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Note by the secretariat*

Addendum

Methodologies for the assessment of desertification at global, regional and local levels

Summary

In promoting activities to combat desertification and mitigate drought impacts there has been emphasis on the assessment of biophysical conditions through indicators such as precipitation, temperature, vegetation cover and soil moisture based on data collected by satellite and geographic information systems, as well as socio-economic and policy indicators. Benchmarks are less addressed in desertification assessment. Even when both are addressed, they tend to be left in isolation without proper integration. In the assessment of desertification, assessment of land vulnerability is imperative, as is the identification of land-use methods that would be effective in reducing human induced pressures on soil vulnerability. The application of technologies for combating desertification and consideration of their cost-effectiveness will make it possible to establish desertification early warning systems. It is a growing concern that drought and desertification have been causing increasingly serious harm, prompted by climate change. In order to tackle such challenges, it is essential to establish monitoring systems for predicting and assessing the potential impacts of drought and desertification propelled by climate change.

* 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. The development of effective methods for monitoring desertification remains one of the important tasks in promoting the activities to combat desertification and mitigate impacts of drought in the context of the United Nations Convention to Combat Desertification (UNCCD). At meetings of the Group of Experts (GoE) of the Committee on Science and Technology (CST) in Beijing, China, in 2004, and in Ispra, Italy, in 2005, various suggestions and recommendations were made in this respect. It was reiterated that the development of benchmarks and indicators for monitoring and assessment of desertification, and the establishment of operational and cost-effective early warning systems for drought and desertification, are part of the important tasks entrusted to the GoE by the CST.

2. Earlier, the Ad Hoc Panel on Early Warning Systems established by the CST carried out instrumental work on this subject. The Panel comprised 10 members and experts from relevant institutions, and presented two reports (ICCD/COP(4)/CST/4 and ICCD/COP(5)/CST/4). The thematic programme networks (TPNs), as a part of the UNCCD regional action programmes, have also contributed to desertification monitoring and assessment, particularly TPN 1 (Desertification monitoring and assessment) hosted by China, and TPN 5 (Strengthening capacity for drought impact mitigation and desertification control) hosted by Mongolia.

3. Many countries have been undertaking useful work on desertification monitoring and assessment, but some deficiencies or constraints have been identified. One is the discontinuation of large-scale and local-scale monitoring. Monitoring of climate and large-scale land cover is often separated from local-scale monitoring based on high resolution remote sensing and field surveys.

4. Another deficiency of monitoring relates to the causal-chain analysis. Data are collected based on pressure, state, impact and implementation benchmarks and indicators, but little consideration is given to the links and sequence of these benchmarks and indicators. As a result, monitoring output is not properly transformed into effective mitigation measures and policy analysis.

5. A third lacuna can be identified with respect to the application of biophysical and socio-economic benchmarks and indicators. To some extent this relates to the causal-chain analysis. The limitation in conducting an integrated assessment of desertification based on biophysical and socio-economic benchmarks and indicators remains one of the key challenges in devising effective desertification monitoring methods.

6. This document overviews the current status of desertification monitoring and assessment methods highlighting major benchmarks and indicators, and monitoring approaches. It then elaborates on the needs for integration of monitoring in three spheres: large- and small-scale monitoring; cause and consequence co-relations; and biophysical and socio-economic links.

II. Desertification and drought, and their impacts

A. Desertification – major causes and indicator clusters

7. Land degradation and desertification have long been recognized as major environmental problems affecting the living conditions of more than 250 million people directly, and more than one billion people are at risk in nearly one-third of global area. Land degradation has continued to get worse in dryland areas in many countries as a result of overcultivation, overgrazing, deforestation and poor irrigation practices. The major causes of desertification are multifaceted and interlinked; they include population pressures, inappropriate land use and agricultural practices, droughts, social conflicts, and limitations in policies and legislation. To a great extent accelerated soil erosion is induced by indiscriminate tree felling. Burning of forest and woodland and changes in the soil–water budget and hydrological cycle are also understood to be important factors leading to land degradation.

8. Desertification is understood as land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors including climatic variations and human activities. Many of the complex causal relationships in the phenomenon are not fully understood. The consequences of desertification likewise vary widely. The cause and consequences of desertification are often intricately linked and create a vicious cycle that affects ecosystems and people’s livelihoods.

9. The Committee for the Review of the Implementation of the Convention (CRIC) reviewed national reports for African countries at its third session, in 2005, and for Asian, Latin American and Caribbean, Northern Mediterranean, Central and Eastern European and other affected countries at its fifth session, in 2007. These reviews identified the causes of desertification in many of the national reports. The review at CRIC 3 of national reports submitted by African countries (ICCD/CRIC(3)/2/Add.1) stated that “Emphasis is mostly placed on describing the various types of land degradation and the factors involved (land clearing associated with expansion of farming or housing, excessive cutting of woody species for firewood, bush fires and overgrazing, etc.).” The reviews showed that biophysical indicators are established for understanding the causes and types of desertification, but “the data contained in the reports are scanty”.

10. The application of benchmarks and indicators for monitoring and assessing desertification varies widely as it is linked to the evolution of the implementation of the UNCCD, particularly at the national, subregional and regional levels. The review process at CRIC 5 revealed variations in such application in countries of the Asia, Latin America and the Caribbean, the Northern Mediterranean and Central Europe regions.

B. Application of benchmarks and indicators

11. The CST undertook work on benchmarks and indicators particularly through its Ad hoc Panel on Benchmarks and Indicators. The Panel met twice in 1998 and made recommendations at COP 2 (ICCD/COP(2)/CST/3/Add.1). The Panel endorsed the framework for selecting benchmarks and indicators as proposed at COP 1 (ICCD/COP(1)/CST/3/Add.1). Thereafter, several countries made attempts to define a set of benchmarks and indicators suitable for facilitating implementation of the UNCCD.

12. At CRIC 5 the UNCCD secretariat provided an explanatory note and guidelines for the preparation of national reports (ICCD/CRIC(5)/INF.3). In the section on country profiles, the guidelines provided key benchmarks and indicators as reference to desertification and related country's conditions. Nevertheless, the synthesis report on the reports submitted by Asian countries in 2006 (ICCD/CRIC(5)/2/Add.1) states that "data on the biophysical indicators of desertification and drought contained in the reports are scanty." This is consistent with what was stated for African countries in 2005.

13. In contrast, Latin American and Caribbean (LAC) countries have made more concerted efforts over the past years to promote the common understanding on application of benchmarks and indicators in desertification monitoring and assessment according to the synthesis (ICCD/CRIC(5)/3/Add.1). The LAC countries have convened regional workshops and a relevant software programme was disseminated. They also drafted a document on the role of non-governmental organizations and grass-roots communities in devising systems for monitoring land degradation using indicators and benchmarks. Two countries have participated in the Land Degradation Assessment in Drylands (LADA) project. Three countries reported progress in strengthening systems for monitoring land degradation in association with academic institutions, and intergovernmental and bilateral cooperation agencies. Yet, the synthesis report states that at the regional level it has not been possible to reach a consensus on comparable and applicable benchmarks, even in generic nature, and refers to the limitation in their application.

14. European Union (EU) countries made notable progress on benchmark and indicator applications as highlighted in the synthesis (ICCD/CRIC(5)/4/Add.1). The synthesis states that the EU countries affected by desertification reported their involvement, together with other European partners, in many scientific projects on benchmarks and indicators, such as DISMED (Desertification Information System for the Mediterranean), DesertLinks (Combating Desertification in Mediterranean Europe: Linking Science with Stakeholders) and INDEX, that constitute important reference bases.

15. The Desertwatch project, funded by the European Space Agency and implemented by a consortium of scientific institutions, has been specifically designed to support the reporting of countries in Regional Implementation Annex IV to the UNCCD in relation to monitoring and early warning. The project produced a methodology, based on earth observation, to monitor and assess desertification over national and subnational areas. The project design and development involved the national coordinating bodies of Italy, Portugal and Turkey. The Desertwatch system produced land cover maps and indicators of desertification for the all continental Portugal, for Sardinia, Sicily and Basilicata in Italy, and for Konia Kanapinar, Corouh Watershed in Turkey, with a spatial resolution ranging from 1 to 100 ha depending on the earth observation data used. The evolution of land use between 1984 and 1994 and between 1994 and 2004 has been used to assess land-use changes according to a legend based on the Corine Land Cover. The Desertwatch methodology also applied earth observations to assess land degradation index using indicators based on the rock/vegetation abundance and the rain use efficiency.

16. The land cover maps and the indicators produced have been validated in pilot areas through field surveys that showed an accuracy level above the threshold of 80 per cent. The socio-economic dimension of desertification is addressed by the project through the use a land-

use model specifically designed and validated in the Gudalentin river basin by the EU MEDACTION research projects. The land-use model provides scenarios of land-use change under user specified socio-economic pressures.

C. Overall lessons learned from benchmark and indicator application

17. Many countries are at varying stages in the application of benchmarks and indicators for desertification monitoring and assessment, particularly climatic and biophysical conditions, and they have collected a great deal of socio-economic data relevant to combating desertification.

18. However, according to the synthesis report on Eastern European and Northern Mediterranean countries, data have not been provided in such a way as to identify links between the degradation of natural resources, socio-economic situations, living conditions or human resource development of an affected country or region.

19. Based on the overall lessons learned from the application of benchmarks and indicators, the following points can be elaborated as future challenges in improving the application of benchmarks and indicators for effective desertification monitoring and assessment:

(a) **Consequential data collection and assessment**. The data are not usually collected consecutively over a certain length of time and a sporadic/transient state can be a mere reference, but cannot provide sufficient basis for developing required policies;

(b) **Methodology development and adoption**. Methodologies for desertification monitoring and assessment must be further elaborated and refined; they must also be adopted in undertaking assessment activities to maintain consistency throughout the assessment because discretional/inconsistent approaches undermine the findings of desertification assessment;

(c) **Combining ecological, socio-economic and policy scales**. There has been an major emphasis on the assessment of biophysical conditions through indicators such as precipitation, temperature, vegetation cover and soil moisture based on the data collected by satellite and geographical information systems (GIS). Socio-economic and policy indicators and benchmarks are less addressed in desertification assessment. Even when both are addressed, they are dealt in isolation without any integration;

(d) **Assessment as a basis for devising effective intervening measures**. Assessment must not remain just an exercise for understanding the current biophysical conditions and desertification mechanisms; it needs to be linked with the process for exploring effective policies and measures for combating desertification. Thus the impacts and implementation indicators must be more proactively used for these purposes;

(e) **Capacity-building**. The major deficiencies in desertification assessment must be overcome by capacity development initiatives to forge institutional capacity and promote human resources development for these purposes. Although there are some forms of technical cooperation, including training, there is a need to promote the sharing of information, the expanding of networks and the building of partnerships on these activities.

III. Methodology of monitoring and assessment for the development of desertification early warning systems

20. A quantitative integrated model should be developed as a method for conducting desertification impact assessment and for implementing countermeasures. In the field of desertification assessment and countermeasures, solutions cannot be produced by focusing on an isolated problem from a single angle, and developing the most effective measure only for this particular problem. Desertification countermeasures consisting exclusively of revegetation provide a good example. This intervention often results in a decline in local residents' living conditions and water availability.

21. Desertification assessment should identify the most suitable balanced choice (that is, the one which provides for the sustainable use of natural resources) through which an equilibrium can be maintained among the various constituent elements, and whereby the entire system can be preserved, while the land is used to support life, and vegetation cover is maintained to prevent land degradation, and thus the ecosystem is conserved on a long-term basis with the most efficient use of limited local natural resources.

22. Development of a quantitative integrated model is thus a prerequisite for tackling such a problem, which requires both a comprehensive perspective and adherence to strict scientific objectivity. For such an integrated desertification model it is essential not only to have a comprehensive understanding of desertification mechanisms, but also to examine the desertification process within a policymaking and managerial framework, so that the most effective management approach can be developed in quantitative terms.

23. Based on the PSR (pressure–state–response) framework, proposed by the Organisation for Economic Co-operation and Development (OECD) as a basic framework for environmental assessment, any pilot study should aim to consider the relevant phenomena, in order to construct a model and to apply it, with an understanding of a relationship between indicators for land degradation and those for its causes and effects. This is because desertification occurs through a complex combination of elements on a local scale.

24. But at the same time, the phenomenon manifests itself on a larger scale. Assessment on this larger scale provides the indispensable basis for policy formulation and decision-making. However, the difficulty of combining the sphere of scope and depth of complexity in a single examination has meant that conventional desertification research has been compartmentalized according to the spatial scales involved in each project.

25. Desertification assessment requires arguments built upon diverse indicators, which are obtained by field surveys. For example, the vegetation coverage rate on its own cannot reveal the ecological stability. Unfortunately, the diverse indicators for large-scale observations and estimates capable of supporting an assessment of the desertification process lack practical applicability and may continue to lack it in the near future.

26. Therefore, it is necessary to focus upon the specific processes involved in land degradation in specific locations. Field surveys on a local scale will enable the stages involved in the degradation/restoration process to be identified. Subsequently, the stability of the ecosystem

during each of these degradation/restoration stages can be assessed and models constructed with indicators applicable for large-scale observation/estimation.

27. With this approach at each location, it will be possible to assess the sustainability through a small number of indicators, which can also potentially be obtained on a large-scale basis. Moreover, because similar environments will most likely follow similar degradation/restoration processes, it will be possible to organize the environment spatial groupings, which will enable large-scale assessments to be conducted by using the landscape ecology method and multiple-point field surveys. By following such an approach, emphasis will be given to observation/estimation through indicators on a large-scale basis, and to understanding the details of the desertification process and benchmarks on a regional scale; the advantages of both spatial scales will be harmoniously integrated. Within this overall framework, the pilot study will comprise three sub-themes. Sub-theme 1 will involve the coordination of results from sub-themes 2 and 3, and also the development of an integrated model and assessment methods. Sub-theme 2 will involve conducting observation/estimation through large-scale desertification indicators. And sub-theme 3 will involve the adoption of the PSR framework to analyse desertification phenomena on the basis of field surveys and experiments to establish benchmarks, and explore restoration measures.

A. Structure of an integrated model for development of desertification early warning systems

28. Sub-theme 1 will involve the development of an integrated model (figure 1) and assessment methods that will use this model, as well as the coordination of the work being undertaken under the other two sub-themes. For developing the model, the data obtained under sub-theme 3 – relating to degradation/restoration processes of desertification, the critical intensity of grazing at each stage, stability and resilience against climate change and human interference, and decisive points for stability and resilience (that is, benchmark stages) – will be included in the model in such a way as to permit calculations according to the large-scale indicators treated in sub-theme 2.

29. Because the degradation/restoration process involves complex qualitative changes in the ecosystem, efforts should be focused on the maintenance of a semi-quantitative empirical model. A parallel element of the modelling exercise should involve versatile process models (such as models for turnover of organic matter in the soil, soil erosion and grazing), which are capable of large-scale application.

30. To explore the universal applicability of models over spatial variability, and to cope with those spatial variabilities which could not be explained fully by the groups of indicators under sub-theme 2, empirical parameters, or models, will be constructed individually for each landscape type. Adjustment of the parameters will allow the results calculated for a separate type to be combined in an appropriate way, accounting for any variability in the environmental elements.

31. At the same time, socio-economic information at macro level, both statistical and non-statistical, should be collected, and an appropriate interpolation method should be used whereby this information could be included in spatial mapping. This information will be managed

according to the GIS, with the biophysical indicators for desertification obtained under sub-theme 2.

32. Finally, by integrating the models created and the information collected, a large-scale mapping system will be developed to include past environmental changes and grazing pressure changes, and also the degradation/restoration stages following the desertification prevention countermeasures, grazing capacity and benchmarks. Once the system is developed, an assessment will follow. First, a simulation covering the past several decades will be carried out to understand long-term desertification trends. At the same time, the politics, and economic and environmental policies in the target areas will be taken into account so that their negative impacts on vegetation can be assessed. The assessment results will be fed into the integrated model as impacts caused by macro-socio-economic factors.

33. Various environmental policies (scenarios) will be examined in context with the current desertification conditions, and the benefit accruing from such interventions will be evaluated. Each scenario will be checked for its feasibility in terms of the social, economic and cultural background. In evaluating the effects of a given policy, consideration will also be given to land-use regulations and cost-effectiveness (including the human and economic costs of introducing eco-technological measures), so that the most appropriate spatial distribution pattern of the numbers of cattle for grazing would be encouraged in order to avoid land degradation and realize a healthy carrying capacity.

B. Desertification indicators for long-term monitoring: standardization of observation methods

34. Climate indicators (mainly rainfall) and vegetation indicators (mainly the normalized difference vegetation index, NDVI) have hitherto dominated the field of large-scale monitoring for desertification assessment. Assessments based on combinations of these two sets of indicators have been found effective for short-term early warning systems such as for drought, but they are not adequate to provide an accurate assessment for the whole desertification process, which does not become apparent except on a time scale of the order of several years or more as a result of complex interactions between diverse elements. The Ad Hoc Panel on Early Warning Systems has pointed out the importance of establishing soil as an indicator, because there are direct correlations for changes over time and the condition of the soil also has a strong influence on land-productivity resilience.

35. With the help of remote sensing, model simulation and GIS, sub-theme 2 will involve the standardization of methods for large-scale and long-term surveys using biophysical indicators such as vegetation and soil. The vegetation indicators will take into account vegetation type, cover, biomass and net primary productivity (NPP). The soil indicators will reflect soil moisture content, snowfall, organic carbon content in the surface soil, and the degree of wind/water erosion. In conjunction with sub-theme 3, the accuracy of each indicator for assessing sustainability will be examined. Other potential indicators will also be considered.

36. The widespread use of remote sensing has made possible an accurate understanding of vegetation indicators; such as vegetation cover and biomass. The NDVI has been found to be capable of producing accurate results. In order to estimate NPP, CASA (the Carnegie–Ames–

Stanford Approach) model will be improved to make application possible to arid regions. As for monitoring soil moisture, because the target areas include cold latitudes, some with permafrost, long-term data will be obtained by algorithm based on the microwave radiation data from satellites such as SMMR and SSMI. Organic carbon amounts will be monitored over large areas by extracting soil-derived spectra by linear spectral non-mixing classical limit and producing a regression model to combine spectrum measurements with field survey data.

37. Wind and water erosion will be estimated by model simulations. Another aspect to be considered is the impact of snowfall in the target areas, as there has been no previous attempt to systematically assess soil freezing and related erosion. Through field surveys, a method will be developed to assess the impacts that snowfall and soil freezing have on erosion.

C. Land vulnerability assessment by soil/vegetation/hydrological analysis

38. If desertification indicators are to be used for land vulnerability assessment, clear benchmarks are necessary. But the lack of clear definition of desertification is causing confusion in the development of desertification benchmarks. In order to overcome this current problem, it is necessary to determine that whether or not desertification is occurring depends on the sustainability of the conditions. Therefore it is necessary to develop instruments that will enable sustainability to be assessed scientifically. Desertification research on sustainability-related benchmarks is almost non-existent, especially in large-scale projects.

39. In the target areas, the relationship between natural resources and sustainability reflects the digestible nutrients in plants. The amount of digestible nutrients which can be consumed (grazing capacity) depends upon vegetation types, species composition, current amount of nutrients and productivity. These factors vary widely according to natural conditions such as climate, topology, geology and soil type, and the changes caused by human interference.

40. More concretely, apart from direct consequences of human interference through cattle grazing, reduced productivity and the change in species composition/vegetation types, indirect impacts are strongly expressed in terms of physical/chemical changes in soil (soil nutrient loss, salination), physical changes (decline in aggregate formation crust, compaction) and soil erosion. Resilience has a strong relationship with soil degradation, which not only restricts the restoration of land productivity, but also leads to accelerated and irreversible land degradation. In desertification assessment, the different stages of the desertification process should be assessed comprehensively.

41. Sub-theme 3 consists of two sub-sub-themes: land vulnerability assessment by field survey, and physiological and ecological assessment of soil degradation.

1. Land vulnerability assessment by field survey

42. On the basis of a thematic map of climate, topology, geology and soil, the target areas is first divided into several landscape types in accordance with their respective landscape ecology. Following this an observation station will be established in each of these districts in collaboration with researchers from the counterpart countries. Here, weather, soil erosion, etc., will be monitored, and the degree of erosion will be estimated based on the activities of

radionuclides in the soil. Fenced pastures will be established for experiments with different grazing intensities, in which a thorough examination of desertification-related indicators will be carried out. In addition, the relationship of the degradation/restoration process to the land-use intensity, dynamic equilibrium state, and rate of change from one level to another will be studied.

43. Parallel to these studies, an extensive survey of the surrounding area will be conducted, in order to obtain more knowledge on the longer-term processes of degradation/restoration, to identify similarities in the spatial variabilities involved in these processes, and thereby to categorize the environment into groups based on similarity in background environmental factors. This combination of experimentation and monitoring will reveal the critical point of grazing intensity, and its stability/resilience against climate change and human interference for each environmentally categorized group.

44. In addition, through identification of the decisive points at which stability and resilience undergo significant changes, the combination of indicators necessary to serve as a baseline will be determined. From the degradation levels established as a baseline, various elements capable of estimation by local residents (e.g. plant species composition, vegetation coverage) will be chosen, and benchmarks for diagnosing local land conditions will be suggested. The focus will be on indicators for the plant species, and through growth experiments the impact of soil factors on the physiological and ecological character of plant species will be analysed.

45. Furthermore, the appropriate restoration/management (ecosystem management) methods for each degradation stage will be explored. For example, taking land productivity and biodiversity into consideration, a judgement based on the degree of land degradation will be made as to whether to restrict grazing intensity in order to promote vegetation rehabilitation, or to introduce technological methods for soil stabilization and plant cultivation. The results obtained under this sub-sub-theme, when combined with the results of sub-theme 2, will become the foundation for mapping degradation stages, stability/resilience and appropriate recovery measures, using the integrated model from the sub-theme 1 as a platform.

2. Physiological and ecological assessment of soil degradation

46. This sub-sub-theme focuses on the effect of physiochemical characteristics of soil on vegetation, species composition and NPP in particular. Using the samples collected in the target area, growth experiments will be conducted in a laboratory under controlled environmental (radiation intensity, air temperature and humidity) and soil (particle size distribution, moisture and nutrient) conditions, to simulate the environment in the target area;, the activity of the plant physiological parameters, such as transpiration and photosynthesis rates, of the major indicator plant species will be analysed in relation to soil characteristics.

47. A model will be used to explain the relationship between the soil factors and the plant physiological and ecological characteristics, as well as the inter-species effects. The validity will be determined by comparing the model results with the data on vegetation and soil in the target area. Furthermore, the change in the species composition and the productivity will be estimated in the cases when the soil is more degraded and where the restoration measures have been

implemented. The diagnositic measure for soil degradation by surveying vegetation indicators will also be provided.

48. Soil erosion is assessed in accordance with the Wind Erosion Assessment Model (WEAM) and Revised Universal Soil Erosion (RUSLE) model. The parameters used for WEAM are based on various data sources such as the European Centre for Medium-Range Weather Forecasts (ECMWF), ECMWF Re-Analysis (ERA), the National Oceanic and Atmospheric Administration (NOAA), the National Centers for Environmental Prediction (NCEP), Oregon State University (OSU), the Air Force and Hydrologic Research Center, and the NOAA/National Aeronautics and Space Administration (NASA) Advanced Very High Resolution Radiometer (AVHRR).

49. Other data sources include the Advanced Microwave Scanning Radiometer (AMSR), AMSR for Earth Observing Systems (EOS) (AMSR-E), the Advanced Earth Observing Satellite (ADEOS), the Special Sensor Microwave/Imager (SSM/I), and the Defense Meteorological Satellite Program (DMSP).

50. For soil erosion by water, the Revised Universal Soil Erosion (RUSLE) model could be used. In addition to soil erosion, vegetation changes were observed in selected sites as an indication of the initial process for soil erosion. The change in grass species composition is not easily observed by remote sensing or NDVI. On the other hand, the changes in vegetation composition, or vegetation degradation are key features that need to be integrated in desertification early warning systems as vegetation degradation is one of the initial indications of soil degradation and desertification.

D. Cost-benefit analysis on policy options for combating desertification

51. In the model simulation processes, cost-benefit analysis was also undertaken for the selected sites based on the estimated cost for shrub plantation/restoration and grazing pressure optimization. The plantation of shrubs palatable and usable as fodder is one of the suggested policy options for reducing grazing pressures on grassland, but the cost of such activities is estimated to be quite high. Given the estimated increase in livestock revenue, it is concluded that such a policy option is not economically viable under the current circumstances.

52. On the other hand, rectifying the distribution of livestock and optimizing grazing pressures across grassland is deemed to be an economically viable and effective policy intervention measure for combating desertification.

E. Capacity-building for combating desertification – social capacity assessment

53. There has been quite a significant emphasis on the assessment of biophysical conditions through indicators such as precipitation, temperature, vegetation cover and soil moisture based on data collected by satellite and GIS. Socio-economic and policy indicators and benchmarks are less addressed in desertification assessment. Even when both are addressed, they are dealt with in isolation without any integration.

54. Assessment must not remain just as an exercise for understanding the current biophysical conditions and desertification mechanisms; it needs to be linked with the process for exploring effective policies and measures for combating desertification. Thus the impacts and implementation indicators must be more proactively used for these purposes.

55. The major deficiencies in desertification assessment must be overcome by capacity development initiatives to enhance institutional capacity and promote human resources development for these purposes. Some efforts are being made towards technical cooperation, including training in various forms, but there is a need to promote the sharing of information, the expanding of networks and the building of partnerships on these activities.

IV. Desertification monitoring and the impacts of climate change

56. The integrated analysis based on biophysical and socio-economic conditions is essential not only for devising policy options, but also for evaluating the performance of policies and measures for combating desertification and mitigating the impacts of drought. There is growing concern that drought and desertification have been causing increasingly serious harm, prompted by climate change. In order to tackle such challenges, it is essential to establish monitoring systems for predicting and assessing the potential impacts of drought and desertification propelled by climate change. However, it remains to be seen what kind of impacts desertification will cause. The multi-scale desertification monitoring is very important to assess the impacts of climate change on desertification.

V. Conclusions and recommendations

57. In order to pursue the effective methodologies for monitoring and assessment of desertification, and to promote the application of benchmarks and indicators, the GoE proposes the following suggestions for the future work of the CST.

58. One of the major deficiencies in the current methodologies for desertification monitoring and assessment is that large-scale monitoring based on climatic data is separated from local-scale monitoring based on high resolution remote sensing and field surveys. Unless such a separate monitoring is replaced by integrated monitoring, it is difficult to systematize a multiple scale monitoring method. It may be possible to examine the changes of vegetation indices even under such an isolated monitoring method, but it would be difficult to monitor large areas using such a methodology.

59. Development of a quantitative integrated model is a prerequisite for tackling such a problem, which requires both a comprehensive perspective and adherence to strict scientific objectivity. For such an integrated desertification model it is essential to have not only a comprehensive understanding of desertification mechanisms, but also an examination of the desertification process within a policymaking and managerial framework, so that the most effective management method can be presented in quantitative terms.

60. Based on the pressure–state–response framework proposed by OECD as a basic framework for environmental assessment, it is necessary to construct a model and to apply it to monitoring and assessment and to early warning systems, while taking into account the same

relationship between indicators for land degradation and those for its causes and effects.

61. But at the same time, the phenomenon manifests itself on a larger scale. Assessment on this larger scale provides the indispensable basis for policy development and decision-making; however, the difficulty of combining breadth of scope and depth of complexity in a single examination has meant that the conventional desertification research has been compartmentalized according to the different spatial scales.

62. The bridge between two approaches of desertification monitoring and assessment is benchmarks and indicators. Common indicators of large-scale monitoring and field surveys are, for instance, precipitation, topography, soil moisture, vegetation density, and human induced pressures. Data collected from the monitoring of desertification from field surveys on desertification can be classified based on the ecosystem and compared with data obtained by large-scale monitoring as in desertification monitoring. With such a process, desertification assessment can be extended to a larger scale.

63. Assessment must not remain just an exercise for understanding the current biophysical conditions and desertification mechanisms; it needs to be linked with the process for exploring effective policies and measures for combating desertification. Thus the impacts and implementation indicators must be more proactively used for such purposes.

64. The major deficiencies in desertification assessment must be overcome by capacity-building initiatives to forge institutional capacity and promote human resources development for these purposes; some forms of technical cooperation/training exist, but there is a need to promote the sharing of information, the expanding of networks and the building of partnerships on these activities.

65. Drought early warning systems as emergency measures are already at the implementation stage for reducing disaster impacts. One of the remaining challenges is that the information network for releasing to local people information obtained from such assessments and early warning systems is still underdeveloped. The integrated analysis based on biophysical and socio-economic conditions is essential not only for devising policy options, but also for evaluating the performance of policies and measures for combating desertification and mitigating the impacts of drought.

66. It is a growing concern that drought and desertification have been causing increasingly serious harm, prompted by climate change. In order to tackle such challenges, it is essential to establish monitoring systems for predicting and assessing the potential impacts of drought and desertification propelled by climate change.

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