down to regional or even local scales showing a more accurate distribution of the characteristics.

24. The reasons for mapping the spatial distribution of drought events and drought-sensitive areas in the world can be summarized –in order of importance – as:

(a) Providing detailed and (as much as possible) site specific information for decision makers and organizers involved in preparedness and drought mitigation actions;

(b) Giving detailed information to local people affected by drought impacts;

(c) Affording specified information for research activities on drought mitigation;

(d) Giving specified information for education purposes.

25. Drought must first be analysed and mapped at small (local or national) scale, taking into consideration the aim of the mapping and the available databases, and using local, but generalized and internationally comparable indicators. These local maps should then be used as a basis for preparing regional (or global) maps.

A. Main aspects of a more detailed and complex methodology for mapping desertification and drought events

26. Complex mapping of desertification and/or drought needs a comprehensive methodology making use of data and information from several sources. Climatic (hydro-meteorological) data and indexes are of basic importance, but are not enough for the expression and characterization of the processes in a given area, and so other ecological aspects should be taken into consideration, such as:

(a) hydrological (groundwater and surface water flow) conditions
(b) soil and topography of the area
(c) vegetation cover (crop) conditions
(d) relating trends of global changes
(e) other human/social factors such as land use, population density and economic evaluations.

27. Therefore a new and complex/integrated approach is necessary. This means that a new methodology has to be developed and new databases have to be created for a better and more accurate mapping process and for illustrating spatial distribution of desertification and drought.

28. According to the advice of the Group of Experts (GoE) of the CST, the following are some of the important elements of a new approach:

(a) Before starting to assess desertification, the preliminary geomorphology unit map (Terrain Mapping Units, TMU) should be extracted through overlying land-use, lithology and topography maps. TMU is the basic map to manage the extracted data during subsequent stages;

(b) For the climate benchmark in the map it is better to refer to climate classification as follows: hyper arid – arid – semi arid – dry sub-humid – humid;

(c) The need for water for irrigation should be taken into account;

(d) For mapping hydrological conditions, analysis of ground flow (streamflow) gives more information than analysis of surface water;

(e) In the soil section of the map, erosion (water and wind erosion) and soil characteristics are important;

(f) Expressing the ecological conditions would be more suitable than depending on the description of the vegetation;

(g) Population and density as well as poverty are suitable indices of socio-economic effects that should be taken into account in the TMU.

B. The process of desertification

29. When mapping desertification it is essential to understand that it is generally a long-term process influenced by several biophysical and socio-economical factors. One of the most important factors is water scarcity and the considerable decrease in the water resources of an area. The more frequent and longer and stronger droughts are one of the major causes of the development of desertification.

30. Climate change – as a consequence of some natural and man-made effects – can also happen and in general if the aridity of the area in question increases. The lack of water means that the water needs of living organisms are not satisfied and the soil becomes continuously dry. As a result erosion – caused by wind or water – becomes more intensive, soil degradation will be enhanced, and the effect of all other soil degradation processes will be increased, especially soil structure deterioration and reduction of the biological activities in the soil.

31. All these processes lead to a thinning out of flora and fauna, to decreasing crop production, and finally to a serious loss of bio diversity in the area. Such damage can occur even faster as a result of inappropriate agricultural technologies and soil cultivation methods, and, in forest areas, deforestation and forest fires. The complex impact of these processes can be described as contributing to land degradation, because the reduction of resource potential of the land is evident. The final result of these processes is likely to lead to the pauperization of the territory, the impaired performance in any kind of forms of life, including the impoverishment of the society.

32. All these processes should be taken into consideration when developing a monitoring system for desertification. Some of the processes mentioned above and their effects build up successively, others happen in parallel, and they should be characterized by one or more parameters which could be either measured and/or observed or determined by calculation and/or derivation from the measured ones.

C. Relevant statements of the Millennium Ecosystem Assessment and the Land Degradation Assessment in Drylands project

1. The Millennium Ecosystem Assessment

33. The Millennium Ecosystem Assessment (MA) was initiated in 2002 under the auspices of the United Nations, with its secretariat coordinated by UNEP. The objective of the MA was to assess the consequences of ecosystem change for human well-being and to establish the scientific basis for actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being. One of the final reports prepared by the MA was devoted to desertification. This desertification synthesis report is based on a sound summary of scientific evidence, and states that desertification must imperatively be addressed to meet the Millennium Development Goals. Desertification must be fought at all levels, but this battle must ultimately be won at the local level. This report makes it clear that desertification is embedded in a global chain of causality and that its impact is felt far beyond the boundaries of affected areas. It became also evident that desertification contributes significantly to climate change and biodiversity loss.

34. The report of the MA points out that desertification occurs in all continents except Antarctica and affects the livelihoods of millions of people, including a large proportion of the poor in drylands. Drylands occupy 41 per cent of the Earth's land area and are home to more than 2 billion people (one third of the human population in the year 2000), and occur in all regions where water scarcity limits the production of crops, forage, wood and other ecosystem provisioning services.

35. According to the MA, some 10–20 per cent of drylands are already degraded, and desertification ranks among the greatest environmental challenges today and is a major impediment to meeting basic human needs in drylands. Persistent, substantial reduction in the provision of ecosystem services as a result of water scarcity, intensive use of services and climate change is a much greater threat in drylands than in non-dryland systems. In particular, the projected intensification of freshwater scarcity as a result of climate change will cause greater stress in drylands. If left unmitigated, this stress will further exacerbate desertification.

36. The climatic factors of concern include droughts and projected reduction in freshwater availability due to global warming. Although the global and regional interplay of these factors is complex, it is possible to understand it at the local scale. The magnitude and impacts of desertification vary greatly from place to place, and change over time. This variability is driven by the degree of aridity combined with the pressure people put on the ecosystem's resources. There are, however, wide gaps in our understanding and observation of desertification processes and their underlying factors.

37. Measurement of a persistent reduction in the capacity of ecosystems to supply services provides a robust and operational way of quantifying land degradation, and thus desertification. Such quantification is robust because these services can be monitored, and some of them are already routinely monitored.

38. Desertification has strong impacts on non-dryland areas as well. The biophysical impacts include dust storms, downstream flooding, impairment of global carbon sequestration capacity, and regional and global climate change. The social impacts relate notably to human migration and economic refugees, leading to deepening poverty and political instability. Improved management of land and water is a key method for preventing desertification. Local communities play a central role in the adoption and success of effective land- and water-management policies. Integrated management of pastoral and agricultural land provides an environmentally sustainable way to avoid desertification.

39. Scenarios for future development show that the desertified area is likely to increase, and relief of pressure on drylands is strongly correlated with poverty reduction. Proactive land- and water-management policies can help to avoid the adverse impacts of desertification. Combating desertification yields multiple local and global benefits and helps mitigate biodiversity loss and human-induced global climate change. Joint implementation of major environmental conventions can lead to increased synergy and effectiveness.

40. These fundamentally important statements strengthen the theoretical basis of knowledge on further efforts in the fight against desertification, but give no direct ways and means of addressing its assessment and mapping.

2. The Land Degradation Assessment in Drylands project

41. The Land Degradation Assessment in Drylands (LADA) project started in 2002 and was funded by, among others, the Global Environment Facility (GEF), to be implemented by UNEP and executed by FAO. This project has benefited from the support of the UNCCD, the International Soil Reference and Information Centre (ISRIC), and several other regional and national partners. The objectives of the LADA project are to develop tools and methods to assess the driving forces behind, and quantify the nature, extent, severity and impacts of, land degradation in ecosystems at a range of spatial and temporal scales; to carry out a global assessment of land degradation; and to build national, regional and global assessment and monitoring capacities for enabling the design and planning of interventions to mitigate land degradation.

42. The LADA project produced a synthesis of existing methods and national experiences and formulated a seven-step approach for undertaking the full-scale LADA, and this approach is considered as the modular part of the LADA methodological framework. This LADA approach integrates biophysical and socio-economic components of land degradation at different scales, recognizing that socio-economic issues are also driving forces for pressures that are exerted on the land. This is an integrated approach to ecosystem management at local, agro-ecological zone, and national levels.

43. To understand the process of land degradation at subnational, national and regional level, the LADA approach relies on the "Driving force – Pressure – State – Impact – Response (DPSIR) framework". This framework states that driving forces exert pressures on the environment and that those pressures can induce changes in its state or condition. The subsequent impacts on socio-economic and biophysical attributes cause society to respond by developing or modifying environmental and economic policies and programmes aimed at preventing, minimizing or mitigating pressures and driving forces.

44. The LADA project has also developed a local assessment tool, a set of simple and inexpensive assessment techniques which can be gradually learned by farmers and which are related to farmers' needs for improving land conditions. In addition, the LADA project will produce a global land degradation assessment (GLADA) – instead of GLASOD – based mainly on the use of the remote sensing normalized difference vegetation index (NDVI) data and other biophysical parameters.

45. Some crucial elements can be pointed out from the achievements gained so far by the LADA activities. For land degradation assessment there is not yet an organized toolbox of methods, but most items that should be included in it are available. The LADA "seven steps" constitute a very rich procedure, and it is easy to become absorbed within one step or another. A web-based database of local, visual characteristics is being developed; this will assist comparison and transfer among countries and strengthen the local-to-global link. It was emphasized that a method is needed to monitor the processes of degradation and improvement at a global and regional scale without having to wait for generalization from detailed, local information, because of the urgent need of the UNCCD process for such information.

46. On the subject of indicators, different sets of indicators would be needed at different scales. For the UNCCD the main question is which decisions should be taken at national level; a minimum set of indicators at national level should be identified that would respond to this question. In the process of selecting and reducing the number of indicators to be used, intuition and understanding of local conditions should play a part, and the process would not be amenable to automation. At local level, innovative ways are needed to encourage communities to collect their own monitoring data, and interpret them for their own objectives. In the model-based pilot studies the LADA methodology was found to be superior in depth of analysis to other current and past land-degradation assessment methods, but the list of indicators used was to long and there were too many interview questions.

47. A toolbox or framework approach would be vital for efficient transfer of the LADA methodology to new countries or areas, but for replicability and comparison, agreement is needed on several matters, including:

(a) Common guiding principles for selection of indicator subsets that are robust (adequately represent states and processes of land degradation) but succinct (practically and economically feasible);

(b) Common methods and units for observing qualitative indicators and their measurement;

(c) Common methods for threshold development of quantitative indicators.

48. Clear analytical pathways should be described to guide the integration of multifarious biophysical and socio-economical data, particularly the networks of causal chains. Graphical representation of these will be useful, and mapping legends should be intuitively clear to users. A report on progress on the LADA project is contained in document ICCD/COP(8)/CST/9.

D. Main elements of desertification and drought assessment

1. Terms and definitions

49. Determining clear terms and proper definitions is a fundamental need for any development. Therefore a glossary of core terms and concepts on desertification, land degradation and drought is necessary. It is also important to reach a consensus among experts on the presently used terms. This was the objective of one of the tasks to be performed by the GoE.

50. As already mentioned, the current *World Atlas of Desertification* does not deal with drought and related concepts, but this may have to be considered when assessing desertification. Developing a glossary of some definitions of terms relating to the drought problems is a task given to the GoE.

2. Assessment methodology

51. An effective assessment methodology has always been of basic importance in any kind of planning and development activity. In the case of such complex, multidimensional and

multifactoral processes as desertification and drought the methodology of assessment is not easy and it becomes more difficult if one needs to have a common, general approach to it. The GoE tried to deal with this topic by taking into consideration this primary concern. Pilot studies were conducted in north-east Asia for developing desertification assessment, but still no model was found that was able to simulate different desertification processes. Moreover, there is no operational desertification assessment model that can be utilized to assess the effectiveness of counter measures to combat desertification, and only some partial – albeit important – results were gained. Based on these results the GoE has formulated some guidelines for effective assessment methodologies, some of which can be taken into consideration in the mapping processes too.

52. Parallel studies and development work have been conducted in the MA and the LADA project with much greater infrastructure and financial backing for working out an assessment methodology, and a methodological framework for assessing land degradation in drylands has been created as a first step. This methodological framework seems suitable for making assessments on local levels, especially for testing it in different ecological conditions, but further development is necessary, and mapping methodology for illustrating the results needs also further studies and research work.

3. Benchmarks and indicators

53. Benchmarks are the baseline that serves a starting point for evaluation and monitoring and thus provide the reference point for determining the trends in land degradation or improvement of the land condition. Benchmarks can be determined by identifying non-degraded ecosystems under the same agro-climatic zone and natural conditions. A benchmark is a numerically expressed indicator suitable for comparison and for ranking the phenomenon (the fact or symptom indicated) to which it was determined. No doubt benchmarks and indicators are crucially important for any kind of assessment or analytical work of natural and social processes. High priority was accorded to this subject in the GoE work progamme (ICCD/COP(8)/2/Add.1).

54. Many studies and propositions have been made in the recent past for benchmarks and indicators for assessing desertification, but no common agreement has been reached. Already in 2003 the UNCCD Ad Hoc Panel on Early Warning Systems proposed several indicators that could be used to develop an early warning system on desertification, as well as for assessing various natural processes, such as wind and water erosion. During the third GoE meeting, in Beijing in 2004, members presented a report in which 79 different indicators were proposed for assessment of land degradation, including land and soil data, social, economic, political and environmental.

55. Despite all these efforts, no evaluation, comparison and selection of the relevant benchmarks and indicators has yet been performed, but there is need for consensus on this particular issue, especially with respect to common benchmarks and indictors that would be suitable for use in the assessment of land degradation. The following points are noteworthy:

(a) For desertification monitoring and assessment the indicator system should include the four aspects of pressure, state, desertification impact and implementation of management,

and interventions – to which PSR (Pressure – State – Response) and/or DPSIR framework seems applicable;

(b) The selection of indicators at the broader (global) scale has to depend on satellite imagery and statistical data. At the local scale it is important to collect field data from field surveys and using questionnaires. There exists a certain relationship between the hierarchy of mapping scales and the derived data.

(c) There is need to broaden knowledge about desertification across various regions, in particular to assist in the development of a set of common benchmarks and indicators, for example, those commonly used by such bodies as FAO and OECD. The aim would be to create a common system for monitoring and assessment based on relevant communication and exchange.

(d) There is need to apply and validate models applicable for the assessment of land degradation in a biophysical and socio-economic context, and to evaluate the effectiveness of implementation of the models in conducting the assessment. It is suggested that preparing a set of socio-economic indicators for poverty should be considered.

56. Status indicators and benchmarks correspond to the condition and trend assessment reflected in the MA, and implementation indicators and benchmarks correspond to the response options assessment reflected in the MA. The MA proposal of the necessity of the scenario assessment is noteworthy, and can later be used to analyse how policies might affect future patterns of land use, and can provide useful information for decision-making when considering various alternatives. Despite evaluation based on the prediction of the condition and trend assessment, in which large uncertainties may exist, the MA scenario assessment provides useful information for users to help decide whether a policy should be supported or not, and by understanding the range of the prediction and the potential consequences of the decisions.

4. Monitoring and early warning systems

57. It is obvious that there is a rather close relationship between illustrating and mapping of desertification and drought, and monitoring and early warning systems, and this relationship should be clarified before giving any suggestions for the future work of updating the present *World Atlas of Desertification*.

58. In the context of the UNCCD benchmarks and indicators, desertification monitoring, assessment and early warning systems have been identified as the integral components of the holistic approach to understanding the causal factors and spatial-temporal characteristics of drought and desertification processes. Early warning systems for drought and desertification provide a useful framework for promoting comprehensive data collection and analysis as well as the formulation and implementation of intervening measures for the mitigation of drought and desertification. Although many countries have done considerable work on early warning systems for drought and desertification, there exist no operational desertification early warning systems to be successfully implemented in strategies, plans and programmes to combat desertification.

59. Early warning systems should be understood as the sum of four subsystems: monitoring and forecasting, vulnerability analysis, information dissemination, and preparedness, including

also mapping of the results of the analyses. Existing early warning systems are still deeply focused on drought and food security. In contrast, progress in enhancing the effective use of warning in the fight against desertification has been relatively slow. At the same time several weaknesses have been detected in areas relating to desertification assessment and monitoring, dissemination of information to end-users, institutional arrangements and coordination mechanisms, as well as appropriate and targeted interventions. From review of the traditional practices of early warning systems, it could be concluded that operational drought early warning systems should incorporate desertification monitoring into their activities and integrate systems to address drought and desertification, rather than establishing separate systems. A substantive report on early warning systems prepared by the GoE is contained in document ICCD/COP(8)/CST/2/Add.8.

5. Database and information exchange

60. It is important to have a forum – preferably on the Internet – where all necessary data and information (including maps, assessment conclusions, analytical results, case studies and forecasting parameters) concerning desertification and drought can be found. This type of information exchange facility can be the website of THEMANET, developed by the GoE as a communication strategy for the CST, on which all kind of information summarized recently in the atlas (maps, data, descriptions, evaluations) could been posted. THEMANET could be the most important forum to all those who are interested and involved in the fight against desertification and drought, complementing the *World Atlas of Desertification*. This in itself is a good enough argument to develop adequate mapping methodology and to draw the different maps representing and visualizing the different situations of desertification and drought events. THEMANET could augment the preliminary effort of assessing existing knowledge to improve the present edition of the atlas through the collection of scientific papers and documents in the above topics. The collection of papers should have been integrated in to the THEMANET web site. Among the most important topics have to be focused on are:

(a) Land-cover mapping using remote sensing
(b) NDVI mapping
(c) Benchmarks and indicators build upon existing experiences.

E. Methodology of mapping desertification and drought

61. Mapping of desertification and its related factors and subprocesses, including drought, needs a thorough selection of mapping tools and methods. In the case of desertification the main parameter to be shown is **vulnerability** of a certain area, or the situation of some side-effects and subprocesses, such as soil erosion, diminished vegetation, or different stages of land degradation. In the case of drought, more often the **severity** of a drought event and the **sensitivity** or **vulnerability** of an area should be interpreted using maps. In both cases a complex, integrated approach is necessary, where not only one index or indicator should be taken into account, but a combined and integrated expression of several factors should be created. This needs a new methodology and new databases for a better mapping procedure.

62. Current versions of geographical information systems (GIS) are tools to manage vector maps with associated databases containing the corresponding descriptions of each polygon.

Mapping tools allow the user to select a specific item and see its spatial distribution. The user can also combine two or more items to create integrated indices. By aggregating information users can evaluate the state of each component (soil, water, vegetation, poverty, quality of life). Good software is needed that allows for interactive management of indicators, calculation of indices by combining several indicators, and the immediate visualization of resulting maps.

63. There are some individual and more or less isolated trials in the countries affected by drought and desertification for the evaluation of the situation and to demonstrate the spatial distribution. Examples are where drought has occurred, but these trials were mainly based on one factor, usually meteorological data, not taking into consideration other aspects, and evaluations were performed only after a given drought event, not to be considered in the forecasting and preparation period of the coming events. In this way the severity of current drought can be expressed, but the sensitivity of an area to drought depends not only on the lack of precipitation, but on other factors too. Although these factors are rather well known, it is not easy to combine them and show them in one comprehensive figure or map.

64. There are different approaches to finding the best way of expressing the complex phenomenon of drought or desertification. Several individual components of threats should be merged into an integrated indicator and the spatial distribution of this could be mapped. Yet the different factors should be illustrated on separate maps and these maps should be combined, resulting in a complex technical map showing the different sensitive areas. It is also suggested that land vulnerability mapping, showing the potential risk of desertification, should be clearly differentiated from the actual status of desertification on a global scale. These two types of mapping could be used for predicting desertification status on certain human impacts. Many problems occur with the scale of the maps and with the databases on which maps with different scales can be drawn. Each dominant scale needs different databases and different methods. According to the most important division of the scales at spatial levels, the following scales are commonly used:

(a) For local (country, part of a country) maps: 1:10,000–1:25,000–1:50,000
(b) For regional (more countries) maps: 1:200,000 – 1:500,000
(c) For continental maps: 1:1000000 – 1:1,500,000
(d) For global (world) maps: 1:5,000,000

65. To assess and map drought events, period of drought and drought consistency should be considered as main factors at local or national level. For the mapping of desertification it is better that the basic survey on desertification be performed according to geomorphology units, because these units are related to topography, soil, surface and ground water as well as to vegetation conditions.

V. Guidelines for updating/revising the *World Atlas of Desertification*: conclusions and recommendations

66. Referring to the detailed explanations given above, the following is a thematically ordered summary of conclusions and recommendations. They may be taken into consideration in the forthcoming updating or revision of the *World Atlas of Desertification.*

A. Conceptual recommendations

67. The objectives of preparing a new version of the *World Atlas of Desertification* have to be determined clearly before the revision work starts. The well articulated aim of the atlas will influence or even determine the approach, scale and method of preparation, and will result in a better defined and more effective publication.

68. The target audience of the atlas should be well defined in advance.

69. Revision of, and possibly new, definitions of basic terms and concepts relating to desertification and land degradation is urgent, to provide a glossary of such terms and concepts. Consensus should be reached among experts on the presently used terms.

70. Consensus should also be reached on glossary of common terms relating to the drought problems.

71. A new methodology for assessment and illustration of drought and desertification should be developed, based on more accurate local databases and national scales of evaluation, and using a bottom-up approach.

72. The complexity of the topic, and the influences of many aspects, should be taken into consideration, so it is necessary to find a method for combining the different factors and data for a given area (e.g. using maps to illustrate the spatial distribution of the different factors and putting these maps together with the help of GIS techniques).

73. Desertification has strong impacts on non-drylands as well as on drylands. Account should be taken that in these territories biophysical impacts include dust storms, downstream flooding, impairment of global sequestration capacity, and regional and global climate change. The social impacts relate to human migration and economic refugees, leading to deepening poverty and political instability.

B. Structural recommendations

74. Desertification and drought problems of all continents should be clearly demonstrated in the new atlas.

75. The atlas should include explanations and analyses, data and figures, even pictures, and description of assessments of case studies on desertification and drought.

76. As well as global overviews, local and regional situations of desertification and/or drought should also be presented in the atlas.

77. Results of successful pilot studies and/or recovery projects should be interpreted.

78. Separate chapters should be devoted to general methodological problems, and also to ongoing or even finished research/development projects on desertification and drought.

C. Content and methodology related recommendations

79. A valid and accurate database should be created for the assessment and mapping of desertification and drought. Available data are often uneven in scale and accuracy, so it is difficult to create a proper map from them.

80. To avoid the mistakes arising from the simplification that is evident in some current maps, the maps should be carefully annotated, and illustrations given correct titles.

81. Desertification should be mapped on different scales, taking into account the real objective of the evaluation possibilities, the available databases and how the map will be used. The maps and evaluations drawn on global data and assessment should be broken down to regional and local scales showing a more accurate distribution of the characteristics.

82. Drought needs to be analysed and mapped first at smaller (local or national) scale, taking into consideration the purpose of the mapping and the available databases, and using local, but generalized and internationally comparable indicators.

83. Mapping of land vulnerability, showing the potential risk of desertification, should be clearly differentiated mapping actual desertification on a global scale. These two types of mapping could be used for predicting desertification trends with respect to certain human impacts.

84. Many problems occur with the scale of the maps and with the databases on which the maps with different scales can be drawn. Each dominant scale needs different databases and different methods. According to the most important division of the scales at spatial levels, the following scales are commonly used:

(a) For local (country, part of a country) maps: 1:10,000–1:25,000–1:50,000
(b) For regional (more countries) maps: 1:200,000 – 1:500,000
(c) For continental maps: 1:1000000 – 1:1,500,000
(d) For global (world) maps: 1:5,000,000

85. For the assessment of land degradation at subnational and regional levels, the LADA approach should be followed, as it relies on the driving force–pressure–state–impact–response (DPSIR) framework. The LADA project has also developed a local assessment tool, a set of simple and inexpensive assessment techniques that farmers can learn and that are related to farmers' needs for improving land conditions. A methodological framework created in the MA and LADA projects for land degradation assessment in drylands seems suitable for making assessments on local levels, and especially for testing in different ecological conditions.

86. Benchmarks and indicators are crucially important for any kind of assessment or analytical work on natural and social processes, so in both cases a set of indicators should be selected which will help with the evaluation and expression of the main processes of desertification and drought. For desertification monitoring and assessment the indicator system should include the four aspects of pressure, state, desertification impact and implementation of management, and interventions, to which the DPSIR framework seems to be applied. The

selection of indicators at the global scale depends on satellite imagery and statistical data. At the local scale, however, it is important to collect field data from field survey and questionnaires. There exists a certain relationship between the hierarchy and the derived data. In order to assess drought and desertification it is necessary to start by making good use of existing data.

87. It is suggested that preparing an integrated index about socio-economic aspect poverty should be considered as a main factor in this section.

88. It is recommended to establish and organize an editorial board for the compilation of the New World Atlas of Desertification. This board should work out the aims, content and methodology of the new atlas.

D. Research needs

89. Targeted research is needed in formulating reliable and objective techniques and methodologies for detecting land degradation in the drylands (and in other regions), and singling out persistent reductions in biological productivity, against the background of natural fluctuation in this critical ecosystem service of the drylands. If this kind of research is not carried out as a high priority, there is not much to display in a new atlas.

90. A web-based database of local, visual characteristics should be developed, where it is not already available, to assist comparison and transfer among countries and strengthen the local-to-global link.

91. A method is needed to monitor the processes of degradation and improvement at global and regional scales without having to wait for generalization from detailed, local information because of the urgent need of the UNCCD process for such information.

92. Different sets of indicators would be needed at different scales. For the UNCCD the main issue is which decisions should be taken at national level; a minimum set of indicators at national level should be identified that would respond this issue. In the process of selecting and reducing the number of indicators to be used, intuition and understanding of local conditions should play a part, and the process would not be amenable to automation.

93. At local level, innovative ways are needed to encourage communities to collect their own monitoring data, and interpret them for their own objectives. In the model-based pilot studies the LADA methodology was found to be superior in depth of analysis to other current and past land-degradation assessment methods, but the list of indicators used was too long and there were too many interview questions.

94. Further development of the methodological framework created in the MA and LADA projects for land degradation assessment is necessary, and mapping methodology for illustrating the results needs also further study and research work.

95. Development of a set of common benchmarks and indicators is needed, creating a common system for monitoring and assessment of desertification and drought based on relevant

communication and exchange. There is need to apply and validate models applicable for the assessment of land degradation in a biophysical and socio-economic context.

96. Further research and development work should be devoted to ongoing projects, especially to testing the already elaborated assessment and mapping methods in different pilot areas.

97. A comprehensive summary of results of already finished research and development projects is necessary to draw common conclusions and formulate scenarios for wider practical use.

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