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THEMATIC PROGRAMMES OF WORK: PROGRESS REPORTS ON IMPLEMENTATION AND CONSIDERATION OF PROPOSALS FOR FUTURE ACTION: BIOLOGICAL DIVERSITY OF DRY AND SUB-HUMID LANDS

Integration of needs for information on the status and trends of dry and sub-humid lands biodiversity in the context of the mandate of the Global Land Degradation Assessment of Drylands (LADA): report submitted by the Food and Agriculture Organization of the United Nations (FAO)

Note by the Executive Secretary

1. In paragraph 1 of recommendation VIII/4, SBSTTA i*nvited* the Food and Agriculture Organization of the United Nations, as the executing agency of the Global Land Degradation Assessment of Drylands (LADA) and the Millennium Ecosystem Assessment to consider integrating, in the context of their respective mandates, the needs for information on status and trends of dry and sub-humid land biodiversity, and ways to strengthen national efforts to conduct assessments, and to report on this matter to the seventh meeting of the Conference of the Parties to be held in the first quarter of 2004.

2. The attached document has been submitted by the FAO outlining the potential contributions of LADA to the assessment of biological diversity of dry and sub-humid lands as foreseen in decision V/23.

3. The Conference of the Parties may wish to consider the proposals made when considering the relevant draft decisions on the programme of work on biological diversity of dry and sub-humid lands (UNEP/CBD/COP/7/1/Add.2).

4. It is being reproduced in the language and form in which it was received by the Secretariat.

* UNEP/CBD/COP/7/1 and Corr.1.

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POTENTIAL CONTRIBUTIONS OF LADA TO ASSESSMENT OF BIOLOGICAL DIVERSITY OF DRY AND SUB-HUMID LANDS; PROPOSAL IN RESPONSE TO SBSTTA RECOMMENDATION VIII/4

I. INTRODUCTION TO COP/CBD DECISIONS ON DRYLAND BIODIVERSITY ASSESSMENTS

1. This information document is prepared and made available by the Food and Agriculture Organisation of the United Nations (FAO) with reference to decision V/23 of the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) which adopted the programme of work on dry and sub-humid lands and requested SBSTTA to review and assess periodically the status and trends of the biological diversity of dry and sub-humid lands on the basis of the outputs of the programme of work, and make recommendations for the further prioritization, refinement and scheduling of activities. In this decision, the Conference of the Parties further requested the Executive Secretary to collaborate with the Secretariat of the Convention to Combat Desertification (CCD), including through the development of a final joint work programme (ref. UNEP/CBD/COP/5/INF/15); as well as with other relevant bodies, in the implementation and further elaboration of the programme of work and to seek inputs from and collaborate with countries with sub-humid lands, and with other bodies relevant to sub-humid lands.

2. This paper responds to SBSTTA recommendation VIII/4 (UNEP/CBD/COP/7/3), which invites FAO, as the executing agency of the Global Land Degradation Assessment of Drylands (LADA), and the Millennium Ecosystem Assessment (MA) to consider integrating, in the context of their respective mandates, the needs for information on status and trends of dry and sub-humid land biodiversity, and ways to strengthen national efforts to conduct assessments, and to report on this matter to the seventh meeting of the Conference of the Parties. In particular, regarding the activities of Phase I (2002-2004) of the proposed process for the periodic assessment of the status and trends of biological diversity in dry and sub-humid lands: (1) Invites LADA and the MA to investigate how the needs of the dry and sub-humid lands could be integrated into the ongoing assessments, emphasizing proposals and ways to strengthen national efforts to conduct assessments. Reference is also made to the other activities of phase I: (2) Develop proposals for mechanisms(s) linking national assessment to regional/global assessment/ report processes and (3) Participatory development of draft guidelines for national assessments, including indicators.

3. The programme of work on the biological diversity of dry and sub-humid lands, including dryland, Mediterranean, arid, semi-arid, grassland and savannah ecosystems, consists of two parts "Assessments" and "Targeted actions in response to identified needs". These are intended to be implemented in parallel so as to enable knowledge gained through the assessments to help guide the responses needed and, in turn, lessons learned from activities to feed back into the assessments. This paper responds largely to the programme element on assessments, the objective of which is to assemble and analyse information on the state of the biological diversity of dry and sub-humid lands and the pressures on it, to disseminate existing knowledge and best practices, and to fill knowledge gaps, in order to determine adequate activities. The decision recognizes that such an assessment is particularly challenging in view of the need to consider the highly dynamic situation of ecosystems in dry and sub-humid lands, as well as their socio-economic value and the consequences of their loss and change.

II. INTRODUCTION TO LADA GOALS AND ACTIVITIES

4. The Conference of the Parties to the desertification convention has recognized that not enough is known of the root causes, nature, extent, severity and impacts of the diverse types of land degradation in drylands. The Global Environment Facility (GEF), in partnership with FAO, UNEP, the Global Mechanism of the CCD, has provided resources to catalyse an international undertaking in support of a global Land Degradation Assessment in Drylands. To this effect FAO, as executing agent, through the project development facility (PDF-B grant, March 2002-2004), has been developing the project and an effective assessment methodology for land degradation in drylands, with the support of

three pilot studies and national teams in Argentina, China and Senegal. Other partners include the CCD Secretariat and some national focal points, ISRIC, and various institutes and NGO's concerned with drylands development.

5. The Land Degradation Assessment in Drylands project (LADA) responds to the need to strengthen support to land degradation assessment at international and national levels. It also responds to the needs of the joint work programme between the Conference of the Parties and CCD as presented in UNEP/CBD/COP/7/INF/28, and welcomed by the sixth session of the Conference of the Parties / CCD in its decision #19 (Havana, Cuba, September 2003). The assessment methods that are being developed for local, agro-ecological zone, national and global levels, will be directly relevant for use through the national and regional action plans (NAPs & RAPS) of the CCD and the national biodiversity strategies and action plans (NBSAPs) of the Convention on Biological Diversity to help in identifying, through participatory approaches with stakeholders, priorities and practical measures to combat desertification and building capacity of local people to reverse land degradation and ensure the conservation and sustainable use of land resources and biodiversity.

6. Land degradation has been recognized as a global problem associated with desertification in arid, semi-arid and dry sub-humid zones (commonly called drylands). Drylands occur on every continent, covering about 40% of the world's land area, and encompass grasslands, agricultural land, forests and urban areas. Drylands are sensitive but resilient environments, and human-induced pressures can lead to degradation and loss of biodiversity and ecosystem services from natural and agricultural systems. To remain consistent with the CCD and member countries national action programmes, LADA has adopted the UN-CCD definition of land degradation, which is described as "a natural process or a human activity that results in a loss of sustainability and economic function", and its definition of drylands, which is based on precipitation and potential evapotranspiration. The ratio of these two variables allows to divide the world into six aridity zones hyper-arid, arid, semi-arid, dry sub-humid, moist sub-humid, and humid.

7. As concluded by the Dahlem Desertification Paradigm, land degradation encompasses both biophysical and socio-economic dimensions. It thus requires assessment, not only of the degradation of soil, water and biological resources, loss of biological diversity and impacts in terms of ecosystem functioning, integrity and health, but also assessment of the natural or human induced factors that affect the status of land resources and cause a change in ecosystem services or in human well-being. The major causes of degradation are inappropriate land use and poor management including intensive tillage and cropping, excessive irrigation, and over-grazing. Climate change also affects physical, chemical, and biological factors and ecosystem processes. The primary driving forces of land degradation are policy, institutional and market failures including insecurity of land tenure, as well as civil unrest. These are, in turn, driven by demographic, economic, and socio-political factors, especially poverty.

8. LADA is developing, with country participation, a framework for land degradation assessment at global and national levels through consensus building process for which the long-term purpose is to identify socio-economic and environmental benefits accruing from addressing land degradation in drylands in terms of conservation of biodiversity and international waters, and sequestration of carbon. LADA will generate up-to-date ecological, social, and economic and technical information, including a combination of traditional knowledge and modern science, to guide integrated and cross-sectoral planning and management in drylands. The specific objectives of the ongoing project development phase, GEF PDF-B grant, are:

(a) review and synthesis of data and information of relevance to the development of a land degradation assessment in drylands;

(b) development, testing and revision of integrated land degradation assessment approaches and methods;

(c) capacity and network development for assessment of land degradation;

(d) conducting pilot studies to calibrate and test methods for land degradation assessment in selected countries;

(e) development of strategies for information communication, partnerships and co-financing and;

(f) development of a full LADA GEF Project.

9. It is widely recognized that environmental conditions is impacted by population dynamics and poverty, in particular livelihoods, health and nutrition and vulnerability dimensions, including capacity to develop coping strategies to address food insecurity and climatic variability. Poor people rely largely on the environment for their livelihoods and well being and so are most severely affected when natural resources are degraded. Moreover, the poor often live in marginal (least productive) and degraded lands and vulnerable conditions (human and climatic), and they may lack the ability to respond to spatial and temporal fluctuations in land resources condition because of socio-political constraints (livestock corridors for access to dry season grazing etc.), thus exacerbating pressures on natural resources and biodiversity and impacts on livelihoods and food security. In deciding what to measure in a specific country or sub-national context, it will be necessary to define what factor is degraded, what are the causes and pressures, as well as what are the societal responses in terms of technological interventions and policy and legal measures, with a view to identifying management inputs that may be required for conservation, sustainable use and remediation.

10. LADA is also promoting an ecosystem approach, as adopted by the Convention on Biological Diversity, for the assessment of land condition and biodiversity in drylands that incorporates the effects of pressures from human activities and socio-economic condition at different spatial and temporal scales. This will help to identify the cause and effect relationships between land degradation, biodiversity and human livelihoods, and ultimately to develop land management strategies and policies that address both bio-physical and human dimensions and interactions among components of the system.

11. The implications are that this global LADA project will pave the way for a country-driven, world-wide assessment of land degradation which will help in the implementation of the CCD, with its focus on socio-economic causes and consequences of land degradation and linkages to developmental issues through the NAPs and RAPS. The LADA process is considering how to establish linkages and synergies with the Convention on Biological Diversity and to contribute, in particular, to the implementation of the programmes of work that address agricultural biodiversity and biological diversity in dry and sub humid lands, as well as cross-cutting programmes that address, for example, monitoring and assessment, sustainable use, incentives, access and benefit sharing. There are also important linkages with the issues of food security and sustainable agricultural and rural development (SARD), in accordance with national commitments, targets and actions to implement the plans of action of Agenda 21, the World Food Summit, the World Summit on Sustainable Development, and the International Treaty and Global Plan of Action on Plant Genetic Resources for Food and Agriculture.

12. The added value of LADA is that the process will be driven by national assessments to address national priorities and environmental and socio-economic issues, while adhering to the extent possible to a harmonized global assessment framework to allow comparability and monitoring across national boundaries and physical and geographic regions. In this regard, the LADA guidelines advocate that local assessments should capitalize on local knowledge and existing initiatives, work with local stakeholders, include integrated assessments of biophysical and social components of land degradation, and develop a standardized methodology. More specific methodologies will need to be further adapted to take account of local conditions and the questions being asked by different stakeholders at local, technical and policy levels. “Hot” spots (areas that are degraded or rapidly degrading land susceptible to degradation or already degraded to a greater or lesser extent), and “bright” spots (areas that are being managed sustainably or have been rehabilitated) will be identified for comparative monitoring purposes and to learn from failures and successes.

13. The assessment of land degradation in drylands at local, sub-national and national levels should contribute, *inter alia,* to the assessment of the impact of land degradation on biological diversity and biological processes and the identification of priority work needed to overcome barriers to the conservation and sustainable use of the biological diversity of dry and sub-humid lands with a

view to targeting funding support to such work. More specifically the LADA project, with appropriate institutional and financial support, could substantially contribute to the assessment activities of the programme of work on dry and sub humid lands, notably through:

(a) Integrating in the drylands degradation assessment, the assessment of status and trends of the biological diversity especially in "hot spots" and "bright spots", including the effectiveness of conservation measures.

(b) Identification of specific areas within drylands that are under particular threat of degradation (hotspots) and areas that are noteworthy in terms of conservation, sustainable use and restoration (bright spots) including *inter alia* biological diversity and its contribution to ecosystem functioning.

(c) Development of indicators of land degradation and an assessment framework for dryland ecosystems that includes biodiversity and its loss.

(d) Building knowledge on ecological, physical and social processes that affect land resources in drylands, including biological diversity, especially in regard to ecosystem structure and functioning (e.g., grazing, droughts, floods, fires, tourism, agricultural conversion or abandonment).

(e) Contribution to the identification of the local and global benefits derived from the conservation and sustainable use of biological diversity in drylands, in terms of soil and water conservation, poverty alleviation and food security and assessment of the socio-economic impact of its loss.

(f) Identification and dissemination of best management practices, drawing on knowledge, innovations and practices of indigenous and local communities and modern technologies, that can be promoted and broadly applied, to mitigate and reverse land degradation and biodiversity loss.

III. RELATED NATIONAL INDICATOR AND ASSESSMENT PROCESSES

14. It is envisaged that LADA should play a lead or catalytic role in developing a coherent and practical national assessment framework and set of indicators of land degradation adapted for dryland ecosystems. This will include methods to assess and monitor status and trends at local, agro-ecosystem and national scales, and increasing knowledge on land degradation (including loss of and threats to biological diversity) trends and appropriate agricultural management and remedial measures also at local, ecosystem and national levels.

15. In developing a standard assessment methodology, that will assist countries in implementing the CCD, the Convention on Biological Diversity and other related assessment processes, effective partnerships and collaborative mechanisms are required among various parallel initiatives with a view to developing consensus on key indicators and assessment methods in particular with :

(a) The CCD NAP mechanisms through LADA national focal points and the CCD panel of expert and thematic networks particularly the one that has been established to develop benchmarks and indicators for desertification monitoring and assessment (including indicators based on vegetation attributes to assess land condition).

(b) The indicators and assessment processes established by the Convention on Biological Diversity, in particular the *ad hoc* Technical Expert Group on the biological diversity of dry and sub-humid lands, and those involved in (i) the development of guidelines for the rapid assessment of biodiversity in inland water ecosystems; (ii) the development of the Global Strategy of Plant Conservation targets; and (iii) in assessing the lack of taxonomic information and needs for capacity building through the Global Taxonomy Initiative (decision V/9 of the Conference of the Parties).

(c) Building on the outcome of SBSTTA recommendation IX/10 on monitoring and indicators regarding the design of national level monitoring programmes and indicators" guidance for national processes. Such guidance could strengthen the capacity of LADA partners and countries in including biodiversity relevant aspects to the assessment.

(d) The Millennium Ecosystem Assessment (MA) focuses on providing peer-reviewed, policy-relevant scientific information on the condition of selected ecosystems, consequences of ecosystem change, and options for response. Collaboration with LADA is already established through a letter of agreement with the pilot project in Argentina in assessing goods and services. A preliminary report is prepared and is under review and will be made available for consultation through the LADA virtual centre (http://lada.virtualcentre.org)

(e) The FAO led planned 2nd assessment of the State of the World's Plant Genetic Resources for Food and Agriculture (PGRFA), first conducted in 1996, which through national reviews and reports is a key element of the Global Plan of Action and the International Treaty for the Conservation and Sustainable Use of PGRFA. It assesses the state of plant genetic diversity and capacities at the local and global levels for *in situ* and *ex situ* management, conservation and use of plant genetic resources, including mechanisms for sharing the benefits and burdens. The review guidelines are currently being tested through a number of country projects.

(f) The FAO led 1st review of the State of the World's Domesticated Animal Genetic Resources which aims to provide a comprehensive inventory of animal genetic resources in terms of their contribution to sustainable development and food security upon which governments can establish priorities for improved policy development and capacity building in the sector.

(g) The FAO led Global Forest Resources Assessment: FRA 2000 used a homogeneous set of definitions for a comprehensive global assessment of forest resources based on information provided and validated by countries, supplemented by state of the art technology for analysis. Work is ongoing for FRA 2005 in response to the invitation by FAOs Committee on Forestry (COFO, March 2003). It will be based on guidelines for country reporting, agreed terms and definitions and following common themes of Criteria and Indicators for Sustainable Forest Management including assessment and monitoring of forest genetic diversity and variation.

(h) The Joint Working party on Agriculture and Environment of the Organisation for Economic Co-operation and Development (OECD) in developing environmental indicators for agriculture primarily aimed at policy makers and the wider public. This includes biodiversity indicators for genetic species and ecosystem diversity (e.g. extent of genetic erosion and loss of crop varieties and breeds; trends in population distributions; wildlife species dependent on agriculture; non-native species threatening agricultural production, agro-ecosystem functioning and integrity. Potential soil biodiversity indicators are being considered as well as soil carbon and soil erosion indicators.

(i) Medaction and Desertlinks, the European, interdisciplinary initiatives for the implementation of Annex iv of CCD funded by the European Commission (2001-2004) and contributing to the work of the CCD by developing a desertification indicator system for Mediterranean Europe.

(j) Other UN bodies and international and regional organizations working on sustainable development indicators, such as NASA, IISD, the World Bank, UNDESA, and so forth.

IV. PROGRESS AND RESULTS OF LADA OF RELEVANCE TO BIOLOGICAL DIVERSITY IN DRYLANDS

16. **LADA Approach:** It has been agreed that land degradation should be assessed and dealt with holistically and in a multidisciplinary way in order to establish links between the driving forces, the causes (pressures), the state of land degradation and its impact on the people and the environment. Various methods and tools to assess land degradation are available, with their individual strong points and disadvantages, but with a clear complementarity. It is proposed that a combination of these tools should be linked with a quantitative modelling approach that appeals to economists and decision makers. The links established should integrate biophysical and socio-economic factors into models that can effectively serve in decision support. The LADA approach comprises seven sequential steps: 1) preparation of initial studies; 2) establishment of a national LADA task force; 3. stocktaking and preliminary analysis; 4) developing a stratification and sampling strategy; 5) Field survey and local

assessments; 6) development of a LADA decision-support tool; 7) development of a LADA monitoring tool.

17. **LADA Virtual Centre**: During the project development phase, LADA has compiled a knowledge base on land resources degradation in drylands. This provides information on LADA, methodological guidelines, meetings and events and partnerships. It also allows a comprehensive thematic search for relevant information, data and ongoing work from various relevant sources, including those of international conventions, the Global Observing Systems, and other programmes. , see http://lada.virtualcentre.org/pagedisplay/display.asp.

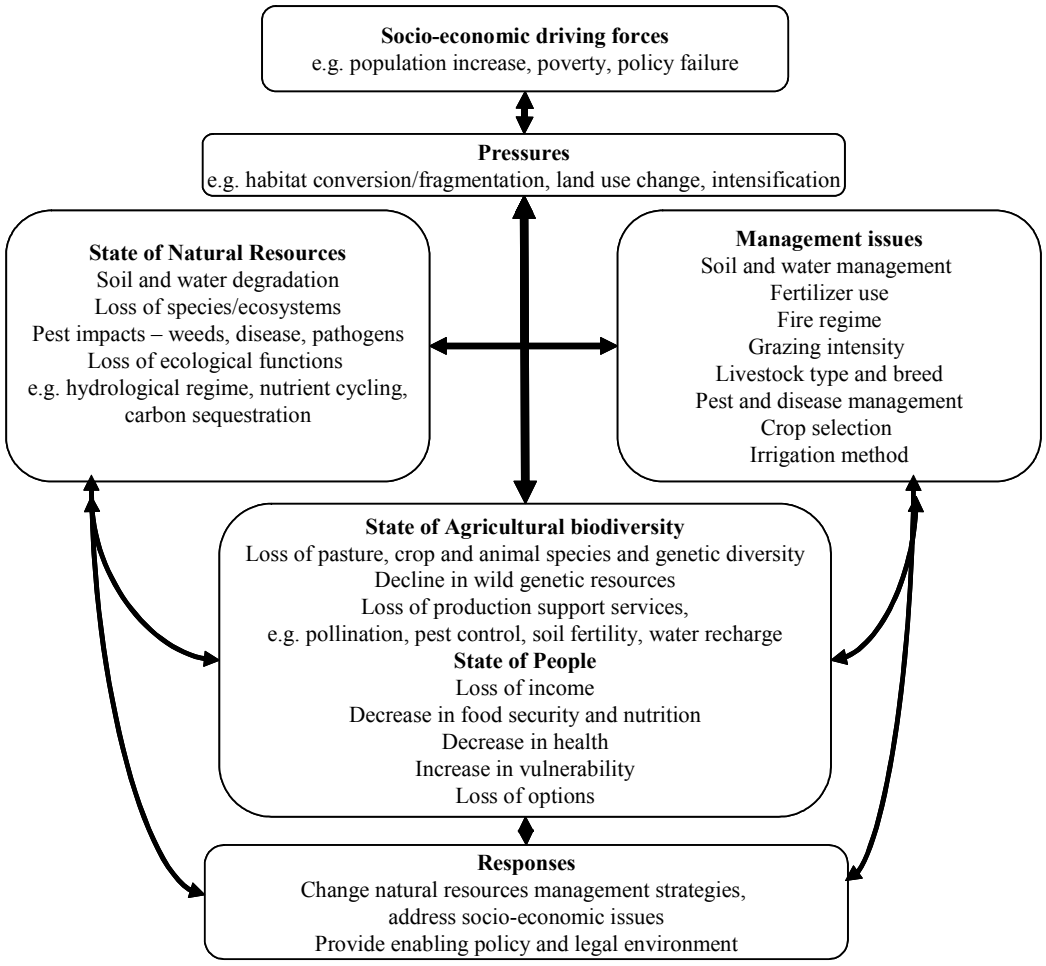
18. **Review of methodologies:** The LADA project will support decision makers by developing land degradation assessment methodologies at a nation-wide scale, the level where most policy decisions concerning land use are taken and the portfolio for environmental action plans is administered. Yet, land degradation is a complex process covering a diversity of biophysical as well as socio-economic factors that largely vary in their spatial and temporal dimensions. Hence, the need to review methodologies that improve our understanding of the degradation process and its impact on land's performance criteria, so as to identify the appropriate policies that arrest further degradation and conserve the land's utility for actual and future generations. In reviewing the needs for a standard assessment methodology the following technical reviews and papers have been prepared:

(a) *Proposed methods for land degradation assessment of drylands*: review and evaluation of six methodologies for land degradation assessment: expert opinion, remote sensing, field monitoring, productivity changes, land users opinion, and farm-level field criteria and modelling.

(b) *Proposed indicators for land degradation assessment of drylands*: An overview and potential indicators of the biophysical land qualities, socio-economic conditions and institutional factors of importance to assessing land degradation in drylands. (A set of indicators based on a review of existing land degradation indicators, data sources and methods, and expert consultation aimed to initiate discussion and collaboration on indicators for the LADA project). Replicability is central to the concept and implementation of the LADA project especially so that land degradation trends can be detected early through local and national monitoring, and be compared globally; and thereby facilitates the design of adaptive & appropriate remedial responsive or preventive actions.

(c) *The Pressure-State-Response framework* has been adopted by LADA, see Figure 1: It provides an overall mechanism for analyzing relationships and identifying indicators for monitoring positive and negative impacts and the effectiveness of remedial responses through feedback mechanisms, both at the assessment stage and during policy examination. It allows the representation of the linkages among the pressures exerted on the land by human activities and natural phenomena, the consequent changes in quality of the resource, and the response to these changes as society attempts to release the pressure or to rehabilitate land which has been degraded. The interchanges among these form a continuous feed-back mechanism that can be monitored and used for the assessment of land quality and degradation processes.

Figure 1. The Driving Force-Pressure-State-Impact-Response (DPSIR) Framework of the EU on which the LADA framework and methodology is based.



19. A substantive technical paper on *Integrating biodiversity issues into the LADA assessment* has also been provided as a guide for country teams, in a first instance the pilot teams in Senegal, Argentina and China, for application at local, agro-ecological zone and national levels. Annexe 1 below provides some of the findings in tabular form, however, more complete suggestion on assessment methods are contained in the paper. In general this paper presents:

(a) The LADA methodology, the ecosystem approach and the DPSIR framework (socioeconomic drivers, pressures on people, land condition and biodiversity with reference to a range of dryland systems (cropping, irrigated agriculture, pastoralism, mixed farming, forestry);

(b) The diversity of natural and human-managed ecosystems in drylands and relevant biodiversity issues that need to be considered, highlighting the importance of agricultural biodiversity and landscape or ecosystem processes that, in interaction with species, maintain ecosystems;

(c) The critical role of human management practices in maintaining biodiversity and land condition, with examples of remedial actions in response to negative impacts;

(d) Key biodiversity and landscape function indicators and assessment methods at local, ecosystem/agro-ecological zone and national levels. Proposed biophysical indicators focus on aspects of soil, vegetation and water resources, and the crop and livestock components of agro-ecosystems. Proposed socio-economic indicators focus on the capacity and constraints of households to manage

natural resources for sustainability and include factors such as demographics, health and food security. Constraints of indicators and monitoring methods in accurately reflecting total biodiversity are noted, and the need to focus on specific components or functions depending on land use pressures and scale of analysis;

(e) Linkages with ongoing programmes and actions on drylands, agricultural biodiversity assessment and sustainable use (e.g. CBD, CCD, MA, OECD, Sustainable Rural Livelihoods); and,

(f) Gaps in knowledge and monitoring and assessment of dryland biodiversity for which specific studies/actions need to be developed.

20. In the context of land degradation, there is a need to better understand *below- and above-ground biodiversity linkages*. In view of the complexity and dynamics of soil biodiversity, the importance of soil functional groups has been highlighted by many workshops and research studies and the need for bioindicators that are robust indicators of soil condition, compatible with physical and chemical indicators of soil health, simple to measure and interpret and relevant to basic attributes of soil function. Linking soil organism taxonomy and biological activity to studies of ecosystem processes will increase our ability to predict responses to environmental change. FAO is providing support to the International Initiative for the Conservation and Sustainable Use of Soil Biodiversity, established as a cross-cutting initiative within the programme of work on agricultural biodiversity (COP decision VI/5). In particular, FAO is providing a focus and coordinating role in identifying priorities and developing a programme of work on the biological management of soil biota and soil ecosystems for sustainable agriculture. In this regard FAO organized an international technical workshop (Londrina, Brazil, 2002) that addressed assessment and monitoring, adaptive management, capacity building and mainstreaming of soil biodiversity. FAO also contributed to the OECD process in developing agro-environmental indicators, including in its review and development of soil biodiversity and soil erosion indicators.

21. FAO has developed a website to provide links to various programmes and activities on soil biodiversity and sustainable agriculture including the GEF project Conservation and sustainable management of below-ground biodiversity, managed through institutions in Brazil, Ivory Coast, India, Indonesia, Kenya, Mexico and Uganda. This research project is expected to develop improved methods for conserving and managing the diverse community of soil organisms (including bacteria, fungi, protozoa, and invertebrate animals) and to lead to improvement in vital environmental services and provide farmers in the tropics with new options for intensifying agriculture while protecting natural resources.

22. *A Framework Database on Indicators for Land Degradation Assessment* is currently being developed and will be refined taking into account the various ongoing assessments in FAO, the contributions of the pilot countries on the basis of their experiences, the CCD and CBD Secretariats and partner organizations (see paragraph 14 above). Since measuring and interpreting all factors and variables that interact ecologically is impossible, LADA recognizes that it is necessary to use indicators that measure characteristics of the most valued ecological components and those that are most responsive to a range of stressors. Indicators include biological, chemical or physical variables as well as socio-economic and cultural variables. The sustainable rural livelihoods (SRL) approach, developed by DFID and partners, is also proposed as a useful guide to analyse the links between livelihoods and natural resource use through consideration of natural, physical, financial, human and social assets or capitals. It can be used to address the needs of policies and project interventions for example to reduce degradation and poverty and is especially applicable at local or community level, although the integration of these five dimensions is not necessarily obvious.

23. **Pilot studies:** Collaborating institutes and organizations in the three pilot studies in Senegal, Argentina and China, with support of partnership organizations, have conducted research and contributed to the development of harmonized methods for land degradation assessment at local, agro-ecological zone and national levels. National LADA task forces have been established, stakeholder consultation meetings held among a range of actors and disciplines and national reports prepared. The pilot countries that have contributed to the methodology development and the further countries to be funded through the full project are expected, through national and regional institutions, civil-society

organizations and with co funding support, to contribute case studies on management practices, resource mobilization, information sharing and priority setting by policy makers as well as to capacity-building and human-resource development.

Senegal

24. The pilot study in Senegal led by the Ecological Monitoring Centre (CSE), has placed particular attention on testing remote sensing methods, tools and applications. Its experience shows that remote sensing can be a useful tool through the selection of appropriate indicators for land degradation assessment. However, it is clear that solutions to land degradation are found at local level with the actors that cause and/or are victims of degradation. Hence the need to link selected national level indicators with others that can measure temporal and spatial changes that affect both the natural environment and local populations.

25. These indicators should be monitored at permanent sites with rural communities that constitute the management units that have the capacity to substantially contribute to combating and reversing land degradation. Monitoring of indicators should be conducted by members of the local population for reasons of motivation and objectivity, with institutional coordination to ensure the transmission of data to national level for analysis. The return of information to local level is essential for their consideration in land management actions and programmes.

26. Such a system will require strengthening of capacity at local level for data collection and analysis. The credibility, efficiency and results of the data analysis and the speed of feedback will depend on the channels of communication. The subsequent use of the information in land degradation assessment and monitoring will require modern information technology. In view of the relatively modest cost and popularity of using Internet it has become an essential tool for information dissemination.

27. The improved understanding of land degradation gained over recent years in Senegal has allowed the development of systemic approaches that place due attention to the interrelations between human and environmental factors. This has facilitated the integration of the national action plans for the environment (NEAP) and combating desertification (NAP) in a wider development framework involving local populations in their design and implementation. Despite these efforts, apart from the success in fixing sand dunes in the zone of Niayes, the trends in the sylvo-pastoral zone and groundnut basin show that actions to combat desertification must be supported by improved understanding of degradation processes, improved assessment methods and identification of causes. Senegal is an ideal country for testing suitable land degradation assessment methods in view of its location in a semiarid zone affected by most types of land degradation and its institutional framework through which experiences in combating land degradation can be used to test and validate proposed methods and responses.

Argentina

28. Using the UNCCD definition of drylands and the UNEP/GRID designation of aridity zones, Argentina ranks ninth in the world for total amount of dryland, and is one of only 14 countries to have more than 1 million square kilometres of dryland (WRI 2003). A webpage is available with information on the pilot study in Argentina which is being implemented by the Secretary of Environment and Sustainable Development of the Ministry of Social Development through the National Directorates of Natural Resources and Biodiversity Conservation and of Soil Conservation and Combating Desertification (http://www.fao.org/ag/agl/agll/lada/arg/inicio.htm.)

29. With a view to establishing effective collaboration between LADA and the Millennium Ecosystem Assessment, the LADA country taskforce collaborated with the World Resources Institute (WRI - a key actor in the MA) in testing the Application of an Ecosystem Approach to Degradation Assessment of Drylands in Argentina. This pilot study adapted the MA framework for applicability for land degradation assessment in Argentina's drylands and established a methodology for applying the ecosystem approach for a national-level assessment of goods and services, using features that easily could be transferred to a similar assessment in other countries. The resulting report identifies ecosystem services of Argentina's dryland regions (focusing on the Chaco, the Dry Pampas, Patagonia,

and the Puna), the benefits they afford to human populations, along with trends in the capacity of the services to be sustained over time. The report (January 2004) is in draft form and will be finalized by June 2004.

30. The MA recognizes that the natural or human induced drivers of change in ecosystems can alter the capacity to provide services or the benefits people obtain from ecosystems. Four categories of ecosystem services affecting human well-being are: provisioning (food, fuel, fibre); regulating (erosion control, water purification); cultural (spiritual, recreational); and supporting (soil formation, nutrient cycling) services. Changes in the ability to provide ecosystem services affect human well-being and efforts to reduce poverty through factors such as changes in human health and economic status. Well-being is defined as "a context- and situation-dependent state, comprising basic material for a good life, freedom and choice, health, good social relations, and security".

31. Relevant data or indicators for each of these human well being components can be compared with identified ecosystem service trends. However, it is recognized that the process of relating ecosystem change and human well-being is difficult because of the difficulty of documenting trade-offs and the current and future dimensions of the relationships. Overexploitation of ecosystems may initially lead to an increase in material well-being and a decrease in poverty with few obvious negative trade-offs. In the long term, however, this strategy may not lead to sustainable well-being. Thus, there is an element of prediction when trying to determine the impact of current trends on future well-being.

32. On the basis of the pilot application of the conceptual framework, a decline in the ability to provide humans with ecosystem services indicates degradation of Argentina's drylands, especially in the dry Pampas and Patagonia. Though, the increase in some services over the same period indicates that trade-offs have been made in the use and development of dryland ecosystem services. The Chaco and Puna regions showed mixed trends in ecosystem services, however, the analysis of human well-being indicators is incomplete and upward trends in cultural services need further verification. An example of trade-offs is seen in the case of increased extent of soybean cultivation which resulted in less land for grazing livestock and for other traditional crops such as maize, wheat, cotton, potatoes, and lentils. In the Chaco, cultivated fields, especially using clean ploughing rather than more traditional no-till practices, eliminates suitable habitat for many wildlife species.

33. The initial findings underline the importance, rather than a biophysical focus, of a wide examination of degradation in drylands and its effects on the entire ecosystem and a range of provisioning, regulating, cultural, and supporting services. Describing degradation in these broader terms has the potential to attract a wider audience, including potential donors concerned with alleviating poverty and improving human livelihoods. It will also open the possibility for consideration of a wider spectrum of responses for addressing the problems occurring in dryland ecosystems. The information on trends in ecosystem services by biogeographic region could be improved through enhancing exchange of ideas and information between WRI and taskforce members /representatives from each dryland region of the country and strengthening the compilation and analysis of temporal and spatial natural resource data in Argentina.

Peoples' Republic of China (PRC)

34. The PRC has some of the worst land degradation problems in the world however there is uncertainty over the true nature, extent and severity due to lack of comprehensive, consistent and reliable methods for assessment and monitoring. Moreover, the PRC harbours significant global biodiversity and a high proportion of endemic species than any other country, of which the dryland biodiversity is most threatened. The greatest threats are from habitat loss through forest and woodland clearance, overgrazing of grasslands and their conversion to croplands and sand dune encroachments and from lost soil and biomass productivity due to adverse changes in soil biological, chemical, physical and hydrological properties arising through poor land management and inappropriate land uses. To date, land degradation assessments in PRC have relied largely on remote sensing at national and provincial levels on a 5 yearly basis with little ground truthing.

35. The LADA pilot study in PRC identified six pilot areas for land degradation assessment (root causes, nature, extent, severity and impacts on ecosystems) focusing on the development and testing of participatory tools and approaches for local level assessment. The LADA pilot will also contribute to the ongoing data collection and review on successful technologies and approaches using the WOCAT questionnaires and database (World Overview of Conservation Approaches and Technologies) through collaboration between the University of Berne and the Soil and Water Conservation Monitoring Centre of the Ministry of Water Resources. It will allow expansion of this review from humid areas in southern China to drylands and from water and wind erosion to wider considerations (e.g. ecosystem services) and will allow sharing of experiences with other countries. The pilot will also contribute to the determination of needs for building national assessment capacities for designing and planning interventions to mitigate degradation and establish sustainable land use and management practices.

36. Building on the LADA process and with a view to upgrade further and streamline its networking capacities prior to its participation in the full implementation phase of LADA, PRC has prepared a draft FAO technical cooperation project (TCP) for Stocktaking of national experiences and further development of national capacities in land degradation assessment and control in China. The aim is to review the knowledge and experiences gained by diverse national institutions for the assessment and control of dryland degradation and to assist in developing the information systems in these fields into an integrated network, with links to relevant international geographic information systems and databases. It will build capacity for integrated management of GIS on land resources and their use for land degradation assessment and control as well as in the selection of appropriate policies, institutional instruments and techniques for land resources conservation and rehabilitation of degraded lands. It will help establish a cooperative network for PRC participation in the global assessment of dry land degradation (LADA).

37. The LADA pilot study facilitated FAO technical support in the formulation of the US$150 million GEF grant and Asian Development Bank (ADB) partnership with PRC on Land degradation in dryland ecosystems, especially project 1 Strengthening the enabling environment and building capacity. This partnership aims to reduce poverty and arrest degradation and restore dryland ecosystems in the country's western region during the period 2003-2012. The land degradation assessment component includes capacity building, interagency coordination, data gathering, monitoring and assessment at national, provincial and county levels. It is working with the 6 most severely degraded provinces/ autonomous regions in Western China (Inner Mongolia, Xinjiang, Gansu, Ningxia and Shanxi). It will thus allow LADA programme and tool and indicator development over a wide range of ecological conditions, as well as scaling up from local field assessments to country, provincial and national levels.

38. **Land Degradation Case studies:** Besides national reports from the three pilot countries, other reports that have been recently made available through the LADA website include a series of case studies on land degradation assessment with a focus on salinization from Egypt, Uzbekistan, Kenya, South Africa, Malaysia and Mexico respectively. These include information on soil and land resources, land use, soil degradation and salinization assessment, institutional framework on land and water conservation, management and restoration, national achievements and partnerships, use of geo-information technology, environmental impacts, soil and crop monitoring and evaluation. The case studies on Mexico demonstrate and evaluate the application of the LADA framework approach for land degradation assessment based on the DPSIR framework

39. **National and regional workshops on LADA** have been organized with support of three pilot countries. The aim to catalyse support, information and knowledge dissemination and partnerships between organizations. Regional workshops have been held in the Asia and Pacific and Africa regions, building on the China and Senegal pilots respectively. Further workshops are planned in the Latin America and Caribbean region, with support of the Argentina pilot, and in the Near East region building on past and ongoing FAO support. Workshop proceedings will be made available through the LADA webpage.

(a) Regional Workshop on Agro-ecological Zoning (AEZ) and GIS Applications in Asia with special emphasis on Land Degradation Assessment in Drylands (Bangkok, November 2003)

organized by FAO and the Land Development Department of Thailand. The aim was to promote AEZ/GIS and their application in the assessment, mapping and monitoring of rural land use and land degradation in relation to food security in Asian countries, and to develop more applied knowledge, policy instruments, national capacities and technologies which would assist to develop more efficient and sustainable management of land resources, especially in drylands. The workshop was attended by senior land resources and land degradation specialists from fifteen Asian countries and CCD representatives. The workshop reviewed the country AEZ/land resources information systems (LRIS) situations, experiences and applications in land degradation assessment, and the LADA methodology on the basis of the China LADA pilot study. It discussed ways to promote exchange of information, data expertise and experiences in land information in the region including collaboration in the FAO global network Gateway to land and water information for the Internet. It made recommendations for the development of the AEZ/LRIS methodology and tools to overcome existing constraints and their use in LADA assessment studies and mapping. Draft national LADA projects and AEZ/LRIS proposals were prepared by each participating country and a draft outline was proposed for an Asia sub-regional LADA project for capacity building in assessing and combating land degradation using local expertise through Technical Cooperation among Developing Countries.

(b) *Regional workshop on Land Degradation Assessment in Drylands in Africa* was organized by FAO in collaboration with the Ecological Monitoring Centre (CSE) (Dakar, Senegal, December 2003). It was attended by some 17 countries and CCD representatives. The workshop reviewed the LADA methodology and achievements and lessons learnt by the Senegal pilot study. It discussed country expectations and information needs and land degradation assessment experiences and made recommendations on ways forward.

IV. FROM LAND DEGRADATION ASSESSMENT TO TARGETED ACTIONS IN DRYLANDS

40. **Priority areas and Target actions:** Dryland degradation assessment is expected to enable countries to better prioritise areas for intervention (hot spots and bright spots) and to identify and promote targeted actions in response to identified needs with a view to mitigating and reversing degradation of land, water and biological resources including combating loss of biological diversity and its socio-economic consequences. Activities to promote the conservation and sustainable use of the dryland resources will depend on the state of the dry and sub-humid lands resources, the nature of the threats and the range of available land use, resources management and livelihood options, taking into account environmental and socio-economic considerations. As noted above, success in achieving conservation and sustainable use of land resources and biological diversity requires addressing the pressures and driving forces that threaten and cause land degradation as well as measures to ensure the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. This illustrates the value of the DPSIR framework in linking the assessment of status and trends with the assessment of pressures and driving forces and of impacts and societal responses.

41. **Multiple stakeholders and levels:** Reversing degradation and promoting sustainable use of land resources, including the conservation and sustainable use of biological diversity, will require assessment of past and ongoing interventions with the range of stakeholders, including local and indigenous knowledge and modern technologies, with a view to the identification of best practices, adaptive management of diversified production systems, efficient use of soil and water resources, and specific measures (e.g. protected areas, in situ conservation of biodiversity, management of alien invasive species). It will also require the valuation of biodiversity and land resources and review of the impacts of policies and legislation and needs for creating an enabling environment, such as incentives to enable and promote responsible use, creation of markets and alternative livelihoods and mechanisms for promoting fair and equitable sharing of the benefits arising from the use of genetic resources of drylands. This illustrates the need for an inter-disciplinary assessment process, from local to national levels and with the involvement and agreement of the multiple user groups concerned (resource users, rural and urban dwellers, technicians and policy makers).

42. **Adaptive management to optimize goods and services:** The decision of the Conference of the Parties on biological diversity in dry and sub-humid lands acknowledges the merits of short-term adaptive management practices compared with long-term management planning and the need to build a knowledge base for conservation and sustainable use drawing on lessons learned, including indigenous and local community practices. It recognizes the primordial importance of effective water management strategies and the need to balance the immediate water requirements of humans, their livestock and crops, and the water required to maintain biodiversity and ecosystem integrity. In order to secure sustained ecosystem services, far more understanding is needed of the multiple goods and services provided by biological diversity and the multiple influencing factors. It is necessary to identify adaptive management practices that minimize negative impacts by humans on soil and water and biological resources and biodiversity, promote the conservation and sustainable use of biodiverse, sustainable and productive systems, and conserve and restore ecological services and protected areas in agricultural and other terrestrial ecosystems. FAO has been collecting and compiling case studies and raising awareness on the importance of agricultural biodiversity in ensuring sustainable, resource efficient and productive agricultural systems, the importance of the ecosystem approach and the need for promoting adaptive management building on local and indigenous and modern scientific knowledge see http://www.fao.org/biodiversity/agroeco_en.asp. The LADA process will build on such work.

43. **Capacity-building and intersectoral cooperation:** LADA is expected to contribute to capacity building and public awareness and improvement of the availability, accessibility and exchange of information on status and trends of land resources and biological diversity of dry and sub-humid lands (degradation, sustainable use and restoration). It should help identify and target research and development programmes, capacities and institutions for effective conservation and sustainable use of land resources and biological diversity and improved planning and conflict resolution processes. The exchange of information across countries and regions should encourage cooperation to address transboundary issues (such as rangelands, wetlands and watershed management) and to disseminate case-studies on successful management of dry and sub-humid lands for replication and adaptation. Improved collaboration among sectors should help harmonize sectoral policies and instruments to promote the conservation and the sustainable use of land resources and biological diversity in drylands, and promote synergy among various national action plans.

44. Noteworthy in this regard, is a *workshop on Biological Diversity and Sustainable Development in West Africa* that was organized by the Ministry of Environment of Mali in cooperation with FAO, GTZ, CIDA and CTA in Bamako in December 2003. This sub-regional workshop was attended by the focal points for the CCD, CBD and coordinators of animal genetic resources and plant genetic resources for some 11 countries and several partner organizations. The workshop aimed to contribute to the development of coherent national policies and instruments for sustainable use and conservation of agricultural biodiversity in the soudano-sahelian zone, taking into account local needs and national and international commitments and processes. The workshop contributed to assessing needs and constraints, analysing policies and legislation, developing a common vision on the role of agricultural biodiversity among the different focal points, and developing recommendations and practical national actions at all levels. Improved land resources management was considered a prerequisite for conservation and sustainable use of biological resources, and opportunities for national land degradation assessment, through LADA, were discussed.

45. This workshop allowed various focal points to share their viewpoints and discuss: a) the impact of land degradation, urbanization and agricultural trends on agricultural biodiversity, productivity and sustainability of agricultural ecosystems; b) the need for an ecosystem approach (with reference to the 12 principles adopted by the Convention on Biological Diversity) to safeguard and improve the multiple good and services provided by agricultural biodiversity at ecosystem, species, and genetic levels; c) the importance of matching needs for conservation and sustainable use of biodiversity with priorities of farmers and governments in increasing agricultural production and food security and rural livelihoods and d) the necessity of a coherent process between the Secretariat for the Convention on Biological Diversity and CCD. A number of recommendations were made on: strengthening local capacities (farmers and livestock keepers); communication, education and public

awareness; access to genetic resources and technologies and research needs; enhancing the policy, legal and institutional framework including marketing and infrastructure; and transboundary issues. The enthusiastic response to and results of this initial workshop demonstrate how such workshops could be instrumental in enhancing coordination and joint programmes, including assessment processes, among CBD, CCD and agricultural and sustainable development programmes.

V. OPPORTUNITIES AND EXPECTATIONS (LADA PROJECT)

46. The Final LADA Steering Committee meeting of the PDF B phase will be held in March 2004 to review a) the LADA achievements and results of the pilot studies, b) the draft project document for the full GEF project and c) the provisional LADA guidelines. It will also formally consider the letter from the Executive Secretary regarding the SBSTTA recommendation VIII/4, (UNEP/CBD/COP/7/3), as mentioned in paragraphs 1 and 2 above. This will enable further consideration of how the needs of the dry and sub-humid lands could be integrated into the ongoing LADA and potential modality of collaboration with MA as well as ways to strengthen national efforts to conduct assessments. It could also provide suggestions regarding mechanisms linking national assessment to regional/global assessment/ report processes and participatory development of national assessment guidelines, including indicators. Nonetheless, it is hoped that the information provided in the current document is a useful basis for initial consideration by the seventh meeting of the Conference of the Parties.

47. It is noted that the successful implementation of LADA will not only depend on government commitments and prioritization of land degradation assessment to facilitate targeting and selection of appropriate interventions and policies. It will largely depend on financial resources being made available to countries for the assessments at national, agro-ecological zone and local/community levels. It is clear that the earmarked U$ 5 million GEF contribution can not suffice the requirement for supporting national level assessments and more resources would be needed. This allow a modest start on some countries and the further development of an agreed, user friendly, cost effective standardized assessment methodology. The global assessment of land degradation in drylands will depend on substantial contributions of financial and human resources and effective partnerships among concerned bodies at international and regional levels.

48. Financial resources and support of the CCD and CBD would be required in order to establish an ad hoc working group to further review the LADA methodology and provide suggestions and clarify the extent to which biodiversity of dry and sub-humid lands, including dryland, Mediterranean, arid, semi-arid, grassland and savannah ecosystems, could be effectively integrated into LADA with minimal additional costs implications Support in mobilising substantial technical and financial support for effective implementation of the global land degradation assessment of drylands through a county driven process and appropriate integration of biodiversity considerations would be welcomed.

Annex

PROPOSED FRAMEWORK FOR INDICATORS OF BIODIVERSITY, LAND AND SOCIO-ECONOMIC CONDITION

The causes of declining biodiversity and land degradation are often multiple and complex and usually involve a combination of human and natural factors. The impacts of land degradation are also multiple and affect a range of natural and socio-economic considerations. There are direct and indirect relationships between the state of natural resources (soil, vegetation, water, ecosystem), and the biological diversity at species level (animal, plant and microbial species) and ecosystem level (habitats, interactions, functions) and the management of those resources. The management practices directly or indirectly affect the capacity of land users to conserve and sustain resources and provide goods and ecological services. The assessment and monitoring of biodiversity and associated ecosystem processes, therefore, requires an integrated suite of biophysical and socio-economic indicators.

Careful evaluation of the relationships between biophysical condition (state of natural resources and biodiversity) in the context of changes in demographics, policy, land use, technology and management practices and natural events, will provide a basis for informed management decisions by the range of stakeholders from resource users and managers to technical advisers, planners and policy makers.

Key biodiversity, land condition, socio-economic and natural resource management indicators that can be used for local (plot and farm-household), ecosystem and national level assessments are summarized in Table 1. These selected variables are indicators of changing state of biodiversity, land condition and human dimensions as a result of pressure.

The effectiveness of ecosystem processes depends on the interactions among species, the environment and human management practices. Monitoring key functional groups and/or organisms coupled with observations of physical aspects of land condition (erosion, soil surface condition, water quality and quantity), will provide an indication of the status of biodiversity and landscape function. These indicators should be applied at local level and supply information for broader assessments at the catchment, agro-ecological zone and national levels.

The specific aspects or attributes of biophysical and socio-economic indicators that are monitored will vary between human-managed systems and the questions being asked. For example, in irrigated cropping systems, soil salinity determination and mapping may be seen as a priority while in rainfed cropping, monitoring of nutrient balance may be important. In designated conservation areas, monitoring the population status of threatened species and the condition and distribution of their habitat will be important, while in rangelands the focus may be on the cover and composition of desirable perennial grasses as a functional group.

Remote sensing techniques can be used to monitor indicators such as land use change, vegetation clearing and habitat fragmentation at zonal and national levels. It may also be suitable for assessing the extent of some processes such as fire, soil salinity and surface water area, as per steps 3 and 4 of LADA.

Management of land and water resources has a direct influence on the status of biodiversity and food security, particularly in agro-ecosystems. Similarly, the capacity of households to manage their land for conservation of biodiversity is affected by socio-economic circumstances and health. Management indicators will be applicable at the plot level and indicators of financial, social, human and physical capital will be relevant to and collected at the farm-household level (F-H). Some management indicators are included in Table 1 to illustrate the linkages but a more comprehensive list with management responses is shown in Table 2

The final set of agreed indicators, particularly at local level (plot and F-H) will depend on specific factors such as user needs, priority environmental issues and management strategies. Local knowledge must play a crucial role in determining indicators, data collection and evaluation, and in providing information to refine imprecise methodology such as remote sensing used to map the distribution of certain plants or plant groups. Table 3 provides a more detailed table that lists the socio-economic driving forces, pressures and potential impacts on biodiversity, indicators of state, indicator methods and potential limitations, and levels of assessment.

A more in depth analysis on the indicators presented in the tables below and general guidelines on selecting indicators and in developing a sampling strategy and monitoring programme are outlined in the above referred biodiversity and land degradation paper.

Table 1. Key biodiversity, land condition and socio-economic indicators and levels of assessment (local, ecosystem or national).

National level assessments often collate information collected at local and ecosystem levels. These national indicators are indicated as X*. [1] = OECD (2001a) agricultural biodiversity indicator

State of biodiversity and natural resources	Local (plot, F-H)	Ecosystem/AEZ/ catchment	National
I Ecosystems			
I.1 Diversity of ecosystems/habitats			
Change in vegetation cover, composition and structure		X	X
Degree of fragmentation by ecosystem (e.g. forest type)		X	X
Rate of conversion of forest cover		X	X
Land use change		X	X*
Change in surface water area		X	X
Proportion of threatened habitats and species protected			X
Arable and permanent crop land		X	X
Type of agricultural ecosystems		X	X*
I.2 Loss of species			
Loss of key species (economic, cultural, eco-services)	X	X	X*
Flora and fauna species diversity	X	X	X*
Rate of harvesting of certain wild target species		X	X
Policies and plans in place for harvesting of wild target species		X	X
No. of threatened species protected			
I.3 Demographics			
Human Population growth	X	X	X
Poverty	X	X	X
Urban/rural area		X	X
Urban/Rural population		X	X
Rural exodus		X	X
II. Soil			
II.1 Soil Biodiversity			
Presence and abundance of selected macro-fauna (see Table 2)	X		
Microbial activity (respiration rate)	X		
Soil organic biomass	X		
II.2 Soil Physical degradation			
Soil surface condition	X		
Ponding (indicating compaction)	X	X	
Erosion	X	X	
Vegetation cover, composition; structure; health	X	X*	
II.3 Soil Chemical degradation/contamination			
Area of salinity, sodicity, acidity	X	X	X*
Vegetation cover, productivity, composition, health	X	X*	
Soil chemical characteristics and nutrient deficiencies	X	X*	
III. Vegetation (non-agricultural)			
111.1 Diversity and composition			

State of biodiversity and natural resources	Local (plot, F-H)	Ecosystem/AEZ/ catchment	National
Species and taxa diversity	X	X	X*
No. and amount of wild food species consumed	X	X	
Structural diversity (vertical and horizontal)	X	X	X*
Proportion of alien or invasive species	X	X	
Distance from stock water points	X	X	
IV. Water			
IV.1 Water Quality – contamination			
Flora and fauna bio-indicators	X	X	
Chemical characteristics	X	X	
Turbidity	X	X	
Nutrient load	X	X	
Sedimentation	X	X	
Algal blooms	X	X	
Prop'n of population with access to good quality water	X	X	X*
Incidence or deaths from water-related human diseases	X	X	X*
IV.2 Water Quantity – loss of habitat			
Flora and fauna bio-indicators	X		
Withdrawal volume or proportion	X	X	X*
Depth to water table	X	X	
Water flow	X	X	X*
Time taken to collect water	F-H	X	
V. Agrobiodiversity			
V.1 Crop diversity			
Share of crop varieties in total production for individual crops[1]	X	X	X*
No. and share of national crop varieties used that are endangered[1]	X	X	X*
No. of species cultivated by local smallholders	X	X	X*
Access to seed	X	X	X*
Nutritional status of households (contribution to food needs)	X	X*	X*
Self-assessment of food security of households	X	X	X*
V.2 Livestock diversity			
No. of breeds used by livestock categories (native and non-native species	X	X*	X*
No. and share of livestock breeds used that are endangered[1]	X	X	X*
V.3 Weeds, pests, diseases, pathogens			
Vegetation composition and cover	X	X*	
Incidence and spread of pests and diseases	X	X*	
Agricultural productivity	X	X*	X*
Soil born pests, pathogens, diseases	X		
Crop and livestock productivity	X	X*	
Change in income levels	X	X	X*
V1 Food and livelihood security			
Farm size	F-H	X	X*
Area under cultivation	F-H	X	X*
Household income	F-H	X*	X*
Income per capita	F-H	X*	X*
Farm profits	F-H	X*	X*
Proportion of income from livestock	F-H	X*	X*
Proportion of income from crops (differentiate food and fodder)	F-H	X*	X*
Land tenure	F-H	X	X
Crop and livestock productivity	F-H	X	X*
Number in HH by gender and age groups	F-H	X	X*
Number of HH member able to work (dependency ratio)	F-H	X	X*
Education (highest level in HH and schooling of children (quality and quantity)	F-H	X	X*
Time to reach nearest market	F-H	X	X*
V11 Land and water management practices			

State of biodiversity and natural resources	Local (plot, F-H)	Ecosystem/AEZ/ catchment	National
Water management	F-H	X	
Tillage and sowing methods	P	X*	
Fertilizing strategies	P	X*	
Crop rotation	P		
Intercrops and cover crops	P		
Fallow period, oversowing	P		
Weed, pest and disease management	P	X*	
Grazing regime	P	X*	
Fire management	P	X	X

Land and water management

Natural resource management practices directly affect the intensity of pressures on biodiversity and other land resources. The effect of many management practices are well known, for example, that regular removal or loss of organic matter (e.g. through burning or tillage) reduces soil fertility and soil surface stability. Relatively less is known about the effects of specific land use changes and management practices on biodiversity above- and below-ground and, in turn, their effects on ecological functions and ecosystem services.

Management practices can be used as indicators of condition, especially for extrapolation across wider areas, providing they are backed up by representative site-specific monitoring and analysis of their effects on resources and ecosystem functioning.

Usually more attention is placed on monitoring negative effects or trends of land use, however, it is equally important to capture positive effects and trends in terms of inducing regeneration of natural processes and rehabilitation of degraded lands. Identified improved management practices can then be supported and promoted with a view to their wider replication.

Table 2 shows examples of management indicators that are relevant to different human-managed systems, their impacts in terms of land degradation/restoration, focusing on biodiversity examples, and possible responses. Negative impacts on biological, soil and water resources and ecosystem functioning can be due, first, to inappropriate land use systems, notably choice of crops and livestock enterprises and their spatial and temporal patterns; increased specialization with reduced rotations and fallows; accompanied by loss of local varieties and landraces or loss of indigenous animal breeds. Second, detrimental impacts caused by inappropriate management practices such as loss of palatable pasture species due to overgrazing and poor pasture management, competitive or parasitic weeds and reduced plant health due to nutrient mining, and/or loss of beneficial soil organisms due to pesticides or intensive tillage. Conversely, appropriate land use systems and management practices can enhance diversity and land condition, as in the case of conservation agriculture systems based on improved crop rotations, diverse cover crops and no tillage techniques.

On significantly degraded lands, the land use/management practices should lead to the restoration of the productive potential. Effective indicators should reflect changes from a baseline condition, in either a positive or a negative direction. They should be used to capture and provide evidence of success and progress in restoring sustainable, productive and viable systems. This information should be collected at the plot and/or farm-household level.

Table 2. Management indicators that may impact on land condition and biodiversity within the major human-managed systems in drylands, and possible management responses.

System	Management indicator	Land Degradation/ Restoration	Examples of responses
Pastoralism	Animal numbers (stocking weight*), type, breed/race	Over- or under-grazing Local loss of species and habitats	Vary stocking weight, farm stock type and breed that are adapted to land type
* average weight reflects impact more accurately than stocking rate	Degree of uniformity within individual livestock breeds; decreased cross-breeding with indigenous and/or exotic breeds	Reduced livestock diversity, increasing susceptibility to disease and decreasing adaptability to environment resulting in increased degradation of natural resources	Diversify breeds, cross breed with local breeds, keep stock that are adapted to conditions
	Density and distribution of water points; Change in grazing mobility or access to pasture	Over- or under-grazing Range degradation through overgrazing	Manipulate dist^{n} or number; Reduce stocking weight
	Seasonal use of different habitats	Degradation of soil, water, vegetation and ecosystem functions	Modify strategies according to habitat ecological requirements and seasonal fluctuations
	Intensity of water use	Decrease in groundwater quantity and quality,	Improve water use efficiency
	Waste management	Soil and water pollution	Improve waste management system
	Extent, timing and frequency of controlled fire	Degradation of pasture and savanna, loss of functional groups and key species	Minimize fire frequency and intensity, develop/revise fire management plan
Mixed	Expansion/intensification of cultivated land	Restricts grazing and fodder crops, loss of habitats and species	Decrease stock, pen feed stock, change stock type, increase fodder production
	Increased cultivation in marginal land	Land degradation-erosion, loss of species, increase in hardy species	Change land use, adopt soil and water conservation practices
	Herd size and composition	Overgrazing, loss of organic matter for crops, loss of palatable species	Revise stocking weight and stock type
	Livestock/cropland ratio	Variable depending on ratio	Review according to impacts/needs eg. pen stock to increase cropping land
	Crop type, diversity and rotations, livestock feeding strategies	Low crop diversity, increase incidence of pests and diseases	Increase crop diversity, improve rotations and fodder production
	Soil fertility management	Decline in soil quality	Conserve organic material, sow legumes for nitrogen, zero tillage
	Weed, disease, pest management	Range degradation, loss of biodiversity, reduced health in animals and crops	Biological management, IPM, retain organic matter
	Management of animal wastes	Water pollution, reduced health of animals and people	Improve waste management system
	Fallow period and cover crops	Decline in soil fertility, loss of agricultural biodiversity and species interactions	Improve fallow quality, review period length, prevent grazing on short fallows
Rain-fed cropping	Crop types, rotation and intercropping, no. of crops/year	Crop diversity, decline in soil fertility soil surface degradation,	Increase crop diversity, select rotations to maximize water use efficiency and soil nutrients, retain organic matter, review crop type, rotate and intercrop with several species
	Fallow period and system	Decline in soil fertility, loss of organic matter	Manage fallow, review period length
	Fertilization type and application rate, use of organic wastes;	Nutrient imbalances, nutrient depleted soils	Use of inorganic fertilizers and reduced tillage to maintain nutrient

			balance
	Conventional tillage	Loss of soil biodiversity and organic matter, compaction, erosion	Zero-minimum tillage, terracing, stone lines etc. on slopes
	Water management	Water waste, salinization	Seasonal leaching of soils, effective water harvesting techniques (e.g. bunding)
	Pest and weed management	Decline in desirable invertebrates and beneficial predators, soil contamination	Biological pest and weed control (IPM), increase crop diversity
	Fire	Loss of organic material, reduction in populations of fire-sensitive organisms	Minimize fire frequency and intensity
Irrigated (including oases)	Water use efficiency	Depletion of freshwater resources, nutrient leaching, evaporation loss	Improve irrigation techniques and efficiency
	Irrigation method	Depletion of freshwater resources; salinization, sodicity	Soil leaching of lasts through drainage and controlled irrigation, use of perennial species
	Crop types, rotation and intercropping	Decline in soil fertility status and hence suitability for agriculture	Rotate and intercrop with several species; improve crop selection, review rotation strategy
	Fertilizer use and pest management	Decline in water quality, displacement of native biocontrol species, soil contamination	Reduce use of pesticides, biological pest and weed control (IPM), diversity of crop species
	Tillage, flooding/drainage	Loss of soil biodiversity, compaction, erosion	Zero/minimum tillage, terracing on slopes
Forestry - agro (AF) and plantation (PF)	Trees species, monoculture (PF)	Decline in habitat and species diversity	Plant forestry on land degraded by agriculture, diversity of tree species
	Tree stocking rate/spacing	Decline in soil condition	Review stocking rate and ameliorate soil condition
	Intensity and ratio of integrated land uses (AF)	Various depending on intensity and ratios	Integrate land uses to optimize use of soil, water and fertilizer resources.
	Fire management	Reduced biodiversity, loss of organic material	Reduce fire frequency and intensity
	Pest, disease and weed species management	Displacement of native biota	Biological pest and weed control (IPM)
	Harvesting of non-forest wood products	Loss of species and ecosystem services	Develop sustainable management plan for vulnerable products

Table 3 Summary of driving forces, pressures and states, and indicators of state at various levels of assessment

Assessment levels: L = local, C = catchment, E = ecosystem or agro-ecological zone, N = national. **Methods:** SSCA = Soil Surface Condition Assessment
Data sources: Smyth *et al*. (2002); CBD (2002); Woodhouse *et al.* (2000)

Driving force	Pressure	State	State indicator	Methods /assessment level	Limitations
Population growth and migration	Land use change/fragmentation/ intensification	Loss of species or communities	Change in vegetation cover; Change in distribution and abundance of species and communities	Remote sensing, e.g. (L,E,N) and field surveys (L,E)	Difficult to distinguish between species or strata. Veg. cover may not closely reflect biodiversity. Time consuming
		Soil degradation	Soil surface stability, infiltration and nutrient cycling capacity; Soil biodiversity (key functional groups)	SSCA field surveys (L extrapolate to E); Bio-indicators and total respiration (L)	No clear link to soil biodiversity, high spatial and temporal variation
			Human population growth Urban/rural area Urban/rural population	Census (L,E,N)	Time consuming, inadequate resources for national coverage
Policy failure - loss of traditional property rights; inequitable benefits and access to resources; population displacement to marginal land	Inappropriate land use	Loss of species or communities	Change in vegetation cover and areas of bare ground;	Remote sensing (L,E,N) and field surveys (L,E)	Can't distinguish between species or strata
		Soil degradation, including erosion	Distribution and abundance of groups and communities.	Remote sensing (L,E,N), field surveys	Cost and expertise
			Extent and severity of erosion/change in area of bare soil;	Remote sensing (L,C,E)	Difficult to distinguish between natural and induced erosion
			Ponding	Remote sensing (C,E)	Variable rainfall patterns
			Soil surface stability, infiltration and nutrient cycling capacity	SSCA field surveys (L extrapolate to E)	Requires a high number of samples – time consuming
Poverty - low capacity to purchase land management inputs (e.g. labour, fertilizer)	Inadequate management inputs for sustainability	Soil degradation, reduced fertility, reduced productivity	Soil faunal groups, plant health, production output;	Field surveys (L) Bio-indicators, total respiration (L)	Time consuming No clear link to biodiversity; high spatial and temporal variation
			Soil surface condition	SSCA field surveys (L extrapolate to E)	Time consuming

Driving force	Pressure	State	State indicator	Methods /assessment level	Limitations
			Crop and livestock productivity	Field surveys (L,C)	Need to consider other variables (management, climate, pests etc)
Increased production for food and sale	Intensification in all human-managed systems	Soil degradation, reduced fertility and pollution	Production output and multiple products; Soil fauna	Field surveys (L) Bio-indicators, total respiration as a surrogate for microorganism activity (L)	Time consuming No clear link to biodiversity; high spatial and temporal variation
			Soil chemical characteristics	Chemical assays (L extrapolate to E)	Cost, expertise
			Plant health	Field observations (L)	Effective reporting system
			Soil surface stability, infiltration and nutrient cycling capacity	SSCA (L)	Time consuming
		Water quantity	Depth to water table; Water flow data	Field monitoring (L,C)	Cost of instrumentation
			Time taken to collect water for HH and stock	HH surveys (L,C)	Time consuming, varies with time
		Water quality	Nutrient load; Chemical residues, turbidity; algal blooms	Field surveys and chemical assays (esp. nitrate, nitrite and phosphate) (L,C)	Cost, expertise
			Flora and fauna bio-indicators	Field surveys (L,C)	Cost, links with biodiversity unclear
		Waterlogging, salinity and sodicity	Land area affected by groundwater salinity;	Remote sensing (C,E,N),	Need to distinguish between natural and induced salinity
			Aquatic biota, birds and terrestrial users.	Field surveys (L,C)	Cost, time
		Human water-related disease (e.g. malaria, cholera)	Incidence of disease, prop'n of pop'n with access to good quality water	Census data, field surveys (C,L,E,N)	Cases not reported, linking disease with water quality

Driving force	Pressure	State	State indicator	Methods /assessment level	Limitations
		Monocultures - loss of biodiversity, reduced ecosystem resilience	Change in vegetation cover and composition; Soil biodiversity	Remote sensing (L,E,N); Soil total respiration as a surrogate for microorganism activity (L)	Need to distinguish between species No clear link with biodiversity; high spatial and temporal variation
	Fire	Negative impacts on flora, fauna and soil properties	Extent, timing and frequency of burning; Flora and fauna surveys	Remote sensing (L,E,N), Field surveys (L,E)	Can't detect intensity Time consuming
	Weeds, pests and diseases	Decline or loss native or production species, reduction in areas of productive land	Change in vegetation composition and cover; reduction in area of surface water (aquatic weeds)	Remote sensing for weeds and large animals (L,E,N), Field surveys (L,R) Observations of plant health (L,C,E), laboratory analysis for soil, plant and animal pathogens (L)	Can't distinguish species unless dense; Cost and expertise No clear relationship between plant health and soil biodiversity
		Reduced soil fertility	Change in vegetation and productivity; Bare ground	Field surveys and observations of nutrient stress	Cost, expertise
Health and nutrition	Labor shortages and declining inputs causing reduced capacity to manage land and water resources and to earn income	Reduced conservation practices → soil degradation including loss of fertility	Extent of severity of erosion Change in crop and livestock productivity	Remote sensing (L,C,E,N), Field surveys (L,C,E) Observations of plant health and vigor (L,C,E), Bio-indicators of soil fertility, e.g. total respiration (L)	Hard to distinguish between natural and induced. No clear link to biodiversity; high spatial and temporal variation
		Weed, pest and disease invasion	Change in vegetation cover and composition	Remote sensing (L,E,N); and	Can't distinguish between species unless dense.
		Loss of productivity and income	Change in income and food security status, no. of HH members able to work	Field surveys (L,C,E) Household surveys	Time consuming

Natural hazards. extreme climatic events - drought, flood, fire, landslides, storms (e.g. cyclone, dust), climate change	Damage to biophysical resources and infrastructure	Reduced capacity to manage resources → decline in land condition	Change in vegetation cover, extent and severity of erosion; reduction in soil fertility	Remote sensing (L,E) Observations of plant health and productivity (L,C,E) Bio-indicators of soil fertility, e.g. total respiration (L)	Need pre-event data. No clear link to biodiversity; high spatial and temporal variation
		Increased poverty	Change in income, food, education and health levels	Field surveys of physical damage, collect data to compare pre- and post-income (L,N)	Lack of historical human data

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