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DATA SETS, INDICATORS AND METHODS TO ASSESS LAND DEGRADATION IN DRYLANDS

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Report of the LADA e-mail Conference 9 October – 4 November 2002

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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Preface

The Land Degradation Assessment in Drylands (LADA) project, funded by the Global Environment Facility (GEF) in association with UNEP and the Global Mechanism (GM) of the United Nations Convention to Combat Desertification (UN-CCD) and executed by the Food and Agriculture Organization of the United Nations (FAO), responds to the need to strengthen support to combat land degradation as foreseen by the UN-CCD.

During the first phase of the project (2002-2004), LADA aims to 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-sector management planning in drylands. The principal objective of the LADA project is the development of tools and methods to assess and quantify the nature, extent, severity and impacts of land degradation on ecosystems, livelihood systems, watersheds and river basins, and carbon storage in drylands, at a range of spatial and temporal scales. The project will also build national, regional and global assessment capacities to enable the design and planning of interventions to mitigate land degradation and establish sustainable land use and management practices.

The LADA E-mail conference (October 9 to 4 November 2002) responded to several of LADA's objectives by providing a forum to: exchange ideas on potential land degradation indicators and integrated methods; disseminate documents reviewing data and information on land degradation in drylands; and initiate the development of a network among national, regional and international teams involved and interested in land degradation assessment of drylands. Specific goals of the E-mail conference were to raise awareness on LADA, exchange expert views on land degradation assessment, and start identifying at relevant scales:

- data sets that can be used to assess land degradation,
- biophysical, socio-economic and institutional indicators that explain the root causes, driving forces, status, and impacts of and responses to land degradation,
- feasible methodologies to assess land degradation, and
- key issues regarding indicator and method development for land degradation assessment.

The LADA E-mail conference initiated discussion on a number of key issues regarding land degradation assessment. Issues raised and suggestions provided during the E-mail conference will contribute to LADA indicator and methods development and more specifically to LADA's pilot studies – currently being developed for Argentina, Senegal, and China. The LADA E-mail conference facilitated dialogue among numerous stakeholders, especially among experts with experience in conducting global, national or local land degradation assessments.

It is anticipated that the LADA E-mail conference Web site

http://www.fao.org/landandwater/agll/lada/emailconf.stm

will become a continuing forum to continue this exchange of ideas on land degradation. Subscribers of the E-mail conference were encouraged to continue providing contributions, which will be posted on the LADA Web site.

Acknowledgements

This document is based on input obtained during LADA's E-mail conference (October 9 to November 4, 2002). We sincerely thank all those who subscribed to the LADA E-mail conference. We extend a special thanks to those that provided contributions: Abdelkader Allali (IPCC WGII, Morocco), Jorge Ares (Centro Nacional Patagónico, Argentina), José Benites (FAO, Italy), Elisabeth Bui (CSIRO Land and Water, Australia), Sally Bunning (FAO, Italy), Andy Dougill (University of Leeds, United Kingdom), Planchon Fatou (Centre de Suivi Ecologique, Senegal), Abbas Farshad (ITC, The Netherlands), Rogério Ferreira (Instituto Voçorocas, Brazil), Vicente Espinosa Hernandez (Instituto de Recursos Naturales, Mexico), Mamadou Khouma (Laboratoire National de Recherches sur les Productions Végétales, Senegal), Dominique Lantieri (FAO, Italy), Charles Lilin (Paysages et Médiation, France), Ramez Mahjoory (Institute of International Agriculture, United States of America), Philippe Mahler (consultant), Timo Maukonen (UNEP, Kenya), Freddy Nachtergaele (FAO, Italy), David Niemeijer (Wageningen University, The Netherlands), Pierre Ozer (Fondation Universitaire Luxembourgeoise, Belgium), Kevin Parris (OECD, France), Raul Ponce-Hernandez (Trent University, Canada), Mark Reed (University of Leeds, United Kingdom), Michel Robert (INRA et Ministère de l'Ecologie et du développement durable, France), Andries Rosema (Environmental Analysis and Remote Sensing Ltd, The Netherlands), Alain Ruellan (TORBA Soil and Society, France), Maurizio Sciortino (l'Energia e l'Ambiente - ENEA, Italy), Ashbindu Singh (UNEP, Sioux Falls, United States of America), Ben Sonneveld (Centre for World Food Studies, Vrije Universiteit, the Netherlands), Michael Stocking (University of East Anglia, United Kingdom), Mohamed Talbi. (Institut des Régions Arides Medenine, Tunisia), Lamourdia Thiombiano (FAO, Regional Office for Africa, Ghana), Andrew Warren (University College, London, United Kingdom), Godert van Lynden (ISRIC, The Netherlands), Anthony Young (University of East Anglia, United Kingdom), and Juliane Zeidler (Secretariat of the Convention on Biological Diversity, Canada).

The E-mail conference was moderated and this report was prepared by Mathilde Snel (consultant); the report was reviewed by Freddy Nachtergaele (FAO) and Ben Sonneveld (consultant). Sylvia Bartl posted contributions, prepared reading lists, and helped out with numerous other tasks; Wolfgang Prante set up the LADA E-mail Web site and helped post documents; José Benites translated agendas in Spanish; and Irene Cukic helped prepare the list of contributors. Many useful insights and suggestions were also received from numerous other colleagues.

The LADA task force

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System requirements to use the CD-ROM:

- PC with Intel Pentium® processor and Microsoft® Windows 95 / 98 / 2000 / Me / NT / XP
- Any Internet browser
- Adobe Acrobat® Reader (included on CD-ROM)

Acronyms

CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)
DPSIR	Driving forces, Pressures, State, Indicators, Response (framework)
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility
GIS	Geographic Information System
IFPRI	International Food Policy Research Institute
ISCRAL	International Scheme for the Conservation and Rehabilitation of African Lands
ISRIC	International Soil Resources Information Centre (the Netherlands)
ITC	International Institute for Geo-Information Science and Earth Observation (the Netherlands)
MA	Millennium Ecosystem Assessment
NRM	Natural Resource Management
PRA	Participatory Rural Appraisal
SMART	Specific, Measurable, Achievable, Relevant and Time-bound
UN-CCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
USLE	Universal Soil Loss Equation
WCMC	World Conservation Monitoring Centre
WRI	World Resources Institute

Part I
Conference report

Introduction

The Land Degradation Assessment in Drylands (LADA) project was designed to strengthen support to combat land degradation in response to the need identified by the UN-CCD.

During its first phase (2002-2004), LADA aims to 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-sector management planning in drylands. The principal objective of the LADA project is the development of tools and methods to assess and quantify the nature, extent, severity and impacts of land degradation on ecosystems, livelihood systems, watersheds and river basins, and carbon storage in drylands, at a range of spatial and temporal scales. The project will also build national, regional and global assessment capacities enabling the design and planning of interventions to mitigate land degradation and establish sustainable land use and management practices.

The project started with an exploratory workshop in Rome in December 2000, followed by a workshop where in January 2002 that established the general strategy and operational details, and dealt with pilot country selection (Argentina, China and Senegal). Details of these meetings are available on the Internet (http://www.fao.org/ag/agl/agll/lada/home.stm). Draft papers were produced on key issues such as the sources of biophysical and socio-economic data, methodologies available to assess land degradation and desertification, and a discussion paper on land quality, socio-economic and institutional indicators, in preparation for the LADA E-mail conference held October 9 to 4 November, 2002.

This E-mail conference was designed as a forum to exchange ideas on potential land degradation indicators and integrated methods; disseminate documents reviewing data and information on land degradation in drylands; and initiate the development of a network among national, regional and international teams involved and interested in land degradation assessment of drylands. Specific goals of the E-mail conference were to raise awareness on LADA, exchange expert views on land degradation assessment, and start identifying at relevant scales:

- data sets that can be used to assess land degradation,
- biophysical, socio-economic and institutional indicators that explain the root causes, driving forces, status, and impacts of and responses to land degradation,
- feasible methodologies to assess land degradation, and
- key issues regarding indicator and method development for land degradation assessment.

In response to the invitation (Annex 1) sent to more than 1 000 experts in land degradation and related fields, 148 persons (Annex 2) subscribed to the LADA E-mail conference. For each of the four weeks of the conference, an agenda with a set of discussion items (Annex 4) was sent to subscribers to solicit input on specific aspects of land degradation assessment. A background document on indicators for land degradation assessment and two sets of tables listing potentially useful indicators were made available to subscribers (Annex 6). In some instances additional questions and discussion items were sent to subscribers, depending on issues raised in contributions.

Since different scales have important and different implications on how land degradation is assessed and on how to best support improved management of land resources, the themes of the agenda highlighted scale issues. Four groups of themes were discussed during the LADA E-mail conference:

- Week 1 (October 9 – 14, 2002): general discussion on land degradation methods and indicators;
- Week 2 (October 15 – 21): national land degradation assessment;
- Week 3 (October 22 – 28): local land degradation indicators and assessment; and
- Week 4 (October 29 – November 4): global land degradation indicators, network for drylands, and next steps.

The weekly agendas, background papers (e.g., on indicator development and methods for land degradation assessment), summaries, contributions, suggested readings, and supporting documents (e.g., reports on specific types of indicators) were regularly posted on the LADA E-mail conference web site: http://www.fao.org/landandwater/agll/lada/emailconf.stm. Background materials on the LADA project, documents and results of the project until end 2002 are available at the following web site: http://www.fao.org/landandwater/agll/lada .

Annex 3 lists all persons who contributed comments and information to the conference. Contributions were obtained from individuals working for:

- national agencies (e.g., Centro Nacional Patagónico, Argentina; Centre de Suivi Ecologique, Senegal; and CSIRO Land and Water, Australia);
- international organizations (e.g., FAO, UNEP, and OECD);
- universities (e.g., Wageningen University; University of East Anglia, and Trent University);
- research institutions (e.g., Institut des Régions Arides, Tunisia; Laboratoire National de Recherches sur les Productions Végétales, Senegal; and ITC, The Netherlands); and
- private agencies (e.g., EARS Environmental Analysis and Remote Sensing Ltd).

The LADA E-mail conference initiated discussion on a number of key issues regarding land degradation assessment. Issues raised and suggestions provided during the E-mail conference will contribute to indicator and methods development and more specifically to the pilot studies – currently being developed for Argentina, Senegal, and China. The LADA E-mail conference facilitated dialogue among numerous stakeholders, especially among experts with experience in conducting global, national or local land degradation assessments. It is anticipated that the LADA E-mail conference web site will become a continuing forum for the exchange of ideas on land degradation. Subscribers of the E-mail conference were, for example, encouraged to continue providing contributions for posting on the web site. An update to the web site in the near future should allow participants to post contributions directly on the web.

While the E-mail conference provided an excellent forum to exchange ideas among numerous land degradation experts, finding ways to further this dialogue and broadening this exchange to a larger group of stakeholders (e.g., to include land users and farmers' associations) is crucial.

E-mail conference results

Overview

A number of recurrent themes were emphasized throughout the E-mail conference. These include the need:

- **to use indicators with caution.** While indicators have the potential to provide important and relevant information, they need to be selected, used and interpreted with extreme caution, since local conditions (and the underlying relationships that influence land degradation) widely vary. An indicator may actually point at differences in the natural state rather than at an inferred process of degradation or improvement.
- **for indicator and methods development to be purpose- or demand-driven.** To facilitate the ultimate use of land degradation assessments (i.e., to improve land conditions), indicator and method development should respond to key issues and questions raised by end users (e.g., farmers and national decision makers). The purpose of land degradation assessment should determine the methods chosen to achieve that purpose. Conducting user needs assessments and explicitly linking land degradation evaluations to decision making processes (e.g., policy development) helps ensure that assessments are demand-driven.
- **to acknowledge land user perspectives.** Local perspectives on issues, conditions, and priorities influencing land degradation –including the meaning and impact of land degradation for farmers and their livelihoods– need to be captured by technical staff implementing LADA.
- **to develop a sufficiently flexible methodology.** Because of the complexity of land degradation, LADA needs to develop a sufficiently flexible methodology that recognizes both the varying biophysical, socio-economic, and institutional factors that contribute to land degradation (and its rehabilitation) and allows for adaptation if or when conditions change.
- **for harmonization and standardization.** It was recommended that standard definitions, guidelines, and a menu of options (e.g., from which to choose indicators and methods) are used to help facilitate exchange of data and information (e.g., among countries) and to ensure integration of land degradation assessment results (e.g., for regional and global evaluation).
- **for up- and down-scaling between the varying scales**. Participants noted that further research is needed to develop methods and mechanisms to facilitate integration of and comparison between data and information obtained at varying scales.
- **for synergy with existing land degradation and related initiatives.** It was recommended that LADA link with existing land degradation and related initiatives: global (e.g., the Convention on Biological Diversity, the Millennium Assessment, and the FAO Forest Resource Assessment); national (e.g., National Action Plans and State of the Environment Reporting activities); and local (e.g., local government, farmers' organizations, and extension services).

- **to retain modest ambitions and clear objectives.** Respondents highlighted that activities should be developed within the scope of LADA's objective –namely to develop comprehensive baseline assessment at the national scale–, keeping in view simplicity and relevance to the aim of the LADA methodology.

While these results indicate issues that participants agreed upon as important for comprehensive and integrated land degradation assessments, some key differences were noted. These include:

- **financing land degradation monitoring:** while some participants emphasized the need for long-term investment (e.g., donor funds), others noted that land monitoring initiatives need to sustain themselves (where areas being monitored pay for their own conservation).
- **using existing vs. collecting new data:** while some respondents emphasized that existing data should be used, others expressed that poor data quality warrants new data collection.
- **conducting a user needs assessment:** although all participants called for linking land degradation assessment with the needs of decision makers, different levels of effort were considered adequate for this: from conducting an extensive needs assessment of land users, to referring to needs already articulated in LADA project documents.

Contributions from Week 1 focused on the use of indicators, methods and tools for land degradation assessment. In Week 2 specific types of national-level indicators and methods were proposed. During Week 3, types of local indicators and approaches for their development were indicated. In Week 4, inputs for global assessments were discussed and next steps on how LADA may proceed were suggested. Results for each weekly group of themes are summarized below

Part II of this volume comprises extensive extracts, and in some cases summaries, from the contributions to the conference. They have been grouped under the specific issues discussed within the four successive groups of themes. The full contributions, as well as a technical background document dealing with land qualities and indicators for LADA, can be viewed on the LADA conference Web site: http://www.fao.org/landandwater/agll/lada/emailconf.stm and on the CD-ROM in the back pocket of this volume.

Theme 1. Methods, indicators and a conceptual framework

Types of methods and tools, possible indicators (and their criteria), and the usefulness of the DPSIR framework for land degradation assessment were discussed during Week 1.

Indicators

The advantage of using well-established indicators for land degradation assessment was recognized by all respondents. Yet these indicators require: the ability to integrate aspects of complicated issues, a broad acceptance by the stakeholders to ensure their effective use, and the use of accurate data to avoid unwarranted manipulation. Important criteria for indicator selection were their causal relationship with land degradation, their availability, and their user-friendliness. Some contributors noted the tendency to develop too long a list of indicators, which impedes a proper identification of priorities. Others pointed to the limitations of selecting a too restricted number of indicators, which might hamper a proper analysis of the causes of

land degradation hazard. Many participants highlighted the need for local community input (e.g., of land users) in the development of indicators.

Methods and tools

Suggestions on methods and tools for land degradation assessment varied from concrete examples (e.g., participatory monitoring and evaluation) to a flexible approach that considers a variety of methods (e.g., rural appraisals, GIS spatial modelling, remote sensing, and aerial images). Application of models was generally encouraged although it was emphasized that their limitations and uncertainty should be clearly understood by both modellers and policy makers. The need to choose indicators and methods that acknowledge user needs and the selection of cost-effective data sampling and modelling exercises were emphasized.

DPSIR

While the DPSIR framework is helpful in conceptually linking the causes, state, and responses to the land degradation processes, the framework may be too complicated and inadequately capture complex relationships and the linkages between indicators. While most participants noted the DPSIR as helpful to LADA, some alternative frameworks were suggested (e.g., the Human Ecosystem Model).

Theme 2. National-level and degradation assessment

During Week 2, participants provided input on specific types of national-level indicators and methods that may be useful to LADA and described a number of key issues of relevance to their development.

Proposed national-level indicators and methods

Various indicators of potential use to LADA were proposed. These include indicators on soil moisture, soil depth and productivity, organic carbon, nutrient balance, erosion (including wind and water erosion), biodiversity, accumulation of salts, waterlogging, land use and cover change, economic productivity, poverty, crop yield forecasting, and land pollution.

Indicators and methods currently being used

Several participants provided information on indicators and methods that are currently being used to monitor land degradation that may potentially be useful in the LADA context. These include indicators and methods being used: in national assessment (e.g., Australia's National Land and Resources Audit and land degradation assessment in Senegal and Mexico); for regional and global monitoring (e.g., OECD, WOCAT, and WRI); and in case studies (e.g., use of panchromatic images to detect early signs of desertification in Patagonian Monte, Argentina).

National-level indicator development

Numerous contributors recommended that national level indicators be framed about key issues, questions, and/or processes relating to land degradation. End users (e.g., national decision makers) should identify and prioritize such key issues and questions. National capacity (e.g.,

existing data collection and institutional capacity) needs to be acknowledged in identifying and prioritizing such indicators and synergies with existing monitoring initiatives are required.

Indicator criteria

In addition to selecting indicators that are cost-effective and SMART, participants highlighted that indicators need to be based on local conditions and used in context/combination with other indicators (e.g., an infant mortality indicator used in context with other indicators may be useful for land degradation evaluation, while by itself it may simply indicate a general lack of medical services).

Development of land monitoring systems

Participants noted the urgent need to develop comprehensive environmental systems to monitor land degradation (e.g., to respond to donor, international convention, and national government needs). While ideally such a system should use a representative set of indicators, the constraints and limitations of many countries (e.g., lack of data) need to be critically acknowledged in developing such a system.

Financing indicator development and monitoring

Participants provided suggestions on the financing of land degradation monitoring that ranged from the development of systems that are self-sustaining (e.g., where areas being monitored pay for their own conservation), to those that require long-term financing.

Theme 3. Local-level land degradation

Key issues raised during Week 3 regarded: specific types of indicators and methods for local-level land degradation assessment; how a local focus can be feasible for national assessment, advantages of local-level assessment, development of local indicators, methods for field-based land degradation assessment, and the importance of monitoring hot and bright spots in local assessments.

Types of local indicators

A number of local indicators were proposed, ranging from the use of indicator plants, to observation of tree and root exposure, gullies, change in soil colour, and salt spots. Participants noted that the identification and selection of these indicators should be based on stakeholders' perceptions (and local conditions) and that ideally such indicators are monitored by land users themselves.

Methods for local land assessment

Various methods were described that may be used for local land degradation assessment – namely the use of rural appraisals and community focus groups. Specific steps on the use of an adapted sustainable livelihood analytical process were also described.

Feasibility of a local focus for national assessment

While various participants acknowledged that local-level assessments may be costly and time-consuming, such a local focus *can* feasibly be used for national land degradation assessment (the scale at which LADA is focusing) if indicators are monitored by land users themselves and if data for such indicators are collected in hot and bright spots.

Advantages of local indicators

Numerous advantages of using a local focus for land degradation assessment were mentioned, including that local-level indicators: link better and more directly to land degradation intervention; encourage grass-roots action; facilitate early detection of land degradation (vs. remote sensing techniques that monitors degradation after it has occurred); highlight local conditions; are cost-effective (e.g., by using existing local infrastructure and services); and provide more reliable results (e.g., for field-based assessments).

Key issues for local indicator development

Participants again emphasized that indicators need to be based on and developed about key issues and questions (e.g., described in user needs assessment). A "good" local level indicator was noted to be one that captures the complexity (vs. a single aspect) of land degradation.

Hot and bright spots

Various participants noted the importance of using hot and bright spots for cost-effective and timely land degradation assessment.

THEME 4. GLOBAL LAND DEGRADATION INDICATORS, A DRYLANDS NETWORK, AND NEXT STEPS

The discussion in week 4 focused on global-level land degradation indicators, next steps on how LADA may proceed, and the development of a network for drylands.

Global assessment

Participants emphasized that global assessments should heavily rely on national data collection and analysis. Such national assessments require a harmonization of results to ensure that data can be compared and exchanged among different countries and linked to global and regional assessments. In addition, such assessments call for the use of sufficiently flexible methodologies that can capture varying national and local conditions. Because of the importance of national assessments for global land degradation evaluation, it was recommended that LADA focus on providing sufficient support to the development of such national assessments.

It was further noted that a growing number of global data sets containing sub-national information are invaluable for global assessment. These include the FAO TERRASTAT and other databases on agro-ecological zones, soil moisture, soil type, nutrient supply, population density, and food self-sufficiency (ftp://ftp.fao.org/agl/agll/ladadocs/terrastatbetamapslist.doc and ftp://ftp.fao.org/agl/agll/ladadocs/faocoredatasetslist2.doc), the WCMC database on protected areas (http://www.wcmc.org.uk/protected_areas/), and the IFPRI data set on arable land (http://www.ifpri.org/pubs/books/page/maps.htm).

In view of the clear linkages among land degradation, ecosystem functioning, and biodiversity, synergy with international, regional, and national initiatives will be critical. It was recommended that LADA establish linkages with such initiatives as the Convention on Biological Diversity, the Millennium Assessment (MA), and the FAO Forest Resource Assessment. Such synergy will not only be important to the development of LADA itself, but will also help ensure that LADA findings are used to strengthen existing land degradation and rehabilitation initiatives (e.g., the International Scheme for African Land Rehabilitation).

Upscaling local and sub-national data for global (and regional) assessment was identified as a major challenge. One participant recommended that LADA refer to an upcoming MA workshop that will deal with mechanisms and methods on how to link local knowledge and global assessments. While few specifics were given on types of global indicators, the use of a desertification/dusty events indicator as well as agro-ecological zones sampling units were indicated as potentially useful.

Next steps

Various proposals were tabled on how LADA should proceed with its next steps. While there are some differences among these proposals, all call for clarifying objectives, assessing user needs, selecting appropriate sampling units, conducting data inventories and collecting data, identifying hot and bright spots, selecting and developing indicators, and analysing and disseminating information on land degradation. Key differences between the proposals concern the extent to which land degradation assessment should rely on new vs. existing data, and the need to review the existing national capacity (e.g., institutional capacity, data availability, etc.) before conducting a user needs assessment (to help ensure that user needs are addressed within the confines of existing capacity).

Whereas some participants emphasized using existing data, others expressed that poor quality of existing data and its poor documentation warrant new data collection. Respondents emphasized that LADA should retain modest ambitions with respect to its key objective: the development of comprehensive baseline assessments at national scale. Specifically, it was noted that user needs assessments should be conducted within the scope of LADA in a way that will not inhibit timely land degradation assessment.

Network on drylands: While a drylands network will ultimately be important to encourage collaboration, data harmonization, and policy development, its development at this stage may be premature. Some participants recommended that LADA should initially give priority towards convincing countries of the value of routine and collaborative land degradation monitoring by e.g., collecting baseline data, developing policy tools, and conducting pilot studies.

Part II
Extracts and summaries of contributions

At the start of each week, a brief introduction to the group of themes and a set of discussion questions were sent to all participants. These background materials have been reproduced in Annex 4. The full interventions and contributions of the participants are available on the LADA conference Web site and on the CD-ROM in the back pocket of this volume. Extracts and summaries of the contributions have been systematically arranged by theme below.

Paragraphs in italics are extracts from contributions. Different extracts from one contribution may appear under more than one theme. Paragraphs in normal typeface are summaries by the moderator or other members of the FAO LADA team of more extensive contributions or other papers directly relevant to the issue being discussed. The original contributions or papers are cited at the end of each summary. They can be read by clicking on the link in the electronic version of this document or by copying the web address from the paper version of this volume into a browser. Note: apparent spaces in a web address should be typed in as low dashes (shift-hyphen).

Themes

1. Land degradation assessment methods, indicators and conceptual frameworks

Methods for land degradation assessment
Indicators for land degradation assessment
DPSIR and other conceptual frameworks

2. National land degradation assessment

Some proposed indicators and methods
Indicators and methods currently being used
Key issues in national land degradation assessment

3. Local land degradation assessment

Types of possible local indicators
Suggested methods for local assessment
Feasibility of a local focus for national assessment
Advantages of a local focus for national assessment
Some key issues regarding local indicator development
Issues regarding methods and models for local assessment
Importance of monitoring in hot and bright spots
Importance of local assessment for LADA

4. Global land degradation indicators, a drylands network, next steps

Global assessment
Next steps
Network for drylands

Theme 1
Land degradation assessment methods, indicators and a conceptual framework

Methods for land degradation assessment

Methods that are currently being used

Finally, there are a host of modelling techniques that could be mentioned as relevant to the LADA methodology, (e.g. simulation models, GIS spatial modelling, etc.)

Raul Ponce-Hernandez (see contribution under Theme 4).

The following approach is currently being tested in the Kgalagadi District, SW Botswana and builds upon work done by the Botswana Rangeland Inventory and Monitoring Programme:

Our approach focuses on participatory degradation appraisal. … Given the desire of LADA to further facilitate the CCD, an emphasis on local participation may be particularly relevant – the CCD heavily emphasizes the importance of grass-roots desertification monitoring and response. The approach borrows from the field of Participatory Monitoring and Evaluation (see Estrella and Gaventa, 2000 for a recent review)…Our approach integrates three of the five degradation assessment methods identified by van Lynden and Kuhlmann (2002 – LADA draft): land user opinion and farm-level field criteria; field monitoring; and productivity changes. I attach a draft paper outlining the full methodological framework. Field data are currently being added by our partners at the University of Botswana. The paper is couched in terms of sustainability to widen its appeal, but essentially addresses degradation monitoring.

Mark Reed and Andy Dougill

The paper is available as an E-mail conference contribution at:
ftp://ftp.fao.org/agl/emailconf/lada/lada1_reed_mark_and_dougill_andy.doc

In Morocco *an integrated assessment approach is being used. This approach emphasizes gaining a better understanding from local populations (e.g., on their experiences in coping with and implications of land degradation). Field evaluations proved to be very useful, to among other things, gain a better understanding of the impacts of land management improvement: field discussions helped indicate a key indicator of programme success - various people voiced they no longer got "sand in their couscous".*

Abdelkader Allali

In Argentina *the National Patagonic Center, CONICET is using aerial photography and remote sensing to assess the degree of dryland deterioration.*

Jorge Ares

More information in Jorge Ares' E-mail conference contribution, at:
http://www.fao.org/landandwater/agll/lada/emailconf.stm .

Use of various methods

This means that one cannot [prioritize any one of] these methods [expert opinion, remote sensing, etc.], but rather [one needs to] consider a palette of mixtures…

Jorge Ares

Graduated and broadly based methods

It requires … a very simple, broad-brush system. Andrew Warren

…[it requires] a graduated system in which national system is extremely broad-brushed (units distinguished and data aggregated only at the District or province level), with increasing levels of detail, and devolved responsibility with smaller and smaller [units of analysis].

Andrew Warren

[it requires] people who understand the limitations of the assessment system (well-trained people).

Andrew Warren

Need for purpose-driven methods and tools

Land degradation assessment is an exercise for a purpose. The purpose must lead and the methods are then chosen to achieve that purpose. Yes, integration is important if we are dealing with complex inter-linked issues related to livelihoods, food security or even the implementation of soil conservation projects. But specify what that purpose is first.

Michael Stocking

Whereas models provide insight and information that can be used to improve management, they do not change things by themselves: something still has to be done. A relevant question, therefore, is whether Land Degradation Models can provide information that can improve decision-making …. The answer is yes: Land Degradation Models can support farming indirectly by being a source from which guidelines, diagrams, and extension service advice can be derived, and by enabling explicit alternatives for agricultural development to be drawn up.

Vicente Espinosa Hernandez (see contribution under Theme 4).

Need for cost-effectiveness

Consider for instance that [the] cost of Remote Sensing [is] probably one (or more) order(s) of magnitude lower than Field Monitoring or Productivity Changes... . Since Cost is so critical a criterion, this would explain why attempts on biophysical assessment of dryland degradation at a regional-national-global scale that are based on Field Monitoring-Productivity Changes have been ... unsuccessful [so far].

Jorge Ares

Need for models

When used correctly and of high quality, models allow us, based on relatively few data points and for relatively low costs, to provide a wealth of information. They allow us to take into account things that by their very nature are not directly measurable, for instance, because of the time or spatial scales involved. They also allow us to carry out experiments and what-if

scenarios that would be unthinkable in the real world. Process-based models have one other vital benefit, which is that they are based on, and may thus reveal a degree of insight in feedback mechanisms that the current indicator frameworks do not reveal.

David Niemeijer

In our experience, simulation models have been needed to help us understand several important aspects of dryland degradation. (See Jorge Ares under E-mail conference contributions, http://www.fao.org/landandwater/agll/lada/emailconf.stm). *While recognizing that models might not constitute an efficient communication tool in some circles of stakeholders, our experience is that once we understand things better by using models, we can better communicate our views to other parties.*

Jorge Ares

Reluctance to use models (in general)

These underlying models are rarely articulated, and few have great certainty. If nothing else, assessors should spell out their models (their assumptions).

Andrew Warren

[a national level framework is] in danger of coming under the control of poorly informed, defensive and rigid cadres.

Andrew Warren

Proposed or possible models and methods

You might take a look at quite a comprehensive model that formally integrates economics, biophysical and agronomic data: Adams, D., R.J. Alig, J.M. Callaway, and B.A. McCarl (1994) 'Forest and Agricultural Sector Optimisation Model: model description'. Washington, DC: Environmental Protection Agency, Climate Change Division. FASOM is a multi-period nonlinear programming model whose objective criterion maximizes the discounted sum of consumer and producer surpluses, net of transport and management costs, of U.S. agriculture and forest sectors over a finite time horizon. It accounts for changes in quantities of carbon in the major carbon pool in the private timberland and cropland, and over the life-cycle of wood products. It is also interesting because it illustrates one of the problems that we often encounter in these kind of exercises, namely that the model uses regional aggregates, hence, the results will be less relevant for land use planners if they would like to know precisely where to undertake a specific activity.

Ben Sonneveld

Regarding a method to assess degradation I believe we should apply an adaptable method (principles of which can be given in a framework) [using an] expert system and fuzzy logic ….

Abbas Farshad (see E-mail conference Web site for reference)

Using model results cautiously; need for testing

I agree with Andrew Warren's reluctance concerning the use of models. Generally, the problem with models is that they will always produce output whatever you feed into them. So even a perfect model (and there are few in the field of land degradation) will deliver poor output if the input data and/or parameters are of poor quality or inappropriate. So, while a statistical or process-based model can help us fill in data gaps it can equally well conceal data gaps (by

providing data that only on closer inspection will turn out to be too poor to use). This implies that when models are used for land degradation assessment we need more than an evaluation of the scientific merits of the model or a sensitivity analysis – we need, for each area in which the model is used:

1. *a serious validation of the model output;*
2. *a proper uncertainty analysis that also takes the uncertainties of the input data and parameters into account;*
3. locally relevant documentation and usage protocols; and
4. *well-trained staff aware of the limitations of the model.*

Validation should ideally be done with measured data of the actual field situation and local land management practices (i.e. not just validation with experimental plots or on-station trials).

David Niemeijer

In sum, as I see it, both measurement based indicators and computer models have their pros and cons and both need to be used with care and perhaps even more importantly interpreted with care.

David Niemeijer

Yet, it may be emphasized that careful testing and evaluation remain essential when models are applied to new situations.

Vicente Espinosa Hernandez (see contribution under Theme 4).

Indicators for land degradation assessment

Need for indicators

...if properly selected and used, indicators can provide a lot of important and relevant information at relatively low costs, so yes, despite the risks involved indicators are useful to evaluate land degradation.

David Niemeijer

We agree that indicators are a key tool for monitoring land degradation, as non-specialists can use them rapidly, cheaply and accurately.

Mark Reed and Andy Dougill

Indicators are important. They are our means of grasping aspects of complicated issues.

Michael Stocking

My opinion [regarding] indicators is that indicators are very important and necessary for land degradation assessment.

Vicente Espinosa Hernandez

Need to use indicators cautiously (e.g., accounting for local conditions, not assuming single universal causality, and being aware of misleading assumptions)

Land degradation is very difficult to evaluate. Because of this indicators need to be treated with extreme care. They should be seen merely as guidelines, within which trained individuals are allowed very considerable latitude. This is because the same amount of physical change

has different impacts depending on…: [varying] household circumstances…, risk-avoidance strategies… [etc.].

Andrew Warren

Indicators are generally selected because we think they reveal an underlying pattern that ties a cause with a problem or a problem with an effect. However, in some cases local circumstances may be so different in one respect or another that the same indicator is a reflection of very different underlying relationships than the one we think it reveals. To give an example from the village- or watershed-level indicators suggested for LADA, the biophysical indicator "number of water harvesting structures" which is mentioned in relation to erosion may be a very appropriate indicator in an area where rainfall is very low and water harvesting an effective tool to harvest water and nutrients and at the same time reduce erosion. A high number could thus be interpreted as an indication of proper response to erosion. In wetter areas the number is likely to be lower, not because people do not respond adequately to erosion, but because this is not an appropriate solution to tackle erosion in these areas. This is a fairly simple and obvious example, but I think it nicely illustrates the need to be cautious when interpreting indicators and not to assume a single universal causality relation for a particular indicator. It also shows how difficult it can be to compare indicators between regions. Some indicators are great for one region but would completely miss the point in another one.

David Niemeijer

Indicators could work in providing a realistic picture of land degradation in drylands; however, care must be taken in their selection. In doing so we must not lose sight of simplicity and relevance to the aim of the LADA methodology.

Raul Ponce-Hernandez (see contribution under Theme 4).

[An] important point to keep in mind when using indicators for land degradation is that natural endowments differ greatly from region to region, country to country and locality to locality. Many potentially appropriate bio-physical land degradation indicators have a hard time distinguishing between a naturally poor state and a human-induced poor state. This implies that ideally indicators should be considered in a historical perspective (which obviously in many cases is not possible for lack of data) and used in combination with other indicators to be able to better interpret the information we think an indicator conveys.

David Niemeijer

In the case of land degradation indicators we need to be very careful not to make misjudgements concerning the underlying relations we think an indicator reveals and not to be misled by false hits that actually point at differences in the natural state. To give an example, absolute population density by itself is meaningless as an indicator for land degradation because natural and climatic endowments vary (and thus carrying capacity) and because societies can respond at different times in different ways to increases in population density following more Boserupian or more Malthusian scenarios.

David Niemeijer

Danger of using 'simple' or a restricted number of indicators

The danger of trying to capture all aspects of land degradation through a necessarily restricted number of simple indicators is that one arrives at yet another system that can only very approximately assess degradation. Indicators often focus on single aspects of (land) degradation

and neglect the various interactions (either cumulative or opposite) that take place. So "simple" and "restricted number" [are] already out of the question.

Godert van Lynden

(Alternatively) Developing too long a list of indicators

[A long] list or table of indicators is typically the outcome of a consultation process whereby people contribute what they think are essential indicators for a particular process, compartment or issue. This usually leads to too many indicators, as is also the case for the current LADA draft (which is also acknowledged in the draft itself). So in a next step, people typically try to reduce such a list by asking experts for what they consider the key indicators, or by assigning attributes to each of the indicators in terms of how cost-effective they are, how reproducible, and so forth, and then determining criteria each of the indicators should meet. While this will lead to a much reduced list of indicators it is not very satisfactory in theoretical terms, because it will always involve a certain degree of arbitrariness and generally will not really take into account the DPSIR model. Instead, I would propose that the causal relationships between the indicators be used as primary selection criteria.

David Niemeijer (see also under "On criteria to help select indicators" for more detail)

But what frustrates me most is that, when asked for indicators, soil scientists (especially) come up with long lists of standard soil variables.

Michael Stocking

Need for indicators to capture complicated issues

Our indicators must integrate. ... a good indicator does not need to know what all these processes are; it just has to capture them. Land degradation assessment must not follow the road of reductionist science in its search for indicators.

Michael Stocking

Local community input

Given the difficulty of developing relevant and feasible indicators at national and global levels (Snel and Bot), it may be relevant to prioritize local and district scale monitoring, where it can be more easily linked to grass-roots action, feeding the results of this into national institutions and policy. While the information policy makers may receive from such decentralized, grass-roots monitoring systems may be more complicated and messy, it may better capture the complexities that so often characterize land degradation debates. It may also enable policy-makers to better target policy at district levels.

Mark Reed and Andy Dougill

The Reed et al paper (Mark Reed and Andy Dougill, under E-mail conference contributions at http://www.fao.org/landandwater/agll/lada/emailconf.stm) *outlines some of the advantages of identifying and selecting indicators with local communities as the first stage in degradation monitoring. With subsequent empirical validation, this approach can increase the number and quality of indicators, and improve the relevance of short-listed indicators to land-users. ... [Furthermore] we suggest that final indicator selection should be carried out firstly by local communities, who are able to evaluate their ease of use. The approach could be made more flexible by providing land users with lists of key indicators approved both by the community and field researchers, and asking them to select a minimum number of indicators from a number*

of categories (e.g. vegetation, soil etc.) to monitor regularly. In this way, indicator use can be adapted to the skills and assets of individual land users.

Mark Reed and Andy Dougill

Basing indicators on accurate and agreed-upon data

Indicators are often composed data, the usefulness of which has been agreed upon by a large group of scientists and decision makers. These indicators might give a good idea on land degradation when they are able to address [the dynamics and interactions with regards to agroecological, socio-economic, and cultural processes, as well as to human decision making processes, knowledge differentiation among stakeholders, and issues of perception]. Key, however, is that they are based on accurate data that are either observed or the result of reliable modelling exercises. For analytical purposes you will need the observed data that later can be aggregated to indicators. Nonetheless, it is a good idea to develop indicators that appeals to large groups of stakeholders and truly reflects the status of land degradation.

Ben Sonneveld

Criteria to help select indicators (e.g., ease of use, focusing on indicators that show causal relationships, recognizing purpose, data availability, etc.)

User-friendliness

The list of key [draft LADA biophysical] indicators ... tends to focus on soils. This contrasts with indicators generated by land users in the Kalahari, which tended to focus on vegetation and livestock (Reed and Dougill, 2002). One of the reasons for this is that soil indicators tend not to be harder for non-specialists to measure. 'Ease of use' was a key evaluation criterion for indicators cited by local communities in the Kalahari, and something that is under-represented in the SMART criteria.

Mark Reed and Andy Dougill

Explaining causal relationships

Indicators should be selected because they take up key positions in the causal processes of land degradation. Indicators taking up similar positions can be evaluated on the basis of the SMART concept (highlighted in the draft) to make a proper selection when multiple indicators are available. But, the first criterion, in my view should be the position of indicators in relation to the land degradation processes leading from driving forces to pressures to changes in the state to impact and to responses. In other words, we need to borrow from the process-based models and apply process knowledge to our selection of indicators.

David Niemeijer

Data availability and purpose-driven

Which of the key indicators we should actually use also depends on the kind of study to be undertaken. If we want to do field work we preferably need end-of-chain indicators (typically state and impact indicators) that reveal the effect of multiple processes on land degradation. If we want to do a desk study we typically do not have access to data for end-of-chain indicators but instead need to look for the pressure indicators that are predictive of a wide range of processes that exert pressure on the land.

David Niemeijer

Misuse of indicators for political purposes (e.g., to obtain additional donor funds)

... we have to [be aware] that some countries prefer to use [specific] indicators because these indicators may [highlight] degradation ... and ... permit ... claim [to] financial support from international organizations.

Abdelkader Allali

DPSIR AND OTHER CONCEPTUAL FRAMEWORKS

Usefulness of the DPSIR

[The DPSIR framework] seems to offer opportunities for conceptually linking diverse approaches regarding dryland degradation.

Jorge Ares

I think that the…Driving forces-State-Impact-Response framework to evaluate land degradation is useful and crucial to make [a] diagnostic on…land degradation around the world.

Abdelkader Allali

... the [DPSIR] model is useful to sort out cause and effect. The advantage is that it categorizes different aspects and allows us to focus on process links.

Michael Stocking

Shortcomings of the DPSIR framework (e.g., complicated framework and linear processes)

I do (and should) know what a DPSIR framework is, but I think it is a fairly complicated approach (to an admittedly very complicated issue). Rather than making things clearer, it only complicate things, at least to me.…It is often difficult to separate, for instance, driving forces from pressures or state from impact (I would say the state is a result of the impact, but apparently that is not how it is seen)….This leads indeed to confusion and ambiguities.

Godert van Lynden

The DPSIR framework represents…an often complicated, recursive dynamic process. The big challenge, however, is to formalize these relationships in a quantitative manner that can be used for analytical purposes, clearly indicating the marginal contribution of the causative factors to the land degradation process.

Ben Sonneveld

Despite the fact that indicators are nowadays often used within a PSR or DPSIR framework cantered on a causality chain, true insight in the complexity of inter-relations and feedbacks is seldom provided.

David Niemeijer

At present most indicator-based studies present the selected indicators in the form of lists or tables that conveniently categorize the indicators as D, P, S, I, or R indicators. This hints at the causal position of each of the indicators in the causality chain, as it is often called, but fails to draw attention to the actual linkages and causative patterns that relate one indicator to another.

David Niemeijer

The disadvantage [of the DPSIR] is that it [may be] promoted as an all-singing, all-dancing framework to be used at all scales and all purposes.

Michael Stocking

Jargon and the need for clarity

I don't know what a Driving Force-Pressure-State-Impact-Response framework is. Does this kind of jargon confuse anyone else?…I believe we should have quickly understood terms and concepts throughout.

Andrew Warren

Frameworks other than the DPSIR

A paper by Rapport and Singh (2002) notes that current frameworks (including the DPSIR) insufficiently recognize complex interactions (e.g., natural system's resilience to stress, time delays, and synergetic effects on ecosystems) and inappropriately establishes causation by suggesting linear causal chains. They propose various alternative frameworks for environmental assessments and reporting including the Human Ecosystem Model (HEM), ecosystem health framework, and human vulnerability to environmental change framework. According to the authors these frameworks better account for the interaction between human and ecological systems and provide information on its consequences on human well-being (since people want to know how environmental changes is affecting them).

For a full copy of this paper refer to:
ftp://ftp.fao.org/agl/emailconf/lada/lada1_singh_ashbindu.doc .

Another method for land degradation assessment that I have found useful is environmental risk assessment. It is compatible with modelling and the DPSIR indicator framework. It is doubly useful because it also forces scientists to think about risk communication and risk management.

Elisabeth Bui.

Theme 2
National land degradation assessment

Some proposed indicators and methods

Soil moisture index

An article by Smith *et al.* discusses the use of radar to acquire uninterrupted drought-relevant information such as on soil moisture and vegetation stress. The ability of radar to penetrate clouds and obtain data under most weather conditions and to obtain daily and nightly images (radar is not dependent on the sun), makes the use of such an active sensor system especially interesting for routine monitoring. Two types of radar sensors may be used: synthetic aperture radar (SAR) - which typically provides high spatial (e.g., for the ESR-1 and -2 SAR at 25 m for a 100x100 km area) but poor temporal resolution (e.g., for the ERS-1 and -2 SAR a 35 day repeat cycle) – and scatterometer - that conversely provides poor spatial (e.g., at 50 km for a 500x500 km area) but good temporal resolution (e.g., at a repeat cycle of 3 to 4 days). The Radar SAR can be configured for different spatial and temporal resolutions. The full article is available under

Theme 2 at ftp://ftp.fao.org/agl/agll/ladadocs/activesensor.doc .

Andries Rosema indicates that data on *actual* evaporation from the Energy and Water Balance Monitoring System may be used to estimate soil moisture, among other indicators.

Rosema's full Email conference contribution is available at:
ftp://ftp.fao.org/agl/emailconf/lada/lada2_rosema_andries.doc).

Soil depth and productivity

…a good indicator does not need to know what all … processes are; it just has to capture them. …Soil depth is [an example of an excellent indicator].

Michael Stocking (see contribution under Theme 1).

To monitor soil degradation it is important to include pH (acidification), organic carbon (fertility), bulk density (compaction), and texture. One may complement these observations depending on the degradation problems with micro-elements or heavy metals.

Michel Robert

Besides … soil fertility …, indicators of [soil] productivity may include the yields, their stability, the level of management and on-farm income, the herd sizes per household, and the degree of intensification, diversification and on-farm processing achieved by the land user. … Indicators of the depletion of soil fertility … can best be given by past and present records of the soil analyses (nutrients and soil organic matter) when available and comparable (this is rare). Otherwise the depletion of soil nutrients can be grossly assessed from the amounts exported by the crops, the amounts of nutrients brought back to the soil by crop residues, animal wastes, and chemical fertilizers (sediments from floods and sand winds as well as

precipitations also play a role locally) . When such balances cannot be worked out, a rough indication of under use of chemical fertilizer can be given by the average chemical fertilizer use per cultivated area or somewhat more precisely by fertilizer use per crop and per hectare. Philippe Mahler (see contribution under Theme 4).

As noted by one of the participants, other soil properties (other than soil depth) will need to be evaluated: *A good description of the soil structure is vital in soil degradation studies. Often the conventional description of soil structure is not enough and must be combined with the description of other soil properties, such as porosity, surface feature and consistence.*

Abbas Farshad

Organic carbon

An article by Anware *et al*. discusses the use of hot-water carbon (HWC) to evaluate soil quality. It is known that pools of carbon in soil (that includes microbial biomass, HWC, etc.) are sensitive indicators to capture soil stability, stress, and restoration. The usefulness of HWC, which is strongly correlated with microbial biomass, is tested as an indicator of soil quality: more specifically in detecting subtle changes of pastoral systems and the long-term impacts of cropping, market gardening, pastoral agriculture, and native vegetation. Results show that HWC is one of the most sensitive measures to grazing intensity and fertilization (of N or P) in pastoral soils and that it can be used as an integrated proxy variable for soil quality.

The full article is available under Theme 2 at ftp://ftp.fao.org/agl/agll/ladadocs/1650.pdf .

Nutrient balance

An article by Syers *at al*. discusses a nutrient audit model that provides national-level nutrient balance information. The model is based on coefficients for estimating nutrient outputs and inputs and FAO crop and animal production data – data that are readily and freely available. The model was used to evaluate annual nutrient (N, P and K) balances for Republic of Korea, Vietnam and China for 1961 to 1998. The article emphasizes the importance of collecting time series data: yearly fluctuations make results of evaluations that rely on "snapshot-in-time" data misleading.

The full article is available under Theme 2 at: ftp://ftp.fao.org/agl/agll/ladadocs/1641.pdf.

Erosion and sedimentation

Use of Caesium-137

Caesium-137 (Cs-137) is an artificial radionuclide with a half-life of approximately 30 years. It was released into the stratosphere by the testing of above ground thermonuclear weapons in the late 1950s and early 1960s and deposited as fallout. Due to the high affinity of Cs-137 to fine soil particles and its world-wide distribution it became a practical tracer for studying upland soil erosion and downstream sedimentation. The technique permits a quantitative assessment and detection of spatial patters of the medium-term erosion rates. Whereas existing measurement techniques like run-off plots posses important limitations in terms of temporal and spatial sampling and long term tedious efforts, the Cs-137 technique provides in a single field a comprehensive distributed pattern for parameterization and testing of erosion and sediment yield models. Moreover, it facilitates geostatistical calculations of error distribution which makes it amenable to an accurate representation through a GIS interface.

An extensive literature overview on Cs-137 applications is available at: http://www.ex.ac.uk/~yszhang/caesium/welcome.htm and a full summary under Theme 2 at

ftp://ftp.fao.org/agl/agll/ladadocs/erosedmeth.doc .

Wind erosion and sand deposition

The frequency and duration of sand winds, the amount of suspended particles in the air and the presence and extent of sand deposits (sparse or contiguous sand sheets or dunes) are the most common [wind erosion and sand deposition] indicators.

Philippe Mahler (see contribution under Theme 4).

Water erosion

... useful [indicators of water erosion] is ... information on the landform, the degree and pattern of its slopes and position in the landscape, on vegetation cover and its recent changes, erosivity of soil (texture, structure in particular the occurrence of compacted layers, sealing of pores and crusting of topsoil), land use system and practices and their recent changes and the impact of recent remedial action, if any. ... At national level, however, complex patterns of water erosion will usually limit the possibility of collecting meaningful data at this level.

Philippe Mahler (see contribution under Theme 4).

Biodiversity

While a set of biodiversity indicators is potentially very large, a smaller subset are of relevance to land degradation and required to represent genetic, species and ecosystem diversity in relation to land use and land management practices. There are two ongoing processes under the CBD of relevance to LADA which consider indicators and assessment: the Programme of Work on Dry and Sub-Humid Lands, which includes dryland, Mediterranean, arid, semi-arid, grassland and savannah ecosystems, and the Programme of work on the conservation and sustainable use of agricultural biodiversity which addresses the worldwide range of agro-ecosystems.

FAO is working with its Members to develop relevant biodiversity indicators, for example, through the State of the World's Plant Genetic Resources (1996):

(http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGP/AGPS/Pgrfa/wrlmap_e.htm),

the State of the World's Domesticated Animal Genetic Resources (http://dad.fao.org/), and the State of the World's Forest Resources (http://www.fao.org/forestry/fra).

In addition, OECD is in the process of developing agri-environmental indicators in OECD countries through a series of expert meetings. In assessing environmental impact of agriculture, the OECD biodiversity indicators include: crop and livestock genetic resources, wild species and non-native species as well as habitat quantity, habitat quality and their linkages, in addition to indicators of soil quality, water quality, land conservation, greenhouse gases and landscape. Other OECD agri-environmental indicators that are also of interest to LADA address the following categories: agriculture in the broader economic, social and environmental context; farm management and the environment; use of farm inputs and natural resources. Various references on this can be found under"biodiversity indicators of relevance to land degradation" at:

http://www.fao.org/landandwater/agll/lada/emailconf.stm .

Biodiversity losses may be indicated by reductions in the number of species of fauna and flora, loss of key habitats for migratory species and other vulnerable animal species, depletion of wildlands, occurrence of plant associations which indicate overgrazing ...etc. While biodiversity losses also occur as a result of other forms of land degradation ..., they are usually more significant, more easily measurable and more critical when associated with the depletion of natural vegetation cover. Similarly losses of carbon in soil occur as a result of erosion but unless past records of soil carbon content of cultivated soils are available, assessments of carbon losses will be attempted only where the depletion of natural vegetation cover can be documented.

Philippe Mahler (see contribution under Theme 4).

Accumulation of salts

Indicators [on the accumulation of salts] are the presence of salts above a certain level/ concentration in the soil; in the parent material; in the irrigation water; in the groundwater; in incoming runoff waters and winds from the sea and salt flats. The minimum levels above which the problem should be signalled should be discussed and agreed by specialists (they usually fluctuate during the year). Additional information on hydrology and water management as well as on the soil profiles may help to determine whether the problem is due to a natural process (e.g. salt marshes) or caused by man (e.g. saline irrigation water) or a combination of both.

Philippe Mahler (see contribution under Theme 4).

Waterlogging

Useful indicators [on waterlogging] are the regime of precipitation and that of water bodies, the importance, duration and frequency of floods as well as information on the origin of the floods .... Other important indicators are the position of the land area in the landscape ..., the presence of gley or pseudogley in the soil profile, recent changes in soil and water management (e.g. irrigation) and ... the presence of plants indicating an excess of water on or ... presence of a surface or subsoil drainage systems ... . For a national assessment [on waterlogging], the focus will be placed on the identification of ... watercourses along which flooding hazards are important ...; on the sections of ... watersheds which play or may play a critical role in generating floods downstream; and on areas which have become ... waterlogged as a result of changes in land and water use ... or new infrastructure developments....

Philippe Mahler (see contribution under Theme 4).

Land use and cover

Information [to monitor soil degradation] should also include land cover and land use (management practices, inputs, outputs) ....

Michel Robert

Beside the identification of the type of natural vegetation, the main indicators are the percentage of barren areas or with limited vegetation cover as compared with areas covered with primary natural vegetation....

Philippe Mahler (see contribution under Theme 4).

FAO is currently developing sub-national data on land use that may be used in land degradation assessments to identify heterogeneous areas (see http://www.fao.org/ag/agl/agll/lclu.stm).

FAO TERRASTAT has available sub-national data (on CD) on, among other items, the ratio of land used for arable agriculture to the extent of suitable land potentially available – which may be useful to LADA (see http://www.fao.org/ag/agl/agll/terrastat/wsr.asp).

Land-Use Compatibility Index (LUCI)

[The Land-Use Compatibility Index]... explains the degree to which a land utilization type agrees with the land suitability class. Abbas Farshad Full contribution at:

ftp://ftp.fao.org/agl/emailconf/lada/lada2_farshad_abbas.doc.

Economic productivity

An article by Byerlee provides an overview of the use and constraints of Total Factor Productivity (TFP) measures to help evaluate sustainability. TFP accounts for changes in agricultural production (e.g., crops, livestock, etc.) in relation to changes in inputs (e.g., land, labour, water, fertilizers, etc.). The TFP was modified into the Total *Social* Factor Productivity (TSFP) which incorporates non-market inputs and outputs and externalities. While TFP measures have been widely accepted among economists as *the* measure of sustainable agricultural systems, there is need for modifications to these approaches and to evaluate these measures in relation to trends in resource quality.

The full article is available under Theme 2 at:
ftp://ftp.fao.org/agl/agll/ladadocs/econoprod_byerlee.doc

An article by Murgai *et al.* discusses the use of TFP to evaluate productivity growth and sustainability in the Punjab of India and Pakistan. Changes in agricultural production (e.g., crop and livestock product costs) and changes in inputs (e.g., land, labour, water, machinery, draught animals, fertilizers, and pesticide costs) were evaluated. TFP was estimated separately for different agro-ecological zones (defined in terms of cropping systems).

The full article is available under Theme 2 at:
ftp://ftp.fao.org/agl/agll/ladadocs/econoprod_murgai.doc .

Poverty and food insecurity

The poverty of the land user is often a major cause and effect of land degradation. It is a reflection of a series of factors which include: the adverse conditions of soils and climate for land use, a low level of land management (in particular limited capacities to undertake land protection and rehabilitation ...), limited access to land (small size of the farms and/or no secure land tenure)...etc.. Food insecurity and population density are also relevant factors to take into account in the assessment of land degradation in connection with poverty as both often force the land user to overexploit the land resources.

Philippe Mahler (see contribution under Theme 4).

Numerous countries are developing sub-national poverty maps (e.g., based on income consumption/expenditure data). The development of several of these poverty maps relies on

small area estimation – a sophisticated technique in which a set of identical variables (e.g., household characteristics) are identified in both a census and survey. Upon combining census and survey data, this approach takes advantage of the wide coverage of the census and detailed evaluation of the household survey (more information on poverty mapping and initiatives at: http://www.povertymap.net).

As noted by one contributor, an evaluation of poverty should only be evaluated where a clear link between poverty and land degradation is evident (e.g., in many developing countries):

Land degradation in Australia underscores that extreme climatic variation and variability combined with inappropriate land uses and/or land management practices are really at the heart of land degradation--much more so than poverty or food insecurity. Poverty and food insecurity reflect lack of control over land use/land management; they are not causes of land degradation but are probably good Socio-economic indicators (D, P, I level) of potential land degradation in developing countries.

Elisabeth Bui

Crop yield forecasting and crop cover curve

... I think that the crop cover curve is one example of an excellent indicator. ... Historical crop yield is an indicator of productivity, which in turn is an indicator of LD status.

Michael Stocking (see contribution under Theme 1).

Andries Rosema indicates that data on actual evaporation from the Energy and Water Balance Monitoring System (EWBMS) may be used to forecast crop yields; and that data on actual evaporation from the EWBMS may also be used to estimate…a climatic moisture index.

Rosema's full Email conference contribution is available under Theme 2 at: ftp://ftp.fao.org/agl/emailconf/lada/lada2_rosema_andries.doc.

Further information at: http://www.earlywarning.nl/.

Land pollution

Depending on the pollutant, its source, its mode of disposal, propagation, degradation or persistence and the amount discharged, [land pollution] indicators may be searched in various media (soil, water, air), or/and at different levels in the food chains or/and in the records of toxic effects on the animals or human population. At national level, the main problem areas may be identified in relation with the sources (agro-chemicals, urban solid wastes and urban effluents, ...) and mode of disposal (on the soil, in the air, in surface water).

Philippe Mahler (see contribution under Theme 4).

Other indicators

The following national and district- or watershed-level indicators were suggested by Raul Ponce-Hernandez:

National-level land degradation

- *Land cover (extent, type and duration – this incorporates the temporal dimension through satellite image interpretation and band-ratio indices such as NDVI and GVI_).*
- *Land aridity indices (computed from meteorological data)*

- *Land productivity changes (productivity records and statistics form national agencies can be useful here)*
- *Spatial distribution of land use activities*
- *Economic parameters, such as per capita income distribution, land tenure and value*
- *Demographic variables associated to changes in land productivity.*

District- or watershed-level

- *Soil loss (erosion) by water and wind*
- *Yield variations (spatial and temporal) across the watershed.*
- *Changes in soil cover.*
- *Evidence of soil chemical imbalance, contamination or toxicity etc.*

Raul Ponce-Hernandez (see contribution under Theme 4).

... after going through the list of indicators proposed, I would suggest to add as indicators both at country and global levels: wild fauna (wildlife) diversity/quantity; level of technologies adoption; existence/implementation of National Plan of land management or Soil Fertility Action Plan; [and] the presence of refugee camps to be linked with the occurrence of war within a region.

Lamourdia Thiombiano (see contribution under Theme/Week 4).

Some suggested methods and approaches

Adapted GLASOD approach

I believe that GLASOD principles can be adapted for studies at [the] national level. Obviously, the larger the scale the more important ... data collection [becomes] [(e.g.,] ... use of remote sensing data and fieldwork). (see full contribution for more detail on GLASOD) Abbas Farshad

The methodology for country-wide assessments and above will ... have to be based on a mix of local studies, generalizations and interpretations based on expert and stakeholder judgement: in other words, something not basically different from the GLASOD methodology but with a wider range and interaction of contributors and multi-level consultations, combined with a broader use of the data bases now available.

Philippe Mahler

Indicators and methods currently being used

Australia's National Land and Water Resources Audit (NLWRA) and CSIRO

Australia was recently engaged in a National Land and Water Resources Audit that established baseline data for soils and vegetation, assessed the nation-wide level of water-borne erosion, Carbon and nutrient balances, soil acidification, salinity…I think that the NLWRA could serve as a template for many other countries' land degradation assessments in terms of data required, methods for making the most from existing data, modelling, and various indicators.

Results of the audit are available at www.nlwra.gov.au.

Elisabeth Bui

The CMIS Remote Sensing and Image Integration group at CSIRO (Mathematical and Information Sciences) has been developing methods to map and monitor rangelands, forests,

and agricultural areas. More specifically this includes monitoring of the spread of salinity, wind erosion occurrence, seasonal waterlogging effects, and remnant vegetation conditions.

More information at: http://www.cmis.csiro.au/rsm/casestudies/index.htm .

OECD work on agri-environmental indicators

While OECD is developing its AEIs [(Agri-Environmental Indicators)] from the broader perspective of tracking environmental trends in agriculture at national/regional scales ..., [these] approaches and indicators ... could be of use in the context of dryland agriculture. ... A number of key areas where the OECD AEIs could be of value to a wider group of countries ... with dryland conditions concern the nutrient balance, soil quality, water use and biodiversity indicators.

Kevin Parris

More detail is available in the OECD papers posted under Theme 2 at:

http://www.fao.org/landandwater/agll/lada/emailconf.stm and at the OECD Web site on agri-biodiversity indicators: http://www1.oecd.org/agr/biodiversity/index.htm .

WOCAT (World Overview of Conservation Approaches and Technologies) indicator on technology and approaches

…WOCAT [identified]… a number of key indicators … for SWC technologies and approaches respectively. These indicators were based on grouped answers in very comprehensive WOCAT questionnaires and consisted of:

- *Indicators for Technologies*
  - *Economic benefits/disadvantages (outputs vs. inputs or benefits vs. costs)*
  - *Acceptance or adoption*
  - *Required or available knowledge*
  - *On-site ecological benefits or disadvantages*
  - *Off-site ecological benefits or disadvantages*
- *Indicators for Approaches*
  - *Focus*
  - *Involvement of stakeholders*
  - *Effectiveness of training*
  - *Effectiveness of extension*
  - *Monitoring and Evaluation*
  - *Use of incentives*
  - *Impact on land management*
  - *Replicability and expansion*
  - *Land ownership.* Godert van Lynden

World Resources Institution's goods and services indicators:

The Pilot Analysis of Global Ecosystems (PAGE) is the first attempt to synthesize information from national, regional and global assessment. The PAGE studies report on the condition of the world's ecosystems in terms of their ability to deliver a number of key goods and services:

food, feed and fibre, water services, biodiversity, and carbon storage. A similar goods and services approach/inventory could be very useful to LADA. The study reports on five major categories of ecosystems:

- Agro-ecosystems: http://wri.igc.org/wri/wr2000/agroecosystems_page.html
- Grassland ecosystems: http://wri.igc.org/wri/wr2000/grasslands_page.html
- Forest ecosystems: http://wri.igc.org/wri/wr2000/forests_page.html
- Freshwater systems: http://wri.igc.org/wri/wr2000/freshwater_page.htm
- Coastal and marine ecosystems: http://wri.igc.org/wri/wr2000/coast_page.html

Soil degradation assessment in Senegal

The following extract is from Mamadou Khouma on soil degradation assessment in Senegal.

In Senegal we have [mapped the] main types of soil degradation based on the following factors: erosion (wind and water), acidification and salinization. Sodication [and biodiversity] [are] recognized but not mapped ... (the [latter being] most difficult to evaluate)... We have evidence of wind erosion by qualitative appraisal (particle removal and deposit). Quantitative figures are available for water erosion in term of tons of soil loss per hectare and year. Acidification assessment is based on acidity survey and delineation of acid sulphate soils, [while] salinization assessment is based on bare surface and specific vegetated area affected by soluble salt excess. Remote sensing [has proven to be] the cheapest and reliable way to assess salt-affected area.

Mamadou Khouma

More detail on land degradation assessment in "Land degradation in Senegal" at: ftp://ftp.fao.org/agl/emailconf/lada/lada2_khouma_mamadou.doc).

Monitoring land degradation in Mexico

Vicente Espinosa Hernandez notes that the following indicators are being considered in Mexico to monitor land degradation in respectively the arid and semiarid zone and the humid and subhumid zone.

Arid and semiarid zone:

Wind erosion: fragility of loose surface (composition), wind-eroded land, surface roughness, formation of sandstone, reactivation of fixed sand dunes, instability of annual precipitation

Population pressure and intensive land use: over-reclamation of sandy surface and over-reclamation on slope land (due to overgrazing, collection of fuelwood, intensive human activity)

Humid and subhumid zone:

Water erosion: concentrated rainfall, loose weathered crust, easily erodible rock, surface erosion, and gully erosion

Population pressure and intensive land use: same as above.

More detail at: ftp://ftp.fao.org/agl/emailconf/lada/lada2_hernandez_vicente.doc .

Desertification indicators for Italy

Maurizio Sciortino describes an initiative to develop desertification indicators for Italy and the Mediterranean region. In Italy, desertification maps have been developed – in consultation with local populations – for Italy's four southern regions (Sicily, Puglia, Basilicata and Sardegna). The Medalus model was used to and map identify areas prone or sensitive to desertification. This model is based on four indices: soil quality, climate quality, vegetation, and management quality. More information on this model, indices, and other steps is available at:

ftp://ftp.fao.org/agl/emailconf/lada/lada4_sciortino_maurizio_attachment.doc. Information on other desertification initiatives in the European Mediterranean region can be found at a Web site that provides documents on desertification in the Mediterranean: www.desertification.it.

Diagnosis of early desertification in Argentina

In the Patagonian Monte, high resolution panchromatic images were used to detect early desertification:

... signs of early desertification ... can be detected through the analysis of Fourier signatures in nadir-oriented panchromatic images digitized to resolutions in the range 0.09m< r < 0.70m (Ares et al. 2002). The procedure allows the periodic monitoring of extended geographical areas at cost-efficient rates with equipment usually available in routine range laboratories and agencies.

Jorge Ares

The full contribution is available at:
ftp://ftp.fao.org/agl/emailconf/lada/lada2_Ares_Jorge.doc .

Stabilization of gullies

In Nazareno, Minas Gerais (Brazil) a project is underway to stabilize gullies. An emphasis of the project has been the development of environmental education to help control and stabilize gullies – this has included environmental training of teachers, adoption of alternative technologies viable for small farmers, and the promotion of seed collection and seedling production.

Rogério Ferreira

Key issues in national land degradation assessment

Development of land monitoring systems

Urgent need for national land degradation assessment

The crux of the matter remains that Donors, the UN-CCD (and other conventions) and national governments are all urgently in need of comprehensive environmental monitoring systems. This implies the establishment of a measured baseline environmental status in every country. To move quickly to establish such national monitoring systems one could start off by measuring a small number of (land degradation) indicators (e.g., carbon, nutrient balances, salinity for irrigated sites, heavy metals in industrialized countries), complemented by remotely sensed data (e.g. moisture status, land cover change) and ground observations on land use (input/output analysis) and its socio-economic implications (e.g., population pressure, poverty, gender).

Note that the indicators between brackets are only examples. ... [Such environmental monitoring systems] would enable to take the pulse of the environmental health of a country and in the long term will confirm or establish causes and relationships among the complex factors involved. On the other hand the results could immediately be used as diagnostics in WOCAT or other case study-based programmes to suggest possible solutions.

Freddy Nachtergaele

We should keep in mind that we will have to come up with a concrete plan of action for land degradation assessment.

Godert van Lynden

Monitoring of interest to drylands and other issues

This system would be of interest not only to drylands and land degradation but obviously to other conventions and assessments as well. The GTOS Network made also a start of this and could serve as an initial base for such an initiative.

Freddy Nachtergaele

Acknowledging constraints and limitations/retaining modest ambitions

At national level and above, there will always be a lack of sufficient factual data, (particularly time series), to cover all the aspects which have been idealistically identified in developing the proposed lists of indicators and the comprehensive methodological framework for LADA. While these are useful references, particularly for local assessments, the existing constraints and limitations in many countries -and those of time and money in the LADA project- will impose the use of simpler working procedures for national, regional and global assessments. What counts most at these levels is the production of comparative/relative assessments over large geographical zones which should enable countries to set priorities among diverse land resource areas, compare and transfer their experiences and establish appropriate policies, plans and programmes and projects.

Philippe Mahler

While our approach to, and understanding of land degradation issues get wider in scope, many countries still do not have the information required and the means to undertake systematic, comprehensive, scientifically conducted assessments with such scope.

Philippe Mahler

Routine and timely monitoring

Ideally, one would like to make land degradation assessments that are based on time series, derived from a dense network of relevant observations. Unfortunately, these data are seldom available. Yet, an effort to collect important land quality indicators at regular time intervals and at representative locations would largely benefit the accuracy of land degradation assessments.

Ben Sonneveld

Indicator Development

The need to identify key issues and questions about which indicators are identified and framed

Going through the contributions to date (abstracts) it appears to me that we may end up with an endless list of factors that each individually (or in combination) may be quite relevant for land degradation assessment. I purposely call them factors because as indicators I do not believe they will help us much further. I do not believe that the list should be reduced by deleting some or many of them until a reasonable number remains, but that these factors should be grouped into a manageable number of key issues or in other words: indicators (to me the term key indicators is a tautology). Whether we should first have a long list with all the individual and sometimes very detailed factors - as is currently already being built up – and then group these, or whether we should (have) start(ed) by identifying what the key issues for land degradation assessment are, does not really matter as long as the key issues are clear and the individual factors can be grouped according to these issues (not very original, but I refer to WOCAT again).

Godert van Lynden

... it is important to see indicators within the context of the land degradation processes we are trying to capture. Indicators should not be selected on their own individual merits alone, but primarily in relation to other indicators and the specific questions we are trying to answer. I would even want to go as far as suggesting that we first must think of a specific question we want to answer and which processes play a role in that particular issue from driving forces down to impacts. Once we have defined which processes are relevant for a particular question we can try to narrow down on particular indicators appropriate for getting a handle on each of those processes, taking into account the kind of information and data typically available at the particular scale we are dealing with.

David Niemeijer

At national, regional, global levels, a selection and some kind of hierarchy/stratification/ prioritization of indicators are required. What kind of assessment results may be of interest to the users at national level and above? For what kind of decision-making and action? Can we provide the information wanted and can we convey this information in a form which will be understood, convincing and useable? How far do we need indicators to produce this information at national level?

Philippe Mahler

Selecting indicators based on national capacity

To sum-up, the use of indicators for LADA at national level and above should be placed in the perspective of both what will be required by the users at these levels and what is feasible taking into account the actual availability, reliability and comparability of data within and across the countries and the constraints of the LADA project.

Philippe Mahler

... an active approach is needed to involve national decision makers to clearly define the goals for the land degradation assessment. [Upon defining goals of the land degradation assessment], we can ... see if specific data sets are available at the national scale that are relevant for the defined objective of the land degradation exercise.

Ben Sonneveld

From here on, suggested indicators and attributes must be matched against the reality of existing statistics and other data sets…

José Benites (see contribution under Theme 4).

Synergies with existing monitoring initiatives

Where monitoring systems have already been established (as in many irrigation schemes for example) an existing system of gathering data exists - of water volumes for example. This could be harnessed to additional monitoring of say, crop or soil samples. … information on nutrient budgets, water use, finance and production can [furthermore] be reviewed ….

José Benites (see contribution under Theme 4).

Need to evaluate root causes of land degradation (e.g., policies)

The root causes … may be discovered through analysis of the flows of the different capital (financial, social, natural) and related policies (that have created disparities of access to opportunities among different social groups and ethnicities to local and external markets, financing, technical support, policy incentives, etc.). It is important to attempt to relate data … with the situation on the ground….

Raul Ponce-Hernandez (see contribution under Theme 4).

Indicator criteria

Adequately acknowledging local conditions

For a national assessment, a given indicator will not have the same significance in different natural or socio-economic environments of the country. In a certain sense, the blind use of indicators independently from each others would be a negation of the diversity of the ecosystems and of the multiplicity of interactions within ecosystems. Therefore one may conclude that indicators should be used with extreme caution and certainly not as a panacea for LADA at national level and higher. Trying to reduce the number of indicators to be used at this level will not help and may be misleading. One should rather use other tools in parallel.

Philippe Mahler

[Indicator selection] will partly be dictated by the specific conditions and priorities of each country with regard to land degradation and how it affects the goods and services produced in its drylands (the effect of the loss of land productivity on food security, on land and water pollution, on the socio-economic conditions of the population). Therefore by searching for a precise and unique set of indicators we may be fooling ourselves.

Freddy Nachtergaele

[In WOCAT] ...for none of these indicators absolute threshold values can be given: what is high costs in one place may mean peanuts in another (compare highly mechanised and computerized farming in W. Europe and US with smallholder farmers in Africa or Asia).

Godert van Lynden

In WOCAT the indicators are only meant as guidance for users to make their own (relative) judgement of a technology or approach for a given set of conditions. The same technology may be highly successful in place A, but a complete failure in location B, for many different reasons.

Godert van Lynden

The experience of local people and the expertise of specialists of diverse disciplines and the views of diverse stakeholders should take precedence over the indicators and over the use of the DPSIR or other models in arriving at an assessment of the land degradation.

Philippe Mahler

It's important to have a broad list of indicators but we must keep in mind that land suitability ... is location specific [and] cannot be dissociated from history, cultural, social and economic factors. [For example,] If we consider sandy soils and low activity clay (0.2 % organic carbon, 0.01 % nitrogen in the first 20 cm) ... [most extensive] in Senegal ... [but] ranked [globally] as [one of] the worst soils. ... in the Senegalese context one finds that [this soil] is suitable for millet, groundnut, cowpea provided [that] they are properly managed.

Mamadou Khouma

Need to evaluate indicators in context (in combination with other indicators)

I do not think it is a good idea to try to evaluate the utility of indicators without treating them as part of a consistent set. For example, the indicator on infant mortality needs to be used in conjunction with several other indicators to be able to say that it really provides information on the Impact of land degradation and not just on the lack of a good medical infrastructure or political turmoil (read war). So, in my view indicators are as good as the way in which they are used (and in particular how they are combined with other indicators). To paraphrase Andrew Warren's paper about land degradation being contextual I would say that the utility of individual indicators is also very much contextual.

David Niemeijer

Need to integrate indicators for comprehensive assessment

The main problem for the implementation of the national LADAs resides in the fact that most countries do not have integrated, comprehensive inventories of their lands as defined for the LADA project. In most cases, separate inventories of individual components/facets of lands are available such as vegetation (e.g. forest resources assessments), soils (or soils and terrain such as SOTER), climate or AEZ, land use (such as the FAO survey farming systems of developing countries). Land degradation should not be assessed merely by using separate assessments of the degradation of these individual land components. How then can the degradation of land be assessed comprehensively at national level ...?

Philippe Mahler (see contribution in Theme 4).

… an integrated inventory of land resources is an implicit prerequisite to the assessment of land degradation.

Philippe Mahler (see contribution in Theme 4).

Cost-effectiveness

...Organic carbon content, soil moisture, nutrient balance,...[indicators,] while process-relevant from an ecological point of view, must be tested [to see if they are cost-effective]...

Jorge Ares.

Financing monitoring and indicator development

Need for long-term investment

[The development of environmental systems requires]…an initial relatively large investment and a long term monitoring effort, partly independent of immediate results or rehabilitation of degraded sites.

Freddy Nachtergaele

Alternatively developing sustainable (self-sufficient) monitoring

Unless we subsidize the monitoring of degradation…with the revenues from other activities in the national economy (and…present mainstream economic theories do not seem to accommodate this view), we must plan for these lands to "pay" for their own conservation. This means that monitoring and assessment systems should be adequate to cover extensive areas, with regular periodicity, at costs commensurate with the rent obtainable from the land.

Jorge Ares

Estimating the costs of monitoring

In the Patagonian Monte we adopted [a] standard practice…[to estimate] costs of land degradation assessment … per km^2 / per year …. We estimated that our monitoring system to detect early desertification…[would require] US$3.30/km^2/year…, an affordable amount considering usual profits of land utilization in [this] area. This…includes…costs such as…equipment repositioning, building rental, ... image processing, flight rental, etc.

Jorge Ares

Theme 3
Local land degradation assessment

Types of possible local indicators

Some suggested farm- or village-level indicators

I*t is at this level that we have to rely on the farmers' knowledge base in order to select the appropriate and relevant indicators. A preliminary attempt should include:*

Field indicators of soil loss:
- *sheet erosion,*
- *rills and gullies*
- *tree-root and rock exposure*
- *soil build-up against structures*
- *formation of pedestals*
- *changes in colour*
- *exposure of fragipan or armour layer, etc.*

Field indicators of productivity changes:
- *yield declines…*
- *increase of spacing between plants in a farming plot*
- *changes in soil colour (darker to lighter)*
- *evidence of increases in toxicity*
- *increasing amounts of nutrients exported from the farming systems (nutrient mining)…*

Field indicators of toxicity in soil:
- *decline in soil productivity associated to presence of salts*
- *evidence of salty spots*
- *irrigation with sewage water*
- *patchy or very localized crop decline in the field*
- *proximity to heavy industry, mining, smelting or major roads*

Field indicators of biological degradation of the soil:
- *evidence of lack of organic residues added to the soil after harvest*
- *changes in soil colour (to lighter)*
- *increased exposure to direct solar radiation*
- *lighter structure and weak aggregation*

Raul Ponce-Hernandez (see contribution under Theme 4).

Indicators for success or failure and sustainability

In Uganda, indicators for success or failure and sustainability were developed for different farming systems using a sustainable rural livelihoods approach (see under Methods). This

approach first discussed assets of importance to the community (i.e., natural, physical, financial, human, and social) through participatory work with stakeholders. These local indicators were then compared with external indicators identified by researchers using a sustainable livelihoods framework. While local indicators tended to focus on human assets, the external or expert indicators highlighted financial and natural assets (note that few indicators of social assets were easily measurable). The approach highlights the wide range and different types of indicators selected among and between different communities and researchers. A combined set of sustainability indictors were compiled based on the local and external or expert indicators.

Sally Bunning

A table of the indicators and more detail on the methodology used can be found at:
ftp://ftp.fao.org/agl/emailconf/lada/bunning_sally_attachment.doc

Sustainability indicators

Various sustainability indicators were identified and selected by land users in the Kalahari. These indicators were then compared and integrated with scientific sustainability indicators. The indicators were categorized with respect to soil, vegetation, livestock, wild animals, and socio-economic aspects.

Mark Reed and Andy Dougill

More information in Table 2 in Reed *et al.* (2002):
ftp://ftp.fao.org/agl/emailconf/lada/reed_mark_attachment.doc

Soil health

A farmer should be able to evaluate the health of his soils and be able to recognize changes in soil health that occur in response to changes in land management or land use. ...Guidelines are presented on how to evaluate land quality in the field using simple techniques that require only domestic tools without needing to resort to sophisticated equipment or laboratory analyses. The list of indicators was developed on the basis of an assessment of soil health done by farmers in several field projects, especially in Central America.)

More information at:
ftp://ftp.fao.org/agl/emailconf/lada/lada3_attachment_benites_jose.htm

José Benites

Soil morphology

One important local indicator of land degradation is soil morphology, mainly in the superficial horizons (colour, texture, aggregation, porosity, biological features, etc.) .... Soil morphology indicates physical, chemical, biological soil degradation and its modifications influence ... water, air, and life .... [It] is not difficult to establish this inventory [and it] ...is a very easy tool for evaluation of land health: everybody can learn to observe and to interpret soil morphology.

Alain Ruellan

More information at ftp://ftp.fao.org/agl/emailconf/lada/lada3_ruellan_alain.htm

Suggested methods for local assessment

PRA, rapid rural appraisals, and community focus groups

I believe PRA processes can be successfully used for a structured and guided assessment of land degradation and impact on livelihoods, including local perceptions and adoption of NRM practices (extent and reasoning) at local level.

Sally Bunning

When data are scarce, detailed conventional surveys and systematic censuses may be replaced by a combination of diverse expert opinions, judgements and advice, questionnaires and on-site observations and consultations of stakeholders and study of existing documents. Rapid rural appraisals can be particularly effective when combining all these methods. Data can then be largely replaced by qualitative descriptions and analyses.

Philippe Mahler

...we are initially generating indicators from local knowledge and evaluating them in community focus groups. To ensure that they are accurate, reliable and linked to degradation processes, we are testing these indicators using field-based methods. Final selection will take place on the basis of these results in consultation with local communities. If successful, there are plans to extend this approach to other districts in Botswana, in collaboration with the University of Botswana....

Mark Reed and Andy Dougill

Adapted "Sustainable livelihood analytical process"

A sustainable livelihood analytical process may be adapted and used for land degradation assessment. The following is a summary of steps from David Howlett *et al*., 2000 (Stakeholder analysis and local identification of the success and sustainability of farming based livelihood systems) adapted for LADA.

Step 1. *Identification and description of key stakeholder groups and organizations and their classification*

Step 2. *Understanding natural resources use in the farm/livelihood systems (and impacts in terms of degradation, sustainable use and restoration)*

Methods: (stakeholder and farming system and degradation analysis through PRA tools, workshops and interviews - seasonal calendars (climate, farming activities), flow diagrams of production system (inputs and sources; outputs and outlets), Venn diagrams of organizations, transects and soil fertility diagnosis, etc.

Step 3. *Determination of perceptions of criteria of success or failure of farming-based systems and core issues and challenges to NRM (natural resource management) and overcoming land degradation*

Methods: Participatory workshop with different stakeholder groups to identify criteria and indicators for farming success and failure (sustainability and extent of degradation) in relation to the five kinds of capital and semi-structured interviews with key informants (e.g. trends, situation 5/10/20 years ago, and predictions in 5/10 years; natural misfortunes and impacts, farm appearance and signs of degradation, conservation actions, obstacles to improvement, and a range of socio-economic criteria).

S*tep 4.* *Determination of livelihood asset status (access, endowment and use of 5 capitals) and range of livelihood outcomes (income, well-being, vulnerability, food security, sustainable use of natural resources) based on local perception*

Method: Small group workshop or interviews with groups of stakeholders to assess best and worst scenarios for the 5 capitals using pictures, quantitative indicators (e.g., land area, no. of cattle, distance to water) and qualitative ones (e.g., poor or good soil, food shortage, fuel source). Develop a scoring on the basis of the five capitals for rapid assessment of farm household level of different stakeholder groups, to identify the range of endowments and their distribution at a site or community (percent per category or scale of operation).

Step 5. *Classification of stakeholders' organizations, functions, interests, involvement, importance and power or access to livelihood assets (this could be focused in relation to NRM or overcoming degradation)*

Method: Through information collected and visits, list stakeholders – types of farmers, service providers, external stakeholders such as landless, downstream resource users, competitors – by institutional category (individual, cooperative, private enterprise, non-profit NGO, local or central government) and classify on basis of function or involvement in NRM or adoption of practices, importance (vital to marginal) and power ((high or low) in relation to the five capitals.

Step 6. *Identification of local (stakeholder or community) indicators of sustainability or degradation to assess or monitor success of farm livelihood systems*

Method: On the basis of the above steps, the research team tabulates local criteria of success and failure (degradation and sustainable resource management) and identifies simple, measurable indicators for each, including indicators from steps 3 and 4 (success or failure and asset status).

The paper by Howlett, D., Bond, R., Woodhouse, P., Rigby, D. 2000. Working paper 5: *Stakeholder Analysis and Local Identification of Indicators of the Success and Sustainability of Farming Based livelihood systems* is available at:

http://les.man.ac.uk/ses/research/CAFRE/indicators/wpaper5.htm.

Sally Bunning

Manual development

We are developing indicator-based degradation assessment manuals with the Ministry of Agriculture in Botswana, for distribution to farmers in Kgalagadi District.…Different approaches to the development of user-friendly manuals will be evaluated during a trial with land users prior to publication and distribution. Manuals will link assessment results to a range of management strategies to slow or reverse degradation. Strategies will be developed from existing literature and local knowledge to provide a range of options to suit land users with differing capital assets.

Mark Reed and Andy Dougill

Details of the methodology and examples of indicators elicited from Kalahari communities are given in *Reed et al. (in prep. - available under Theme 1 contributions)* and at:

ftp://ftp.fao.org/agl/emailconf/lada/reed_mark_attachment.doc.

USLE

Very often, a modified version of the Universal Soil Loss Equation (MUSLE, RUSLE, etc) is used for local studies where water erosion is involved. Unfortunately, this method has been misused …(Wischmeier and Smith, 1978). A similar method (parametric) has also been used to assess wind erosion. Remote sensing data have been employed to calculate biomass, which can be used in the assessment of nutrient depletion. Examples of using USLE and Morgan models (used in a GIS environment) are given in the applications guides of ILWIS (ITC, 2001) under ILWIS at: www.itc.nl.

Abbas Farshad

Feasibility of a local focus for national assessment

Monitoring by land users themselves

We are developing an approach to local-scale assessment…[that] involves mobilizing communities to monitor degradation themselves…. Devolving degradation assessment tasks to land users sets the stage for equipping individual land users with the knowledge and tools to slow or reverse land degradation. Appropriately selected degradation indicators can enable non-specialists to monitor land degradation themselves.

Mark Reed and Andy Dougill

Use of hot spots

But local scale assessments are notoriously time-consuming and costly. …We are developing an approach to local scale assessment in…degradation hot spots…

Mark Reed and Andy Dougill

As [PRA] would require substantial resources (human, time, funds) it would require prior determination of hot spots, bright spots and representative farming systems and degradation situations for such in-depth local analysis (i.e. a good sampling basis).

Sally Bunning

Advantages of a local focus for national assessment

Linking with land degradation intervention

We would suggest that local scale assessments link better to land degradation interventions, which are increasingly focusing on communities and land user groups. This is also consistent with calls for grass-roots monitoring and response to desertification in the UNCCD.

Mark Reed and Andy Dougill

By giving local government, land user groups or individuals a role in developing indicators and a limited choice over which indicators they use, indicators are more likely to be relevant to conditions in the local agro-ecosystem…[and] can better link to farm-level interventions to combat land degradation.

Mark Reed and Andy Dougill

If these indicators are linked to a range of potential management responses, land users should be able to respond in a timely and effective manner to degradation. …By empowering

the majority of land users to carry out these tasks themselves, ...it may be possible to facilitate informed land management responses to degradation at a grass-roots level.

Mark Reed and Andy Dougill

It encourages a targeted response to degradation, rather than broad-brush national solutions that may not be relevant to all Districts or sectors of society.

Mark Reed and Andy Dougill

Few examples link indicators to policy and institutional development at farm, community and district levels (see work by Howlett in Rigby, 2000) but [indicators] can [help in]:

- *develop[ing] capacity and commitment towards more sustainable land use and allow farmers to evaluate their own practices;*
- *... diagnosis of problems and improvements to farming practices and identification of appropriate research and extension activities;*
- *assessment and monitoring spatial and temporal sustainability of different farming systems for evaluation, planning and management*
- *enhancing relationships between farmer, researcher and extension agent and encouraging farmer participation incorporation of indigenous knowledge and increase adoption of improved technologies.*

Sally Bunning

Cost-effective

[Local indicators] can be managed by local groups of ranchers with moderate technical guidance, employs local hand-labour and is affordable within the local productive systems, without need of external subsidies (... see ... contribution to Week2). ... If we compare [this to national and global assessment]..., we conclude that these techniques might not be affordable without international subsidies because of the needed technological platforms, expertise, etc. These techniques cannot detect EARLY desertification at a cost-efficient scale.

Jorge Ares

... the approach builds on and rationalizes the use of existing institutional infrastructures and services, rather than requiring investment in long-term field-based monitoring capacity. It may be a more cost-effective way to monitor wide tracts of land, building degradation monitoring capacity among local communities and linking to grass-roots strategies for tackling degradation.

Mark Reed and Andy Dougill

Improved extension services

In many countries, local scale degradation assessment is still the domain of (often external) experts, usually extension workers. Such services are often overstretched. By empowering the majority of land users to carry out these tasks themselves, extension services may be able to target their assistance to the minority of land users who are still unable to carry out these tasks (most likely the poorest in society).

Mark Reed and Andy Dougill

Early detection

At a local scale in the Monte, we propose looking at structural changes of the vegetation cover (...also see our contribution to Week 1, Ares et al 2002). This allows monitoring EARLY

desertification. This technique can be multiplied at many local places and can constitute a national system of local detection of early desertification. At a national scale (a low-resolution spatial scale), only LATE (advanced or extensive) desertification processes can be monitored.

Jorge Ares

Recognizing local conditions

By giving local government, land user groups or individuals a role in developing indicators and a limited choice over which indicators they use, indicators are more likely to be relevant to conditions in the local agro-ecosystem.

Mark Reed and Andy Dougill

Local indicators of success or failure and sustainability for selected farming systems were identified in Uganda based on assets of importance to communities (natural, physical, financial, human, and social). The use of this approach highlights the wide range and different types of indicators selected by different communities.

Sally Bunning

More reliable results (field-based results)

Given the problems associated with national scale indicators, farm-level collection of data may lead to more reliable results when aggregated across a District or agro-ecological zone, despite being collected by non-specialists. Integration of data across districts could be carried out during routine visits by extension services, or through a representative sample of volunteer land users who could be visited annually to collect data. At this scale, results could be fed into local government, and from there into national government.

Mark Reed and Andy Dougill

(Conversely, less reliable results)

The suggested approach [monitoring of local indicators by land users themselves] is unlikely to provide the quality and comparability of data collected in purely field-based approaches.

Mark Reed and Andy Dougill

Some key issues regarding local indicator development

Identifying key issues and questions

... rather than trying at the outset to identify ex ante indicators for local assessments and wondering which minimum data sets are required in general and then whether such sets are available, it seems preferable to formulate the set of basic questions to be answered for each main category of hot spots... .

Philippe Mahler

...indicators and methods for detailed studies should be developed problem-wise (erosion, salinity, pollution, ...) by formulating sets of specific questions to be addressed for each category of problem. According to the question raised, indicators may be selected and used in connection with the type of question raised.

Philippe Mahler

Land degradation assessment is an exercise for a purpose. The purpose must lead and the methods are then chosen to achieve that purpose. Yes, integration is important if we are dealing with complex interlinked issues related to livelihoods, food security or even the implementation of soil conservation projects. But specify what that purpose is first.

Michael Stocking (see contribution under Theme 1).

Some key issues about which indicators may be structured

Abbas Farshad provides an overview of some key land quality issues. See p. 2 in:

ftp://ftp.fao.org/agl/emailconf/lada/lada3_farshad_abbas_attachment.doc.

So I think that the crop cover curve is one example of an excellent indicator. Soil depth is another. Historical crop yield is an indicator of productivity, which in turn is an indicator of land development status.

Michael Stocking (see contribution under Theme 1).

Need for indicators to capture issues and integrate the different causal processes

... what frustrates me most is that, when asked for indicators, soil scientists (especially) come up with long lists of standard soil variables. These so-called 'indicators' are nothing of the kind. Our indicators must integrate. They are likely 'black-box' variables, such as the relationship between plant cover and erosion – why is it curvilinear, generally exponential? The answer is that there are numerous drivers, such as plant roots, or the effect of raindrop interception on infiltration .... But a good indicator does not need to know what all these processes are; it just has to capture them. Land degradation assessment must not follow the road of reductionist science in its search for indicators.

Michael Stocking (see contribution under Theme 1).

Different indicators for different levels

...the degree of expectation ...varies from one level to the other. The indicators applicable at [the local] level should be different from those applicable to other levels.

Abbas Farshad

Importance of using indicators to raise awareness (in environmental education)

I think ... the use of indicators [in] environmental education [is very important] ... to [help] achieve the restoration of degraded areas ....

Vicente Espinosa Hernandez

Issues regarding methods and models for local assessment

Need for a dialogue among and between researchers and policy makers

To me it seems more important to invest in a better and common understanding of land degradation among researchers from biophysical and socio-economic disciplines and also to promote a better understanding of the problem between researchers and policy makers.

Charles Lilin

Modelling for local assessment

Before asking how to [integrate biophysical and socio-economic data] one should ask the question if this is really a necessary step…. I doubt very much that there is a demand from the user community for such models or that it is a very useful exercise in practical terms.

... This does not mean that user interest cannot be generated, for instance policy makers would be provided with a tool that apparently tackles a situation over which they seem to have little control.

Charles Lilin

Importance of monitoring in hot and bright spots

Need for evaluation in hot spots

It should be kept in mind, however that some hot spots are critical because they combine several types of land degradation problems and therefore several sets of questions should be associated, adapted and used concurrently.

Philippe Mahler

Emphasis on assessing hot spots and bright spots

...in the framework of the LADA project, priority should be given to the monitoring of the hot spots in view of the risk involved and to that of the bright spots in order to confirm their success and get further experience in their maintenance.

The detailed studies for monitoring of the hot spots should first aim at verifying the diagnosis of the causes and impacts …. The second objective of this monitoring should be to assess the validity of the option taken for the urgent remedial and preventative action undertaken. ...

The detailed studies for monitoring the bright spots should also be established on an ad hoc basis and focusing on their specific vulnerabilities. In addition, more data should be collected in general to ascertain the costs and benefits of their establishment, the costs of their maintenance and the effectiveness of the technologies used.

Philippe Mahler

Criteria to identify hot spots

What are then the indicators or rather the criteria which characterize a hot spot? These include

- *the nature, severity and speed of the land degradation process, including the frequency and dimensions of related natural disasters or of economic and/or social crises ; ...*
- *the value of the land being degraded and that of the other land areas at risk (economic, social, ecological, or cultural); this criterion is often overlooked whereas it is important for decision making ; ...*
- *the size and conditions of living of populations affected and at risk; precedence may be given to hot spots with high population density and prevalence of poverty.*

Philippe Mahler

Types of classifications that may be used for hot spots

Philippe Mahler suggests classifications that could be used to categorize hot spots:

- *A. lands with highly critical problems (or risk) of erosion requiring urgent attention (hot spots)*
- *lands with high productive value*
- *lands of low productive value but of high ecological, or cultural importance*
- *degraded lands threatening other areas of economic, social, ecological or cultural importance*
- *degraded lands with widespread poverty, food security problems or other major social problems*

B. Lands with highly critical problems (or risk) of salinity requiring urgent attention.

C. D. E. F. ditto ... with other major problem or risk.

Philippe Mahler

Need to assess hot spots and reverse land degradation

... by definition, a hot spot requires urgent action which cannot be overly delayed by the needs for detailed studies. Some compromise has to be found between the need to fully understand the land degradation process and the need to take immediate remedial action against existing those damages and risks which are both critical in a hot spot.

Philippe Mahler

Identification criteria and indicators for hot spots should not be limited to their problems, however, they must also include those related to their potentialities and limitations for prevention and remedial action. As part of the detailed assessment of hot spots, additional information is required to determine the feasibility of diverse options (such as those compiled by WOCAT). Of particular importance are the local capacities to implement the option, the requirements for technical, social or financial support services, the needs for human resource capacity building, and those for equipment, investment and land use controls.

Philippe Mahler

As action on hot spots is by essence urgent, decisions will have to be taken on the basis of the answers to a minimum set of basic questions, leaving other questions to be answered by monitoring activities and adjusting the decision/action taken accordingly.

Philippe Mahler

Use of bright spots to help identify successful management

The main issue is to determine how the experience gained in a bright spot can be extended to wider areas and to identify the other factors which , beside the technology (see Godert van Lynden's contribution 15/10/02), have played a role in their successful management. For example, in addition to local factors, broader policy aspects of trade, land use, tenure ..etc may have had a positive determining influence on the occurrence of a bright spot and the possibility of transfer of its success to other areas.

Philippe Mahler

Data collection in hot spots

Then it is necessary to examine whether, for the specific hot spot concerned, these questions are relevant and whether they should be amended and can be answered with the use of available data or/and by collecting new data or/and by other means (consultations of documents, experts, stakeholders, available studies of similar cases, WOCAT data bases ..etc.).

Philippe Mahler

Importance of local assessment for LADA

From the guidance given by the LADA project document, it is clear that local assessments may be conducted for diverse objectives and at different stages of the overall LADA project. Some of these objectives partly overlap and the same local assessment may serve several of them, while others are quite distinct and their results are meant for different kinds of users. A recapitulation of the objectives of local assessments can be presented as follows

i. *to experiment locally the validity and feasibility of the methods (including indicators) to be used for national and sub-regional assessments (pilot testing in the preparatory phase)*
ii. *as part of the methods for national or sub-regional assessments, to analyse in more detail sample areas representative of specific problems identified in larger areas at national level or subregional level*
iii. *to study in detail specific sites identified as hot spots and assess the associated problems and risks*
iv. *to study in detail specific sites identified as bright spots and assess the effectiveness and transferability of the experience and technologies used with a view to developing further a compendium of best practices of control and prevention*
v. *to establish baseline studies for the selection and establishment of monitoring sites*
vi. *to prepare pilot action projects in priority areas.*

Philippe Mahler

Theme 4
Global land degradation indicators, a drylands network, next steps

Global assessment

Importance of national assessments

It is recognized that reliable data on dry and subhumid lands biodiversity should come from national assessments. Therefore it is recommended that support to national assessments and monitoring programmes should be a primary focus, especially in dry and sub-humid lands. Systematic data collection, processing thereof and effective communication of the assessment results ought to take place on a national level.

Juliane Zeidler

Linking national assessment to global assessment

It will be important for …national level work to be linked to existing regional and global assessments, and mechanisms and methods should be developed to foster this.

Juliane Zeidler

Sub-national global data sets of importance to global assessments

Lists of core sub-national FAO global data sets (FAO_core_datasets_list2.doc) and maps developed for the Poverty and Food Insecurity Mapping Project that may be useful to LADA (TERRASTAT I Beta Maps list.doc), as well as the FAO map of global irrigated areas can be found on the LADA conference Web site and on the CD-ROM; the irrigated areas map also at http://www.fao.org/ag/agl/aglw/aquastat/irrigationmap/index.stm. Subnational spatial global data not distributed by FAO that may also be useful to LADA include:

- protected areas by WCMC (available at http://www.wcmc.org.uk/protected_areas/);
- land cover characterization by USGS EDC (http://edcdaac.usgs.gov/glcc/glcc.html);
- population density 2000 by Landscan (available at http://www.ornl.gov/gist/landscan/LandScan_2000_Release.htm); and
- percent arable land by IFPRI (http://www.ifpri.org/pubs/books/page/maps.htm).

Need for conformity: data standards and guidelines

While recognizing the specificities of the needs of participating countries and diverse regions… a degree of congruence should be sought among the national methodologies and their products if a global assessment is to be obtained. Otherwise exchange of experience among countries will remain limited, opportunities for international cooperation in research, monitoring,

rehabilitation activities and capacity building will be seriously reduced and, of course, the feasibility of making a global assessment by compiling the diverse sub-national and national assessments will be almost impossible.

Philippe Mahler

[The development of] core guidelines should include provisions for a minimum of common elements for all the national assessments as regards [to] terminology, basic definitions, classifications, presentation of results ...etc while leaving sufficient flexibility for elaboration and diversification of the norms at national level. In this way, LADA would secure a minimum common denominator to all the national assessments which would allow for reviews of progress at regional and global levels and facilitate the compilation of national products into subregional, regional and global assessments, as anticipated by the LADA project.

Philippe Mahler

A wider set of criteria are required by the national and international agricultural agencies that have the responsibility of monitoring the course of development into the future.

José Benites

… I have been thinking of the utility of LCCS for LADA as a standard for assessing the land cover and land use. I find quite several 'selling points' for LCCS worth considering.

... LCCS ... is suited to assessing biological and physical aspect of the landscape ... LCCS is scale insensitive and therefore suitable for LADA's multi-level assessment needs. ... LCCS can provide easily comparable information from different ... climatic or agro-ecoregions.

Timo Maukonen

Need for flexible methodologies

If a rigid methodology is adapted, the risk is that as conditions change (as they will when going from one country to the next, or from one scale to another) the methodology can no longer deal with the factors that were not considered when developing it. ...If we take erosion risk as an example, we note that during the erosion crisis of the 1930s in the USA, the work of the American Soil Conservation Service (SCS) was well adapted to the context ... and [the USLE] model .. performed well. ... When in the 1980s an erosion crisis erupted in France, ... under pressure [the]…USLE [was adapted] to French conditions. But as historical and social conditions were very different, ... this approach could not work. ...In developing countries the land degradation situation is again very different ..., it is not the result of a pioneering agriculture (US) or of overhasty modernization (France) but rather a result of misguided (dualistic) developing policies. Here again, as in France, only negotiations and participatory approaches will work, but probably with lower expectations of immediate results given the more difficult context.

Charles Lilin

... I would like to underline ... the necessity to take into account five main considerations at global level:

1. *Diversity of climatic conditions: land degradation occurs across a quite range of climatic conditions (from Sahel to sub-humid zones);*
2. *Diversity of causes: from structural fragility of ecosystems to human mismanagement of lands;*
3. *Heterogeneity of contexts in term of land degradation severity levels: ...;*

4. *Heterogeneity of available data and even institutional capacities and national policies relating to the awareness on land degradation, its ecological and socio-economical impacts;*
5. *And finally the challenge to propose a minimum set of indicators which is flexible enough to take into account the considerations above: accurate enough and relevant to catch the state of degradation and also the process (modelling) of land degradation.*

Lamourdia Thiombiano

Need for synergy

Synergy with the CBD

It is recommended that further links between LADA and the dry and subhumid lands programme of the…[Convention on Biological Diversity] or a cross-cutting theme on indicators and assessments, or both, should be established.

Juliane Zeidler

More information at: http://www.biodiv.org/decisions/default.asp?lg=0&dec=V/23 .

The draft framework for the development of a national set of biodiversity indicators developed by a Liaison group under the cross-cutting theme of indicators and assessments of the CBD could provide some interesting guidelines also for the development of a national core set of land degradation indicators, ….

Juliane Zeidler

The draft can be read at:
http://www.biodiv.org/doc/meetings/sbstta/sbstta-03/information/sbstta-03-inf-13-en.pdf

Developing synergy with MA, Forest Resource assessment, GEO, and other initiatives

Amongst others it is recommended to closely interlink with LADA and other [Global Environmental Assessments] GEA's. The Millennium Ecosystem Assessment (MA), the FAO Forest Resource Assessment process and the Global Biodiversity Outlook (GEO) initiative are amongst those GEA's that are potentially relevant and can contribute directly to the dry and subhumid lands programme.

Juliane Zeidler

It is recognized that LADA is focusing on land degradation assessment. There are clear linkages between biodiversity, ecosystem function and land degradation. Therefore we recommend further exploring such linkages and reflecting them in the development of indicator development, subsequent assessments and monitoring programmes. The framework of the MA makes some interesting connections. These though should be brought forward in the scope of national assessments, which should preferably include much more direct biodiversity indicators, and eventually, over a longer term, include inventories and studies as described in the Global Biodiversity Assessment (UNEP, 1995).

Juliane Zeidler

The draft MA framework currently under review is available at:
http://www.millenniumassessment.org/en/about/cfreview.htm .

Linkages with desertification initiatives

We are aware [that] current work of the International Geosphere and Biosphere Programme (IGBP) and the related Land Use and Cover Change (LUCC) are currently developing desertification indicators, which will be discussed during an internal workshop in November of this year. The outcomes and recommendations from such work should be included in the LADA development process.

Juliane Zeidler

IGBP at: http://www.igbp.kva.se/cgi-bin/php/frameset.php
LUCC at: http://www.indiana.edu/~act/focus1/index.html .

Strengthening the implementation of existing initiatives

The overview of ...different kinds of land degradation [data and information] at country and regional levels generated from LADA could provide basic support to boost the implementation of the International Scheme for the Conservation and Rehabilitation of African Lands (ISCRAL).

Lamourdia Thiombiano

Indicator development

Possible use of a dusty events frequency indicator for desertification

Over the last decades, it has been recognized that dusty events frequency analysis was one of the major indicators to assess the evolution of the desertification process. ...This indicator is available at the global scale for long-term periods of observations. Its application at the national and regional level should help decision-makers estimate the trend of desertification which is, in many countries, one of the most severe impediments to poverty reduction, improvement in the quality of life of local populations, and sustainable development.

Pierre Ozer

Possible sampling units

...at global level it could be more appropriate to define [a] specific set [of indicators] for a specific global agro-ecological zone (AEZ). This will give the possibility to capture the bio-physical, socio-economical and cultural factors within a given global AEZ.

Lamourdia Thiombiano

Upscaling issues

The merit of including real household, community and local level indicators into assessment and monitoring programmes cannot be stressed enough. However, difficulties have been encountered in the upscaling of such data, as well as in the systematic collection and communication thereof. Case experiences will be discussed during a workshop of the MA, as well as mechanism and methods how to deal with linking local knowledge and global assessments. The outcomes of this meeting could be useful for the further development of LADA, as would potentially be country experiences.

Juliane Zeidler

Meeting Web site:

http://www.millenniumassessment.org/en/meetings/meeting.subglobal.2.htm

Network for drylands

Need for a network, although premature

While ... a logical follow-up, ... establishing a network already now may be premature .... Nevertheless, ... while a monitoring network is premature, a cooperative network of stakeholders for a comprehensive and balanced assessment is a must. This cooperative network may then be used subsequently to discuss and select the problems, the areas and the indicators to be monitored and to establish the monitoring sites and their linkages. Philippe Mahler

Next steps

Some proposed steps

Proposal 1: A proposed set of steps (and figure) on how LADA proceed to conduct land degradation assessment was sent to participants along with the agenda for Week 4 (Annex 5). Extracts follow.

S*tage 1: User needs assessment and National stakeholder meeting*
- *identify key issues in political and economic terms*

Stage 2: Inventory of data and capacity
- *identify and collect existing data sets (review biophysical data and socio-economic data)*
- *identify important missing data sets (e.g., socio-economic)*
- *identify indicators (based on user needs)*

Stage 3: Implementation
- *select appropriate stratification and sampling*
- *develop models (e.g., that link biophysical and socio-economic data)*

Stage 4: Analyse results
- *determine cause, state, and effect (frame data within the DPSIR framework)*
- *conduct participatory local surveys in hot and bright spots*
- *discuss results with stakeholders*

Stage 5: Disseminate results and policy recommendations
- *link results with solutions and policy recommendations*
- *disseminate results (e.g., meetings with policy makers, brochures, etc.)*

Stage 6: Monitoring and evaluation
- *repeat steps above*

Proposal 2: Dominique Lantieri (FAO) provided a proposal on how LADA could proceed with its land degradation assessment. Extracts follow:

1. *Undertaking of a user needs assessment: ... there is a need to undertake such a survey to specify better what types of different products LADA is supposed to provide for each main category of users: e.g. decision makers and technicians working for development, scientists, civil society and NGOs, environmentalists, wide public and mass media ....*
2. *Definition of main common methodological steps ...:*

   ...details on the methods [are not critical] but rather a broad consensual and flexible framework [is needed]. ... :

   - *step 1: The collection of the existing data (biophysical, socio eco, remote sensing etc...)*
   - *step 2: The stratification of the territory into homogeneous land systems at around 1: 500 000 ...*
   - *step 3: The further stratification or analysis within these land systems of main land use or farming systems with identification of farming practices (essential) , cropping strategies, inputs levels (human, technical and financial), land tenure and market issues, cultural behaviours, main environmental problems ...*
   - *step 4: The pre-identification of hot spots*
   - *step 5: Sampling strategy to perform the field survey ...*
   - *step 6: Field survey using a range of methods such as farmers enquiries, measurements on plots, rapid visual assessment by experts ...*
   - *step 7: Integration of results, analysis and synthesis ...*
   - *step 8: Preparation and dissemination of LADA information products ...*
   - *step 9 : Definition of the specifications of the desertification monitoring system ...*
   - *step 10: Consultation process on actions to be done to support the effective use of LADA products for land degradation.*
3. *Implementation of Pilot studies ... to test the above approach and assess some possible practical methods for various steps ....*

Dominique Lantieri

The complete set of steps can be viewed at:
ftp://ftp.fao.org/agl/emailconf/lada/lada4_lantieri_dominique.doc .

Proposal 3: Philippe Mahler (consultant) provided the following "next steps" on how LADA may proceed. Extracts follow:

[Stocktaking exercise on past experiences/review of national capacity:] *Rather than starting with a user survey, right away at national level, a national lead institution should initiate a preliminary stocktaking exercise with the main sources of information and experience available in the country and from international data bases. ...*

[Presentation of national capacity review and stocktaking results to potential users:] *The results of this preliminary stocktaking should then (and only then) be presented to and discussed with a range of potential users. Out of these discussions, a clearer picture would emerge on, not only what are the diverse gaps to be filled in the assessment of land degradation, but also the requirements in national capacity building, in overcoming communication gaps and institutional barriers, and other lessons learnt.*

[Developing a consensus:] *This national process of stocktaking and review of past experiences should be undertaken with a view to arriving at a consensus among national stakeholders on: a) the present state of knowledge and state of the art as regards land degradation assessment*

…; b) the available knowledge of the interactions among the driving forces, pressures, impacts and responses related to the degradation problems …; c) the major conclusions and strategic implications of this stocktaking exercise …. The output of this national review should take the form of an executive summary … and include a descriptive account of its method of preparation….

[Discussion on methodology/needs assessment based on national review/capacity:] *On this basis, a wider discussion on the methodology should take place based on the nature and range of the LADA products which are … needed and feasible/attainable in the conditions of the country concerned. In fact, the user needs - and the LADA products which could meet these needs - cannot be examined without reference to the means available in the country, the constraints and the methodology. …*

[Development of guidelines/procedures for the national assessment:] *The next steps should …include the development of core of common principles and procedures for the national assessments by translating the methodological framework … into guidelines. The drafts of these guidelines should be widely circulated prior to regional workshops which would refine them and develop a consensus on the ways to proceed. ….*

Philippe Mahler

The full contribution can be read at:
ftp://ftp.fao.org/agl/emailconf/lada/lada4_mahler_philippe.htm .

Clearly stating objectives and not losing sight of LADA's modest ambitions

… the ambitions of LADA should remain modest: in most dryland countries, a comprehensive baseline assessment at national scale ([e.g.,] 1: 1 million) should be the main objective with an identification of the diverse hot spots and bright spots.

Philippe Mahler

… we must not lose sight of simplicity and relevance to the aim of the LADA methodology.

Raul Ponce-Hernandez

… the main objectives of the assessment of land degradation could be formulated as follows:

i. *to identify the type, degree and relative extent of the main land degradation problems encountered in the country(ies);*
ii. *to provide basic contextual information on the main causes and impacts of the land degradation problems … as well as on the main features of the natural and socio-economic and institutional environments which influence land use and land degradation processes.*
iii. *on the basis of the above, to delineate the major land degradation problem areas (LDAs) of the country(ies) and indicate the relative … urgency of their requirements for … protection or rehabilitation. Within the land degradation problem areas, the location and nature of the most critical sites of degradation (hot spots) should be indicated.*
iv. *…to identify and characterize the land areas with no significant land degradation problem in their present state …[and] to assess their degree of stability or vulnerability and the requirements for their maintenance.*

Philippe Mahler

It was recommended that reference to the full GEF project be made. Extracts follow:

Expected results and outcomes of the full GEF project

a. *Standardized methods and guidelines for dryland degradation assessment and monitoring. ..... It should be a multi-level system that enables the inclusion of detailed field studies into national and regional statistical frameworks*
b. *A baseline map of dryland land degradation at sub-regional scale. The baseline map should be based on the collection and collation of existing maps and databases…*
c. *Global assessment of actual dryland degradation and degradation hazards. ... It will enable an initial identification of areas at greatest risk (hot spots)*
d. *Detailed assessment of land degradation at national level, focusing on areas at greatest risk (hot spots) and areas where degradation has been successfully reversed (bright spots): This detailed assessment will use all available methods, with emphasis on field studies and indigenous knowledge. It will cover not only the state of degradation but its causes and impacts, together with identification of remedial measures. A field database will be developed to allow monitoring of changes. ..*
e. *Analysis of the effects of land degradation areas at risk. The effects of land degradation areas at risk will be analysed in terms of the types, extent and severity of degradation, their driving factors or causes, their impacts on the environment (ecosystems, carbon emissions, international waters, etc.) and on human livelihoods, food security, poverty, migrations, etc.*
f. *Best practices for the control and prevention of land degradation in drylands. Best practices for the control and prevention of land degradation will be developed considering indigenous and traditional knowledge, existing information on indigenous practices (e.g. the World Overview of Conservation Approaches and Technologies, WOCAT), the findings of UNEPs program on Success Stories in Desertification Control, and results of the LADA project. The WOCAT project has established a methodology for collecting soil and water conservation experience that could be employed by the future LADA project*
g. *Communication and exchange of land degradation information, and promotion of its use in decision making. The information generated on land degradation in drylands will be packaged, communicated and exchanged especially for use by policy and decision-makers in various ways, such as for Policy Guidance; GEF Interventions; Priority Actions; Lessons Learned and Best Practices; Monitoring Tools; ….*

Acknowledging national capacity

Rather than starting with a user survey, right away at national level, a national lead institution should initiate a preliminary stocktaking exercise with the main sources of information and experience available in the country and from international data bases. A series of ad-hoc working sessions with the national experts concerned should enable them to determine jointly what is known, what are the gaps, what, in their opinion, were the past successes, failures and shortcomings of past assessments in mobilizing political will and action and what might be undertaken in the framework of LADA. … The results of this preliminary stocktaking should then (and only then) be presented to and discussed with a range of potential users.

Philippe Mahler

Users' needs assessment

Need for a users' needs assessment

I agree ... with [regards] to [the need for] a user assessment ... - it will [ensure that] ... information that is needed [to answer key] ... questions [is obtained].

Vicente Espinosa Hernandez

Ensure user needs assessment does not overextend LADA's scope

The survey of user needs as proposed is certainly desirable but this should not lead to a cumbersome process by which the same ground may be covered again and again without much progress. ...Of course, more potential users may be consulted, but as we may broaden the range of users to be consulted, we may also overextend the scope of LADA and end up with such multi-purpose exercise that it would be even more difficult to develop and agree on a methodology (and indicators!) and complete the assessments in a reasonable time (while land degradation is ongoing at a rapid pace in many areas).

Philippe Mahler

Use of the LADA PDF-B document to help assess users' needs

To some extent, a fairly good idea of what is needed can be obtained from reviewing the preparations that enabled the launching of the LADA project, the LADA project document and consultations held so far before and during the PDF-B phase, including visits to some countries. A number of stakeholders were involved, supported the project, advised on its preparations and were convinced on its usefulness.

Philippe Mahler

Need to be more reserved in asking user needs: potential users may expect answers from LADA

[Stakeholders involved in the PDF-B phase of LADA] now assume that LADA is on its way to be implemented. They might be surprised and perhaps disappointed if they would receive questionnaires asking them to indicate or otherwise develop proposals on what they need.

Philippe Mahler

Many potential users do not even know what can be provided by LADA and may turn back the questions and ask what LADA may have to offer and how its results could be used.

Philippe Mahler

Selecting an appropriate sampling unit

When covering the whole territory of a country, ... the difficulty is to delineate the areas where these problems occur and to show them on a map at a relatively small scale (e.g. 1:1 million).

Philippe Mahler

Some [indicators] ... are not easily aggregated ... . Major watersheds and drainage basins are the most appropriate boundaries for delineating surface waters, land-terrain features and major soil categories, but to fit into the present System of National Accounts, natural resources must be aggregated along administrative boundaries to the level of countries.

José Benites

The scale problem ... cannot be answered simply. ...The following aspects need to be coherently considered to clarify the problem of scale: objective of the Land Degradation Assessment of Drylands; level of organization or scale of process; possibility of clearly defining subsystems ..; possibility of validating the model ...; possibility of returning to the field ...; [and the] action plan for the rehabilitation .... It should be kept in mind that in order to generate corrective or preventive measures, homogeneous areas are required… .

Vicente Espinosa Hernandez

Data collection

Collecting new data vs. using existing data

... it will be important to determine whether a particular question should be answered on the basis of existing (usually less detailed data) or on the basis of detailed field level data (which will often have to be collected) ...

David Niemeijer

... we ... should resist the temptation of creating ever larger data bases that in the end do not significantly contribute to the solution of the problem.

Ben Sonneveld

... there are numerous data inventories (AEZ, SOTER, WOCAT, census, household surveys) available that allow or support the analysis of land degradation. There is also a large array of accumulated scientific process knowledge that has been built up in the last decades and that can not be neglected. The challenge is to formalize relationships by combining process knowledge with statistical techniques, so that we understand and quantify the land degradation process and find the answers for the relevant policy questions. I am also sure that once the country studies get started a lot of indicators, data sets, methods and techniques will fall in place like a jigsaw puzzle.

Ben Sonneveld

The emphasis in LADA should be on design of a policy tool and not on collection of <u>new</u> data. There are three (or four) important reasons for this. ... To warrant land degradation a place on political agendas we need hard evidence that people will benefit from investments in land degradation and this should be substantiated with decision making tools.

Ben Sonneveld

Collecting data for selected indicators

... [it should] be made more explicit, that ... data [are collected] only for those indicators that [have been] selected.

David Niemeijer

Need to collect data over time

Land degradation acts in space and time and it is therefore [important] to establish a georeferenced monitoring system that [can provide better information] about the actual state of land degradation [and] ... the evolution over time, and [enables] evaluation of the effect of rehabilitation interventions.

Michel Robert (see contribution under Theme 2).

There exists ... a network in Europe ... France's network has 2000 observation sites. Observations take place…[at intervals] depending on the indicator concerned (1 to 10 years).
Michel Robert (see contribution under Theme 2).

Identifying hot and bright spots

...[more details should be given to a] description of the hot spots in the [Land Degradation Problem Areas] ... with indication of their occurrence and location and an explanation of the problems which make their degradation particularly critical (risks and impacts).
Philippe Mahler

Philippe Mahler provided a number of possible categories to help delineate hot spots or land degradation problem areas. These include categories to distinguish between those areas that are eroded due to water or wind. He also describes characteristics of bright spots or stable land areas. More detail on land degradation problem areas and stable land areas respectively in points 4 and 6 in Philippe Mahler's first contribution to Theme 4 at:

ftp://ftp.fao.org/agl/emailconf/lada/lada4_mahler_philippe.htm .

Indicator development

Framing indicator development about important questions or needs

..., it will be important ...[that] we not just get into listing good indicators, but try to frame them within the context of the specific questions that need to be answered. ... the structuring should ... be in terms of ... what are the best indicators to use for each of the questions we would like to see answered.
David Niemeijer

Recognizing land users perspective in developing indicators

From the perspective of the farmer (who ultimately experiences in her/his own livelihood the impacts of land degradation) land degradation has a meaning, which LADA implementing technical staff on the ground need to be able to capture, ...
Raul Ponce-Hernandez

Selecting indicators carefully

Indicators could work in providing a realistic picture of land degradation in drylands – however, care most be taken in their selection.
Raul Ponce-Hernandez

Broad issues and categories for indicator development

Eight broad categories for indicators are proposed by Philippe Mahler: accumulation of salts, wind erosion and sand deposition, water erosion, waterlogging, depletion of natural vegetation cover, biodiversity and soil carbon, degradation of land or soil productivity, land pollution, and poverty. The full contribution can be read at:

ftp://ftp.fao.org/agl/emailconf/lada/lada4_mahler_philippe.htm under his first contribution for Theme 4. Also see summary notes in Theme 2 under "Some proposed indicators and methods".

José Benites provided a set of key issues and clusters about which indicators specifically for drylands may be developed. The following three clusters, followed by issues, were suggested:

1. Diversity and intensity of land use: resource availability, availability of fuel wood, and decreased water supply;
2. Soil and surface water quality: inappropriate soil management strategies
3. Societal commitment and response: policy environment unsympathetic to conservation and lack of awareness.

Various land degradation indicators for drylands are recommended for each of these clusters. They can be read at: ftp://ftp.fao.org/agl/emailconf/lada/lada4_benites_jose_attachment.htm .

Need for standard definitions

... it is necessary to identify relevant set of indicators for each land degradation problem category and, for each indicator, to adopt standard definitions and, where feasible and needed, classes to qualify and quantify the indicator.

Philippe Mahler

Need to build upon existing national to local capacity

From here on, suggested indicators and attributes must be matched against the reality of existing statistics and other data sets, ...

José Benites

José Benites (FAO) provides a number of priorities to help ensure that indicator development builds upon (and strengthens) existing national to local capacity. Extracts follow:

- *Develop methods to increase usefulness of available data ([e.g., census, ...])*
- *Increase reliability of national census, timeliness and data quality ([e.g.,] special census…)*
- *Increase ... modules for on-farm land management in the national census to collect necessary data…*

José Benites

Routine monitoring may be premature in the LADA context; need for a baseline policy support tool first

Discussing ... how to start a routine multi-level monitoring of land degradation would open a kind of Pandora box which would unduly prolong the discussions on indicators.

Philippe Mahler

While monitoring should be kept in mind as a logical follow-up, elaborating a monitoring scheme ... already now may be premature in a number of countries: most users will be convinced on the need for monitoring when and only when the results of a thorough baseline assessment are available.

Philippe Mahler

Information dissemination

Danger of distributing preliminary products

I find the idea of providing some information or intermediate products ... pretty dangerous. ... It is my experience ... [that intermediate products] in the hands of policymakers often become actual degradation assessments on which policy will be based. If such material is made public there will also be a lot of confusion once final products tell a different story.

David Niemeijer

Annexes

Annex 1
Invitation to the LADA E-mail conference

This is to announce an International Electronic Mail Conference on the subject of **Land Degradation Assessment in Drylands (LADA)**, in which your participation would be highly appreciated.

Background material on the LADA project, documents and results of the project until now are to be found on the Internet at the following site:

http://www.fao.org/landandwater/agll/lada

LADA is an international partnership project in support of the UN-CCD, funded mainly by GEF and FAO, implemented by UNEP and executed by FAO with significant contributions by the Global Mechanism of the UNCCD, MA, WRI, ISRIC and national institutes in several pilot countries.

The objective of this Electronic Mail Conference is to take stock of available land degradation assessment methods at global, national and sub-national scales and exchange expert views in order to arrive at a broadly agreed practical land degradation assessment methodology, to determine a minimum set of biophysical, socio-economic and institutional root causes, driving forces, factors and indicators involved, their applicability at different scales as well as the economic feasibility of monitoring them, particularly in dryland situations.

The conference will be moderated by Ms Mathilde Snel, supported by the FAO LADA task force. It will run in the first instance from Tuesday, 7 October until 8 November 2002 and will then become a continuing forum on the LADA Web site.

If you wish to participate, please send an e-mail message to mailserv@mailserv.fao.org leaving the subject blank and entering in the first line of the message body the command: subscribe lada-l.

This message is sent to more than 1 000 well-known experts in various fields related to land degradation and desertification, but do not hesitate to send it on to colleagues we may have forgotten.

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Annex 4
Introductions, discussion items and questions sent ot participants for each week's theme

Week 1. Land degradation assessment methods, indicators and conceptual frameworks

Land degradation is a complex process involving a diversity of biophysical as well as socio-economic factors that largely vary in their spatial and temporal dimensions. A key objective of LADA is, therefore, to develop a framework for land degradation assessment that accommodates these information sources in order to support policy makers and stakeholders in their evaluation on future land use scenarios. The LADA project aims to operationalize this framework at a national scale, the level where most policy decisions concerning the land use take place and where the portfolio of environmental action plans is administered. This exercise should also lead to methodologies that will be applicable at a global scale.

The development of such a framework includes a reconnaissance phase in which tools, methods, and indicators are identified that evaluate the state and causes of land degradation. Indicators on the degree and impact of land degradation should clearly reflect the stakeholders' opinion on criteria of land performance, while causative indicators will be used to explain the degradation process in its geographical dependence on biophysical variables and land management practices. Land degradation assessment methods at the national scale should aim for a balance between data availability and applicability. Therefore, the LADA project is considering the use of interpolation and redressing techniques that maximize the use of existing information (e.g., in national census or household surveys), while maintaining a cost-efficient, timely routine assessment.

The first week of the LADA email conference starts with a request to provide input on methods that may used for land degradation assessment. We anticipate that various participants have important insights on, and experiences with, a variety of land degradation methods. We shall be grateful to hear of your triumphs (and challenges) in using such methods.

Since this email conference has as a major goal the development of feasible land degradation indicators, please share your views on the usefulness (or not) of indicators. Do you feel that the use of indicators will adequately help assess land degradation? If so, why? If not, what alternatives would you propose? We also submit for discussion a draft Driving force-Pressure-State-Impact-Response framework that is envisioned to help in global and national land degradation assessment. Is such a framework helpful in achieving the LADA objective to develop a replicable and easily usable methodological framework for land degradation assessment? Are there alternative frameworks that you think may be more useful?

We welcome feedback and suggestions and thank you in advance for your input.

Discussion items and questions

1. A main objective of LADA is to develop tools and methods to assess land degradation. What types of methods do you propose may be used to assess land degradation? These methods need to be able to integrate biophysical, socio-economic and institutional aspects of land degradation at differing scales. A review of some methods can be downloaded at:

   ftp://ftp.fao.org/agl/agll/ladadocs/redameth.doc .

2. Are indicators useful to evaluate land degradation? If so, why? If not, what alternatives do you propose? Can indicators sufficiently capture the dynamics and interactions with regards to agroecological, socio-economic, and cultural processes, as well as to human decision-making processes, knowledge differentiation among stakeholders, and issues of perception? (e.g., at local, technical and policy levels on degree, impacts, and causes of land degradation and opportunities to reverse land degradation).

3. LADA proposes a Driving force-Pressure-State-Impact-Response (DPSIR) framework to evaluate land degradation. Do you find this framework useful? What advantages and disadvantages do you envision with the use of such a framework?

   The draft DPSIR framework can be downloaded at:
   ftp://ftp.fao.org/agl/agll/ladadocs/dpsir.doc .

Week 2. National land degradation assessment

Lack of information on land degradation at the national level has stifled many efforts to arrest a further decline of lands' productivity. Decision makers voice that information is lacking on *where* land degradation is occurring, *why* it occurs, and *how* it may be reversed. Based on our discussion last week, participants noted that while indicators may be used to help provide information on land degradation, such indicators need to be selected and used with great care. Therefore, this week participants are invited to take on this challenge and identify a minimum set of Land Degradation Indicators (LDIs) that may be used at the national level to assess the degree of land degradation (i.e., *state* indicators); explain the underlying causes (*pressure* indicators); and describe efforts to reverse land degradation (*response* indicators).

Please specify for each suggested indicator: the data required, a description of each data set, the proposed data collection method(s), data availability, applicability to agro-ecological zones (or other conditions, such as kinds of land management), and critical thresholds. Ideally the proposed indicators should be based on existing data (e.g., national agricultural census or farmer surveys). If, however, you propose to collect new data sets we would like you to consider the cost-effectiveness of conducting such a survey. Since LADA aims to develop a practical methodological framework for routine national land assessment, preference should be given to using data collection methods that have a solid scientific base (are replicable and quantifiable) and that are economically feasible. Furthermore, we encourage suggestions on using modelling to predict changes for proposed indicators. We will appreciate your attaching articles that may provide further detail on the indicators and methods proposed. Please refer to your own experiences (successes and failures) in providing input to these issues.

As a follow-up to this discussion, next week's theme will be the utilization of local data, knowledge and descriptive studies. We will discuss how these information sources can be used

to (1) strengthen our understanding on the underlying causes of and responses to land degradation and (2) to test our national assessments. Furthermore, we will discuss methods that may be used to link data that are collected at the local level with national land assessments.

We look forward to your feedback and thank you in advance for your input.

Discussion items and questions

1. A set of criteria are indicated below that may be used to help select a minimum set of key indicators for national land degradation assessment. Are there other criteria that you feel should be added? Alternatively, is this list too restrictive?
   - the indicators should ideally be based on existing data
   - if new data are collected, cost-effective methods should be used
   - robust measurements – that provide replicable results – should be used
   - data need to be routinely available or collected
   - indicators need to be clearly defined
2. What are the most important indicators that can be used to assess the status of land degradation in drylands for national level assessment?

   Where applicable, please refer to your own experiences (successes and failures). Please list for each proposed indicator:
   - data required
   - description of each data set (e.g., soil, soil carbon, climate, water, vegetation, biodiversity, economic productivity, institutional)
   - data collection method(s) (e.g., sampling, remote sensing, …)
   - data availability

   Relevance general or only for a specific AEZ, farming systems or other category
   - critical thresholds if applicable
3. What key (minimum) indicators can be used to explain the underlying biophysical, socio-economic, and institutional causes of land degradation for national-level assessment?

   Please list proposed indicators according to their importance and complete for each indicator the sub-questions mentioned under question 2.
4. What key indicators can be used for national level assessment of responses to reverse land degradation?

   Please list proposed indicators according to their importance and complete for each indicator the sub-questions mentioned under question 2.
5. How feasible do you feel it would be to routinely collect data for these indicators towards developing a national monitoring network that regularly (e.g., bi-annually) monitors and informs on land degradation?

Week 3. Local indicators and assessment

Land degradation varies for each location under different land management practices. Therefore, land degradation assessments at the national scale – the intended main focus of the LADA project – should be verifiable and based on observations that are obtained at the local level. Then, policy and decision makers can compare and build on results of national assessments to formulate locally explicit recommendations towards arresting further land degradation.

In last week's discussion several key Land Degradation Indicators (LDIs) for national land degradation assessment were identified. Many of the proposed indicators are based on existing or easily obtainable data (e.g., soil organic carbon and soil moisture), although these need to be verified in the field. Furthermore, new data sets for which no data currently exists (land use, access to land and water, input/output relations, etc.) need to be collected at the local level. This week, participants are invited to provide input on *what* types of local level data sets (especially socio-economic) are scarce or non-existent but need to be integrated in national land degradation assessments, and *how* these data sets can be cost efficiently and reliably collected. Where possible please indicate what types of stratification and sampling strategy can be used (e.g., to account for varied agroecological systems and land use management schemes). Once collected, how can these data sets be linked with national level assessment? For example, one method that is gaining respect (e.g., in the realm of poverty mapping) has been the use of a small area estimation technique that links national census data and local surveys (e.g., farmer surveys). Do you feel this method would be useful to LADA? Are there other methods that you feel may be helpful?

A second theme to be addressed this week came up several times during the discussions so far: the need to strengthen national-level assessment (that tends to rely on robust methods and quantifiable data) with local descriptive evaluations (that more extensively explain the underlying causes and consequences of land degradation over space and time). In particular, such descriptive evaluations can help disentangle some of the complex linkages between the causes of land degradation and the consequences (socio-economic, institutional, etc.) – a key challenge to scientists developing land assessment methodologies. Such local evaluation can also provide a rich understanding on *why* land degradation is occurring (e.g., due to institutional policies, cultural practices, gender roles, poor access to information and technology, lack of democracy, etc.). How can local descriptive evaluations be cheaply, easily and regularly integrated in national assessment? Would it, for example, be useful to routinely conduct descriptive evaluations in identified hot spots –severely degraded areas– and bright spots –showing improvement or resilience– ?

Please refer to your own experiences (successes and failures) in providing input to the above noted issues. We thank you in advance for your feedback.

Discussion items and questions

1. What types of issues need to be evaluated at the farm or community level to gain a better understanding of:
   - the underlying socio-economic, institutional, and biophysical causes of land degradation?
   - responses to cope with land degradation?
   - the degree of land degradation?

2. Based on the above key issues, which data sets (especially socio-economic) are scarce (or non-existent) that at the minimum need to be integrated in national land degradation assessment (e.g., land use data and precise land management information)? Please describe how such data sets may be collected cost-effectively and reliably. Where possible, indicate stratification, sampling, and other relevant issues.

3. What types of methods do you feel can successfully be used to link local data and information with national-level land degradation assessment? Do you feel a small-area estimation approach may be useful? (see short explanation in the above text)[1]

4. Local analytical studies on land degradation often describe the underlying socio-economic, institutional, and biophysical circumstances that contribute to land degradation in great detail and with very specific information. How could these descriptive studies be integrated in national land degradation assessment? Would it be feasible, for example, to routinely conduct participatory rural appraisals (or similar methodologies) within identified land degradation hot spots and bright spots?

Week 4. Global land degradation indicators, network for drylands, and next steps

Land degradation is recognized as a global problem and is a major focus of such international conventions as the Convention to Combat Desertification (CCD) and the Convention on Biological Diversity (CBD). Obtaining a thorough understanding of the current condition of the world's drylands and the causes and consequences of its degradation is a key objective of LADA. During the past weeks we have discussed various indicators (and key issues in developing such indicators) that can be used for national land degradation assessment. How can sub-national data – upon which such national assessments rely – be generalized to the global level and what does this imply for the harmonization of methods at the local level? Could the use of existing global data sets containing sub-national information be complementary[2]? Conversely, can the sub-national information in this growing number of global data sets be used to help strengthen national assessments?

This week's agenda has been broadened to discuss next steps to help LADA further identify key indicators and methods for land degradation assessment. This may include the development of user assessments to identify key questions, and the subsequent identification of indicators, collection of data, manipulation of data (e.g., through the use of models), etc. Please find

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[1] More information on the small-area estimation approach: i) Hentschel, J., Lanjouw J., Lanjouw, P. and Poggi, J. (2000). Combining Household Data with Census Data to Construct a Disaggregated Poverty Map: A Case Study of Ecuador. *World Bank Economic Review* 14 (1): 147-165 :

http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/1998/06/01/000009265_3980709144909/Rendered/PDF/multi_page.pdf

and ii) Keyzer, M.A. (2002). *Kernel learning for poverty mapping: an introduction*. Centre for World Food Studies of the Vrije Universiteit. Staff Working Paper no. 02.08. Vrije Universiteit, Amsterdam, http://www.sow.vu.nl/pdf/wp02-08.pdf.

[2] See, for example, global sub-national data sets posted on: http://www.usgs.gov/, http://www.grida.no/db/maps/prod/level0/, http://lime.isric.nl/index.cfm?contentid=236, http://www.ciesin.org/sub_guide.html, http://www.fao.org/geonetwork/srv/en/main.search, http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGL/agll/gaez/index.htm, http://www.fao.org/catalog/book_review/giii/w7189-e.htm,and http://www.fao.org/forestry/fo/fra/maps.jsp?lang_id=1.

attached a draft outline on Next steps for LADA (Annex 5) to begin this week's discussions on the subject. We would be interested in getting more feedback from participants on this and other proposals how LADA should develop a methodological framework to cost-effectively and routinely monitor land degradation, and to help decision makers develop policies to arrest land degradation.

With the development of national capacities to monitor land degradation and to design policies to combat land degradation, how could such national operations benefit from, and contribute to an international network for dryland assessment? What should this network's role be? Would it be helpful if a main role of such a network would be to act as a data repository of national and global land degradation assessment?

Discussion items and questions

1. How can national land degradation assessments be generalized from the sub-national to the global level? If countries are using different variables to measure and assess land degradation over space and time, is such transformation feasible? If not, what alternative methods can be used to assess land degradation at the global level?

2. What are your reactions on some of the proposed next steps for LADA. Do you feel these proposals are feasible towards developing routine monitoring of land degradation for drylands? If so, why? If not, what type of refinements do you propose?

3. What are your thoughts on the feasibility of developing a network for dryland assessment? What should be the role of this network? Should a key role of such a network be to serve as a data repository of national and global land degradation assessments?

Annex 5
Next steps for LADA: draft outline for discussion

Stage 1 : User needs assessment and National stakeholder meeting

- identify key issues in political and economic terms: goods and services approach

Stage 2 : Inventory

- identify and collect existing data sets; review biophysical data (e.g. available radar and satellite images for land cover mapping) as well as socio-economic data
- identify important missing data sets (e.g. socio-economic)
- identify indicators (geared to user needs)

Stage 3 : Implementation

- use appropriate stratification and sampling (more in hot spots) in a baseline assessment for a monitoring scheme
- develop models – including models to link biophysical and socio-economic data

Stage 4: Analysis of results

- determine cause, state, and effect (frame data within the DPSIR framework)
- conduct participatory local surveys in hot and bright spots to help formulate policy recommendations
- discuss results with stakeholders

Stage 5: Dissemination of results and Policy recommendations

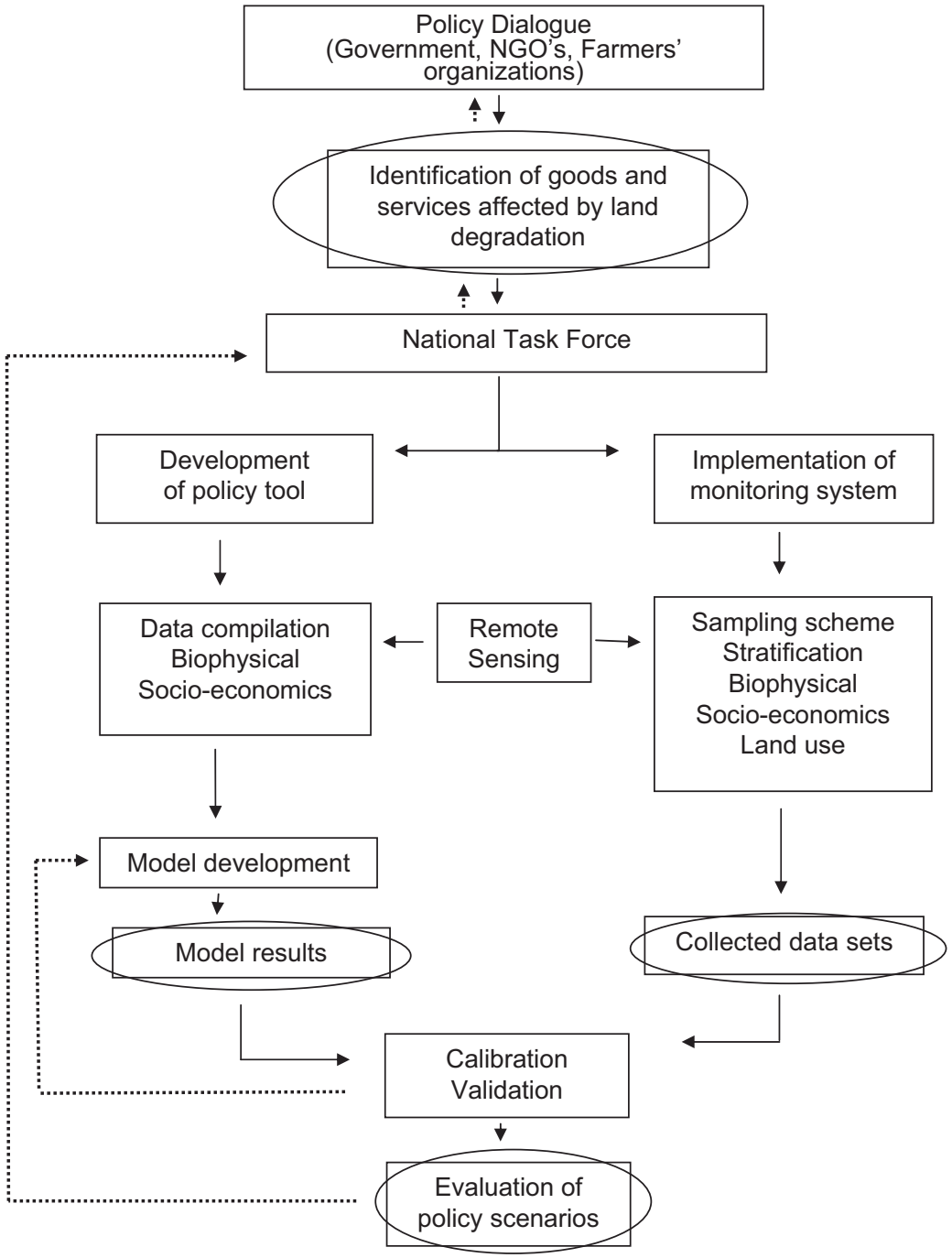
- link results with solutions and policy recommendations
- disseminate results (e.g., meetings with policy makers, brochures, etc.)

Stage 6: Monitoring and evaluation

- repeat

The Figure A5.1 outlines the basic steps and the relationships among them in some more detail.

FIGURE A5.1
Scheme of basic steps in LADA



Squares = actions; ovals = output; dotted line = recursive evaluation.

Annex 6
Land qualities and potential indicators for land degradation assessment of dryland areas

Introduction

This paper presents an overview of land qualities and lists of biophysical and socio-economic indicators potentially useful in the assessment of land degradation in drylands. A wide range of indicators may be needed for the assessment of land degradation, its direct and underlying causes, its effects on livelihoods and the promising remedial or preventive approaches. In contrast, the assessment of the nature, severity, extent and distribution of different kinds of land degradation, generally based on mapping techniques, will require restriction to a small number of indicator variables. These may be intrinsic or may be proxies, validated within a specific range of agro-ecologies or socio-economic conditions.

Tables A6.2–5 appended to this paper list potential indicators for use at four scales: global, national and regional, watershed or village, and farm. The indicators are subdivided into biophysical, demographic, institutional and socio-economic groups. The position of each indicator in the DPSIR framework is indicated. Tables A6.6–10 provide annotated, more detailed lists and selected references on socio-economic and institutional indicators, organized by main issue: insecurity, incapability, lack of opportunity or income, disempowerment, and lack of incentive or inadequacy of policies.

Background

Dryland systems are under threat from a combination of socio-economic and biophysical changes that are culminating in a downward spiral of land degradation. The lack of reliable and comparable information on land degradation in drylands has been a major constraint to the implementation of Rio Conventions, particularly UN-CBD and UN-CCD.

The root causes, and at the same time consequences, of land degradation and desertification are often poverty and food insecurity combined with harsh climatic events such as drought. This leads to excessive pressures on often fragile ecosystems, the natural resource base, and the adoption of resource depleting survival strategies by the land users.

One of the immediate causes of land degradation is inappropriate land use, including overgrazing, excessive irrigation, and intensive tillage and cropping. The resulting degradation of soil, water and vegetation cover and loss of both soil and vegetative biological diversity affect ecosystem structure and functions. The primary driving forces of land degradation are policy and institutional distortions or failures in the public or government, private or market, civil or community sectors, as well as civil strife.

At global and eco-regional scales, land degradation results in the degradation and loss of unique ecosystems and their endemic components of biodiversity, and the breakdown of traditional livelihood systems. It threatens especially culturally unique agro-pastoral and silvo-pastoral farming systems, and nomadic and transhumance systems. Its consequences are widespread poverty, hunger and mass migration, requiring emergency assistance on an unprecedented scale and frequency, and creating a potential cycle of debt and indebtedness for the affected populations. The nature of interrelationships and thresholds between these technical, institutional and policy factors at different scales and in their temporal dimensions are still poorly understood.

Land qualities to be taken into account in assessing land degradation

Dryland degradation often starts with crop expansion into ecologically fragile zones and poor soils not suitable for sustained cropping, and formerly used by herders or acting as a buffer zone between farmers and herders. As long as the carrying capacity of the land is not exceeded, sustainable land use is possible. A solid vegetation cover can be kept and precipitation infiltrates into the soil, remaining available for vegetation.

However, if land use pressure exceeds the carrying capacity, the ability of the vegetation to recuperate decreases. Unprotected soil is very vulnerable to slaking, which will entail increased runoff, diminishing the availability of water for biomass production. Moreover, the higher albedo of bare soils results in lower surface temperatures because of higher reflection. This results in reduced cloud formation and thus decreased rainfall. The final result is accelerated degradation.

The processes causing or accelerating dryland degradation are varied but can be reduced to the following four:

- Cropland management or cropping practices damaging the land
- Deforestation
- Overgrazing
- Irrigation systems or practices inappropriate to the land conditions

These processes are often interlinked and have multiple consequences. Still some disagreement exists about the root causes of dryland degradation: whether it is climatic change leading to severe droughts or increased human activity in sensitive areas. However, it must be kept in mind that human activities, when badly managed, aggravate the consequences of drought.

Land degradation may take six different forms, all of which lead to loss of soil productivity:

- Erosion by water
- Erosion by wind
- Salinization and sodication
- Chemical degradation (including nutrient depletion)
- Physical degradation (including compaction)
- Biological degradation

Soil degradation can be defined as a process that reduces the actual or potential capacity of the soil to produce goods or services. Land degradation refers to a loss of intrinsic qualities or a decline in the suitability for one or more specific uses.

A number of land qualities therefore need to be evaluated in order to assess the degradation status of the land under consideration.

Land cover

Land cover can be described by using the eight major land cover types as developed in LCCS (Di Gregorio and Jansen, 2000). Not all eight are relevant for dryland systems, but the fact that this classification is widely accepted will facilitate comparison at global and national scales. Each land cover type is described by a number of "pure" land cover classifiers, describing the nature, extent, density, etc. of each cover.

Landform

Landforms refer to the shape of the land surface. They should be described by their morphology, and not by their genetic origin or the processes responsible for their shape. The dominant slope is therefore the most important criterion, followed by relief intensity.

Soil qualities

A description of the soil surface in bare areas should give a good idea of the ability of the soil to allow water to infiltrate or of the presence of shifting sands or hardpans. For instance, the slaking of the aggregates at the soil surface by rain impact leads to formation of a dense crust, and partial sealing of the pores in the soil by the detachment and washing in of soil particles.

Soil profile description will give additional information on the behaviour and properties of the soil, especially the occurrence of compacted layers, macropores from macrofauna and discolouration of certain layers. Systematic description of the soil profile needs expert observation, and a number of databases are available. Alternatively, a method developed by ICRAF can be used: The reflection spectrum of bare soil is measured and compared to spectral libraries. These spectral libraries are constructed from soils sampled from georeferenced locations, for which a soil fertility index is calculated from the following variables: pH, clay, silt, ECEC, Ca, Mg, K, P, organic C and mineralizable N. The association of specific reflection spectra with value ranges of the soil fertility index is then used to map soil quality and soil constraints for larger areas on the basis of remote sensing imagery.

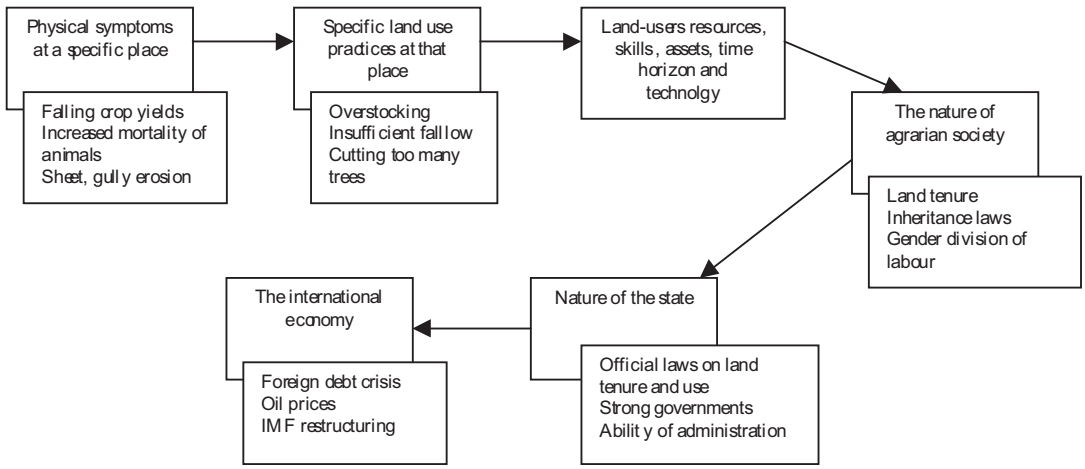
Reasons and effects of land degradation

It is essential to understand the question why degradation has occurred before any control measures and restoration actions can be designed. Figure A6.1 shows a suggested chain of explanation.

The conditions faced by farmers are remarkably diverse. The options available to poor farmers to improve their land are much more constrained than those available to richer farmers, who have easier access to labour, livestock, land, credit and cash. Even within a single farm, the management of land may vary considerably between different fields. Typically certain fields tend to receive far greater concentrations of labour and nutrient inputs, while others are more extensively managed.

At village level, issues include the different kinds of land available, the overall pressure on farmland and its availability, access to grazing and forage resources, the importance of labour

FIGURE A6.1
Chain of explanation of causes of land degradation (after Blaikie, 1989)



flows between households, as well as location in relation to markets. At the national level, factors of relevance relate to macro-economic policy, input-output price ratios, access to credit, institutions and legislation regarding tenure and land management, approaches to research and extension policy, markets and infrastructure.

The diversity at different scales has important implications for how land degradation is assessed, and still more important, for how best to support land users in improved management of their land resources. This diversity has major implications for design of technical options, extension approaches and policy frameworks.

Soil erosion provides a clear example of such diversity. Erosion is a natural phenomenon. However, in the assessment emphasis should be given to accelerated or human-induced erosion. Most erosion can be classified as water or wind erosion or deposition. Mass movement can be seen as another major category. Erosion can be further classified according to its severity and details of the process.

Land degradation by erosion has effects at the site of the detachment as well as downslope or downstream, where the excess water and soil from the detachment area may cause flooding and sedimentation (off-site). Therefore the effects of land degradation should be assessed both locally and within the watershed or village area as a whole, and be related to social, cultural and economic aspects.

On-site effects of land degradation

The process of land degradation usually starts with a decrease in organic matter content of the top layer of the soil. This results in a rapid decline of biological activity in the soil. A deficit in the humus balance leads to destabilization of soil aggregates and a reduction of soil fertility. Macropores are filled or collapse, and infiltration rate and water-holding capacity are drastically reduced. Less vegetation can be sustained and more bare soil will be unprotected from the impact of rain or wind.

The most important on-site effect of land degradation is a gradual decrease in soil fertility, soil productivity and eventually crop yield and animal productivity. Land degradation is more damaging to the quality and productivity of some soils than others. The effects on productivity depend largely on the thickness and quality of the topsoil and on the nature of the subsoil. Many soils are shallow or have some undesirable properties in the subsoil that may adversely affect yields. Productivity will decrease as the topsoil becomes thinner, or as water storage capacity and effective rooting depth are decreased. Chemical imbalances may occur because of the mixing of the topsoil with subsoil material, which may be more acid or less fertile.

Off-site effects of land degradation

The greatest single pollutant of surface water, on a volume basis, is soil sediment. It reduces the value of streams for home and industrial use, for recreation and as habitats for fish and wildlife.

Nutrients and pesticides washed or leached from the fields may also cause pollution problems when they reach streams or other water bodies. High levels of nutrients in water induce rapid growth of algae, reducing the available oxygen in water as well as releasing certain toxins. Soil sediment, nutrients and pesticides increase the costs of water purification for public water supplies.

As less water can infiltrate on degraded land, more rainwater will disappear as runoff. The result is that serious downstream flooding is more frequent, resulting in destroyed crops, lands, infrastructure and buildings, and in killing people and animals. Fertile and productive soils can be spoiled when thick layers of coarse sediment are deposited on them (by flooding or as wind-blown sands). Sediment is also deposited in reservoirs, lakes and streams, which leads to reduced storage capacity, reduced power generation, increased costs and reduced habitats for biodiversity.

Indicators

Indicators are statistics or measures that relate to a condition, change of quality, or change in state of something valued (Dumanski and Pieri, 1996). They provide information and describe the state of the phenomena of interest. Indicators of land quality are statistics that report on the condition and quality of the land resource, but also on the cause-effect relationships that may result in changes in quality and the responses to these changes by society. If a number of indicators is reduced by aggregating them according to some formula, then these are called indices. Indicators differ from other statistics (processed raw data) in their significance to a specific problem.

As the project aims at identifying driving forces and impacts of land degradation at different scales, the indicators are classified accordingly: usable at global, national, agro-ecological zone or farming system scale. Indicators at different scales need different degrees of detail; for instance for problem identification and awareness raising, general descriptive indicators are needed. Strategy, policy or project formulation require more detailed indicators, also focusing on the causes of a certain problem and on projections of impacts (modelling, scenarios, benefit/cost and multicriteria analysis) so that effective and realistic responses can be formulated. For the actual implementation of policies related to land quality, national goals and targets need to be established as well as local ones, which need more quantitative indicators. At this stage the social and economic context becomes more important. To evaluate the effectiveness of policies and actions, quantitative indicators are needed that illustrate how the situation has changed in relation to the goals and targets. Assessment activities should preferably be formulated together

with users (or even better upon request of users) in order to create more direct links between users and producers of information.

Land quality indicators are needed to address major land-related issues of national and global significance, such as land degradation in dryland areas, as well as policy-related questions on sustainable land management. Land quality indicators report on the biophysical condition of land, but indicators are needed as well on how the land is being managed and on the policy and social environment, which may facilitate improvements in land management or give rise to practices that foster deterioration.

A so-called DPSIR (Driving forces-Pressures-State-Impacts-Responses) framework (Table A6.1) is one of the approaches that can be used to structure and classify information and to assist in the identification of the key set of indicators that best describe how farmers and other land users are managing their land and the impacts of this management. The DPSIR is a convenient representation of the linkages between the pressures exerted on the land by human activities, the change in quality of the resource, and the response to these changes as society attempts to release the pressure or to rehabilitate land that has been degraded. The interchanges among these form a continuous feedback mechanism that can be monitored and used for the assessment of land quality.

TABLE A6.1
Types of indicators in a DPSIR framework

Driving forces
Indicators in this group include those activities that may (in)directly cause the problem.
Pressure indicators
Indicators in this group include those activities that may (in)directly result in an increased pressure on the natural resource.
State indicators
State indicators reflect the conditions of the land as well as its resilience to withstand change.
Impact indicators
Impact indicators describe the effect and impacts of the increased or reduced pressure on the natural resource. Impact indicators or change indicators measure change in either positive or negative direction (degradation or improvement). They are needed by land users to guide them in their decisions on the management of their land and water resources and inputs.
Response indicators
Response indicators include those mechanisms which are normally achieved through direct actions by the land users themselves to release the pressure from the land. In rare instances environmental regulations may be necessary to effect proper control of land degradation.

Land degradation and the resulting environmental problems are predominantly induced by human activities. Only when the causes and the impacts of the resulting pressures on the system are known can adequate responses be formulated. To qualify and quantify the driving forces, pressures, state, impacts and responses, indicators need to be found that adequately represent the various aspects of the complex situation.

The challenge is to find those core indicators that are sufficiently representative and at the same time easy to understand and measure on a routine basis. Indicators should be SMART: specific, measurable, achievable, relevant and time-bound (Schomaker, 1996).

In the case of LADA, indicators may help to make an assessment and to develop baseline information and undertake monitoring. These activities serve two purposes:

- to detect and identify the type of degradation and assess its severity; and
- to determine and analyse the cause-effect relationships involved with a view to identifying trends and taking remedial action.

Indicators for the first purpose may be used to assist in relatively simple and factual assessments at any scale. Appendix tables 2-5 may be of use in this regard. The potential indicators to be used for the second purpose, e.g. in a DPSIR model, are more numerous and complex. Their relevance and the feasibility of their use tend to decrease from local to global scales: diagnoses and interpretations are easier to develop locally, whereas the generalizations required at national or global scales make the use of indicators more problematic. Appendix tables 6-10 contain material that may be useful in the assessment of the causes of land degradation, its impacts and possible corrective or preventive responses.

In the assessment of the cause-effect relationships in land degradation, the two functions of humans need to be taken into account: people are both agents and victims of land degradation.

The use of indicators for LADA

- Several issues need to be considered in deciding on the usefulness of indicators for the LADA project:
- The systematic assessment of current land uses can be hampered by too many detailed data that are difficult to interpret, lack baseline information from which to compare change, or are inconsistent over time or over the geographic area (USDA, 1994).
- As natural resource variables generally change slowly, particularly the soil-related ones, the monitoring interval for identifying trends in relevant indicators may well need to be as long as a decade. This time span can possibly be reduced by using proxy indicators and relating them to existing historic data.
- Because of the dynamic aspects of land management, a flexible and adaptive process approach is essential for monitoring the quality and quantity of land resources (water, soil and plant nutrients) and for determining how human activities affect these resources and how their activities are affected by land degradation. For example, as the natural resource base is being degraded, first the proportion of palatable species in grazing lands tends to be reduced. There may be increasing stock movement; the amount of open water (ponds) or flow rates of boreholes may be diminishing; the carrying capacity will be reduced, resulting in a decrease of cattle relative to small ruminants. Less cattle may be available for agricultural activities such as ploughing and thus a shift from two-oxen to one-ox ploughs may take place.
- To avoid dangers of aggregation, the focus of the assessment should be on the diversity and dynamics of the systems. Key questions will be:
  - What factors result in land improvement or decline?
  - What pathways of change are evident and how are these linked to broader livelihood strategies?
  - What institutional and policy factors are important to encourage more sustainable strategies in different settings?
- Most important when using indicators is the question: “Does the change in the particular indicator chosen really matter”? (Scoones, 2001)
- It may be useful to define the significance of indicators in the context of specific major agro-ecological zones and specific ranges of socio-economic conditions.
- For the assessment at farm, village or watershed scale an effective communication channel needs to be constructed jointly by land users and technicians so that they will understand

each other's language and concepts. Local indicators derived from an intuitive integration of changes of land quality need to be translated into scientifically used terminology to allow aggregation at national and international scales (Barrios *et al*. 2001).

- National assessments and monitoring should permit future refinement of the assessment at a global scale.

Conclusions

This brief paper and the appendix tables of indicators already show the dimensions and complexity of the use of indicators for LADA. It now appears urgent to address the questions how indicators should be used in LADA methodology, and for what purposes; and to concentrate on what is feasible.

In the case of LADA, indicators may help in making an assessment as well as in the establishment of baseline information and subsequent monitoring. These activities have two distinct purposes:

- to detect and identify the type of degradation and assess its severity; and
- to determine and analyse the cause-effect relationships involved with a view to identifying trends and taking remedial action.

Indicators for the first purpose may be used to assist in relatively simple and factual assessments at any scale. The potential indicators to be used for the second purpose, e.g. in a DPSIR model, are far more numerous and complex. Their relevance and the feasibility of their use tend to decrease from local to global scales: diagnoses and interpretations are easier to develop locally, whereas the generalizations required at national or global scales make the use of indicators more problematic.

Detecting and monitoring changes in land degradation, which are usually gradual, is more demanding in terms of quantification and replicability (standardization) than a one-time assessment. It would be useful to identify which indicators could be used as qualitative indicators and which require semiquantitative estimation or precise measurement.

Another consideration complicating the use of indicators for environmental assessments is that indicators may in a sense be a negation of the diversity of ecosystems. When an indicator is used as a common yardstick to measure and monitor one element in different ecosystems or socio-economic conditions, it may be a source of misunderstandings and misinterpretations. In the case of land degradation, natural and human-induced processes are often inextricably associated (e.g. salinization, erosion, sand deposition) and an indicator may not have the same weight or relevance in different environments.

Acronyms

DPSIR	Driving force-Pressure-State-Impact-Response
CIAT	International Center of Tropical Agriculture
FAO	Food and Agriculture Organization of the United Nations
LADA	Land Degradation Assessment in Dryland Areas
UNCBD	United Nations Convention on Biological Diversity

UNCCD United Nations Convention to Combat Desertification
UNEP United Nations Environment Programme

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Appendix
Tables

Tables A6.2–5 list potential indicators for use at four scales: global, national and regional, watershed or village, and farm. The indicators are subdivided into biophysical, demographic, institutional and socio-economic groups. The position of each indicator in the DPSIR framework is indicated. These tables may be useful as checklists –not necessarily complete– of indicators useful in mapping and assessment of land degradation at different scales.

Tables A6.6–10 provide annotated, more detailed lists and selected references on socio-economic and institutional indicators, organized by main issue: insecurity, incapability, lack of opportunity or income, disempowerment, and lack of incentive or inadequacy of policies. The scales at which each indicator may be useful are indicated, as well as the position of each indicator in the DPSIR framework. The tables do not yet include indicators with reference to human health in relation to land degradation (e.g., to soil or water pollution). These tables may be useful as checklists of indicators useful in the assessment of the driving forces and pressures causing land degradation, its impacts on people and society, and the possible corrective or preventive responses.

TABLE A6.2
Indicators at global scale

Indicator	DPSIR
Biophysical	
Land deformation	S
Shifting sands over fertile soils	S
Area affected by salinization	I
Area affected by waterlogging	I
Climate: high-intensity rains	D
Slaking properties of soil	S
Slope, terrain	S
Land cover	S
Loss of topsoil and subsoil	I
Dunes and hollows	I
Acidification	S
Mass movement of soil	S
Compaction	S
Rocks, stones and hard surface layers	S
Dry wells	I
Change of permanent waters into seasonal	I
Siltation of water ways and reservoirs	I
Livestock density	S
Demographic	
Population	S

TABLE A6.3
Indicators at national and regional scale

Indicator	DPSIR
Biophysical	
Drought index	S
Land use and farm management	D
Deforestation	D
Slope, terrain properties	D
Livestock concentration	D
Change in diversity of (wild) annual species	I
Change in diversity of perennials	I
Substitution of woody species by thorny bushes	I
Ratio of cattle or camels to small ruminants	I
Sedimentation of dams and rivers	I
Water harvesting structures	R
Afforestation	R
Percentage ground cover	S
Extreme land surface deformation	S
Soil loss or accumulation	S
Coverage of fertile soils by shifting sands	S
Area affected by salinization	S
Area affected by waterlogging	S
Water quality (turbidity, …)	S
Flooding: severity and occurrence	S
Fuel-efficient technologies	R
Demographic	
Population	D
Gender balance urban and rural	D
Migration	R
Land reform and resettlement policies	P
Institutional	
Research staff and budget	
Research focus on crops rather than on resources	
Information systems available	
Number and role of NGOs	
Legislation on natural resources management	
Replacement of local informal arrangements by rigid legal or administrative rules	
Protected areas policy and existence	
Government subsidies on resource management	D/R
Socio-economic	
Land tenure, ownership rights, access to land	D
On-farm and off-farm income	D
Unemployment rate	D
Input-output price relationships	
Location and type of input and output suppliers, traders and markets	
(Rural) infrastructure investment	
# HIV/AIDS affected people	D
Conflicts and violence	D
Dependence on public relief or emergency aid	I/R

TABLE A6.4
Indicators at watershed or village scale

Indicator	DPSIR
Biophysical	
% of irrigated area	D/P
Drying of wells and water sources	I
Change of permanent waters into seasonal	I
Dying trees at river banks	I
High salt content of surface water	I
Adoption of soil conservation technologies	R
Protected areas	R
Number of water harvesting structures	R
Amount of water stored in check dams	R
Reclamation of wastelands	R
Water quality/turbidity/ algal blooms	S
Seasonal water fluctuation in rivers	S
Flooding and meandering of rivers and streams	S
Bad smell of water: surface and groundwater	S
Fragile sites (ponds, creeks, wetlands)	S
Area affected by salinization/waterlogging	S
Ground water salinization	S
Water table depth	S
Coverage of fertile soil by shifting sands	S
Occurrence of dust storms	S
Water shortage	S
Main fuel source	P
Production of charcoal	P
Most important construction material	P
Increasing depth of boreholes	R
Fuel-efficient technologies	R
Demographic	
Population	D/P
Migration	D/R
Institutional	
Replacement of local informal arrangements by rigid legal or administrative procedures	
Number and role of NGOs	R
Degree of people's participation	R
Establishment of committees	R
Availability and frequency of extension services	R
Socio-economic	
Changes in availability of consumer goods in market	
Decline in common property resources	
Occurrence of religious/church/age groups	S
Spiritual beliefs and taboos	D
Employment rate	D
Frequency and violence of conflicts	D
School enrolment	D
Dependence on public relief/ emergency aid	I
Transport problems due to bad roads	P
Installation of water pipes	R
(Seasonal) migration of men	R
Availability and access to credit	R
Access to markets	S
Existence of manure contracts between farmers and herders	S
Value of (standing or cut) grass	S
Amount of meat available in market	
Corrugated iron sheets for roof cover	R
Public telephone/link to Internet	
By-laws on land use and protection	R
Agricultural education	R

TABLE A6.5
Indicators at farm scale

Indicator	DPSIR
Biophysical	
Burning of crop residues	D
Use of by-products	D
Position on the slope	D
Steepness	D
Attitude towards and use of mineral fertilizers	D/R
Use of manure, compost, litter, …	D/R
Farming or grazing intensity	D/R
Shift towards monocropping, mainly grains	I
Cattle or camels substituted by small ruminants	I
Shift from 2-oxen to one-ox plough	I
Yield and change in productivity	I
Indicator plants	I
Availability of supplementary wild plant species	I
Replacement of woody species by thorny bushes	I
Protected areas on-farm	R
Indigenous SWC measures	R
Use of mulch	R
Adoption of soil conservation technologies	R
Area under SWC	
Water harvesting structures on-farm	R
Cropping pattern, cover crops, crop rotation	S
Animal mortality	S
Rooting depth	S
Crusting and slaking properties	S
Soil compaction	S
Exposure of subsoil	S
Main fuel source	D
Construction material (Thatched houses/wood)	D
Institutional	
Membership in committees/associations/groups	R
Participation in Farmer Field days	R
Socio-economic	
Off-farm employment	D
Land/labour ratio	P
Land tenure	P
Manure contracts with transhumant herders or other livestock owners	R
Diversity of diet (meat, legumes, eggs, fish, etc.)	R
Concern about livelihood of children	R
Distance to field	S
Home field or outfield	D
Number of months w. people facing hunger	S
Distance to drinking water	S
Distance to markets	S
Price of transport	S
Availability or access to cart	D
Access to credit and cash	S

TABLE A6.6
Socio-economic indicators related to insecurity

ndividuals – especially in the poorest segments of society - are driven to degrade land and soils because of their necessity to secure basic needs (e.g., provision of food) for their day-to-day survival. Food insecurity, malnutrition, and water depletion, particularly in the event of external shocks and extreme events (e.g., drought), compels individuals to act within shorter-time horizons, exacerbating land degradation.

Food insecurity

- (percentage of) farmers who grow drought resistant crops (N, V, F)[1] (d/p, r) (*)
- (percentage of) farmers without access to cultivable land[2] (N, V) (d/p, r)
- (percentage of) farmers without access to irrigation[3] (N, V) (d/p)
- falling cereal yield trends/decreased yields[4] (N) (s) (*)
- (percentage of) dried wells[5] (V, F) (s)
- food production index (G)[6] (s)
- Value of Production (VoP) per hectare of cropland[7] (G, N) (s)
- changing ratio of staple (subsistence) vs. cash (marketed) crops produced by women and by men (V, F) (i) (*)
- change in food consumption (V, F) (i) (*)
- change in percentage of household budget spent on food (N, V) (i) (*)
- change in quantity of household consumption derived from forest and fisheries products[8] (V, F) (i) (*)
- dependence on public relief and emergency aid (G, N)[9] (r)
- abandonment of (farm) land[10] (V, F) (r) (*x*) (*)

Malnutrition

- amount of meat available in market (V, F) (*x*) (s)
- life expectancy years at birth in years (G, N)[11] (s)
- percentage of rural children under five who are underweight (G, N)[12] (i)
- percentage of rural children who are stunted[13] (G, N) (i)
- percentage of children who are “wasted” (weight for height)[14] (G, N) (i)
- per capita calorie, fat and protein intake (G, N)[15] (i)
- change in diversity of diet (meat, legumes, eggs, fish, etc.)/ frequency of meat, poultry or fish consumption (V, F) (i)
- number of months facing hunger (V, F) (i)
- rural infant mortality rate per 1000 live births (G, N)[16] (i)
- concern about livelihood of children[17] (V, F) (r)

Legend

G: Global; N: National; V: Village; F: Farm
d: driving force; p: pressure; s: state; i: impact; r: response
x: a proxy indicator
*: indicator that links biophysical and socio-economic aspects of land degradation

[1] Drought related indicator (Shyamsundar, 2002, p. 14)

[2] (Bojö *et al., Environment chapter in PRSP sourcebook*, 2001, p. 26)

[3] (Bojö *et al., Environment chapter in PRSP sourcebook*, 2001, p. 26)

[4] Yield trends used in Henninger and Hammond, 2002 rice, wheat, maize and sorghum (p. 17).

[5] (Bojö *et al., Environment chapter in PRSP sourcebook*, 2001, p. 26)

[6] Good indicator since this reflects changes in land and signals food insecurity (Shyamsundar, 2002, p. 20). *World Development Report* (2001, p. 288) includes data on the food production index for 1996-1999 by country.

[7] Data available in FAO’s national tabular data for 1965 – 97 (World Resources Institute, PAGE Agroecosystems, 2000, p. 4).

[8] This indicator emphasizes how poor people rely on natural resources during lean times. Natural resources are often used as a form of insurance to help poor people cope with food insecurity (Shyamsundar, 2002, p. 14 and 16)

[9] Data on Official Development Assistance (ODA) by percentage of GNP or per capita available in the *World Resources Report, 2000 – 2001*, table EI.2. Data on food aid as a percent of total imports available in *World Resources Report 2000-2001,* table AF.3.

[10] (Shyamsundar, 2002)

[11] Used as a measure to assess *labor quality* (Word Bank, 1999 in Wiebe *et al.,* 2000, p. 7). Global data on life expectancy at birth available by country (for women and men in 1995-00 and 1975-80) in WRI, *World Resources Report*, table HD.2.

[12] Global data available by country in WRI, *World Resources Report 2000 – 2001*, table 8.1 (although missing values for several countries!).

[13] Global data available by country in WRI, *World Resources Report 2000 – 2001*, table 8.1 (although missing values for several countries!). See definitions of wasting and stunting in Henninger and Hammond, 2002, p. 7.

[14] Global data available by country in WRI, *World Resources Report 2000 – 2001*, table 8.1 (although missing values for several countries!). See definitions of wasting and stunting in Henninger and Hammond, 2002, p. 7.

[15] Data available in FAO’s Food Balance Sheets (FAOSTAT 1999) and FAO’s World Food Survey (1996) (WRI, PAGE Agroecosystems, 2000, p. 4). Global data on calorie supply (kilocalories) by country available in the WRI, *World Resources Report 2000 – 2001*, table AF.3..

[16] Available at a national-level in the Demographic and Health Surveys by the World Bank and Macro International for some countries (see www.worldbank.org/poverty/health/data/index.htm.). Description of infant mortality in Section 2.7 of World Development Indicators, 2001, p. 69. Global-level infant mortality data available by country (World Bank, *World Development Report 2000/2001*, p. 286).

[17] (Shyamsundar, 2002)

Table A6.6 (Continued)

Water depletion
- annual internal renewable water supply per person (m3) (G) (s)[1]
- hours of available rural water supply (V, F) (s)
- (percentage of) rural households with potable water (N, V, F) (s)
- (percentage of) rural households with adequate water for livestock (N, V, F) (s)
- change in water availability per capita (m3) (N) (i)
- increasing amount of time spent to obtain water (V, F) (i) (*)[2]
- projected annual renewable water supply per person by river basin (G) (i)[3]
- increased distance walked to by household members to collect water (N, V, F) (i) (*)

External shock/extreme event[4]
- number of people affected by drought or other extreme event (e.g., flooding, conflict) [*include specific definition of "extreme event"*] (G, N) (d/p, s)[5]
- presence and frequency of conflict and violence over land resources (G, N, V, F) (d/p, r) (*x*)[6]
- number of deaths due to drought or other extreme event (e.g., flooding, conflict) (G, N) (i)
- number of households rendered homeless due to drought or other extreme event (V, F) (i)
- migration due to drought or other extreme event (e.g., conflict)/number of environmental refugees (G, N) (r) (*)
- stunting before and after external shocks/extreme events/natural disasters[7] (N) (i) (*)

Poverty
- percentage of rural population below poverty line[8] in relation to agro-climatic zone and soil type (N) (d/p, r)
- percentage of rural population below poverty line (G)[9] (d/p, r)
- household consumption expenditure rates (N) (d/p, r)
- GDP per capita (G)[10] (d/p, r)
- rural poverty headcount index (N) (d/p, r)
- female headed households (N, V) (s) (*x*)[11]
- number of HIV/AIDS affected people (G, N) (s) (*x*)[12]

Legend

G: Global; N: National; V: Village; F: Farm
d: driving force; p: pressure; s: state; i: impact; r: response
x: a proxy indicator
*: indicator that links biophysical and socio-economic aspects of land degradation

[1] Global data available by country in WRI, *World Resources Report 2000 - 2001*, table FW.1. Global data also available by major watershed in table FW.3 (also see Revenga, 2000, p. 4).

[2] This indicator is important for understanding the impact of land degradation on women and children. National data may be available in the World Bank's Living Standards Measurement Surveys (LSMS) (Shyamsundar, 2002, p. 15).

[3] (See Revenga, 2000, p. 4)

[4] *Broad indicators of vulnerability to drought.*

[5] (Ekbom and Bojö, 1999, p. 23)

[6] (Shyamsundar, 2002)

[7] See definitions of wasting and stunting in Henninger and Hammond, 2002, p. 7.

[8] Widely published indicator of income poverty (World Bank, *World Development Indicator*, 2001).

[9] Data available for some countries in World Bank, *World Development Report 200/2001*, p. 280 or WRI, *World Resources Report 2000 - 2001*, table El.3 (several countries missing data).

[10] See data in WRI, World Resources Report 2000 – 2001, table El.1. (Ekbom and Bojö, 1999)

[11] (Shyamsundar, 2002)

[12] The HIV/AIDS pandemic has contributed to increasing the number of female and children headed households, characteristic of some of the poorest segments of society (Torkelsson, 2002, p. 6). Global data available by country in *World Resources Report 2000 – 2001*, table HD.2.

TABLE A6.7
Socio-economic indicators related to incapability

Poor individuals or families in particular face constraints in land management and soil conservation because they lack access to improved and appropriate technology (e.g., to conserve soil) and information (e.g., on how to manage land and soils)[1]. In some instances, however, even where access to technology and information may be available, cultural and spiritual practices may restrict their use.

Lack of access to improved and appropriate technology and tools

- access to inputs (e.g., tools) in market (V, F) (d/p)
- availability of inputs (e.g., tools) in market (V, F) (d/p)
- distance to market (input and output suppliers) (N, V, F) (d/p)
- availability/access to cart (V, F) (s)
- availability of irrigation (V, F) (s)
- hectares per tractor (G, N)[2] (s)
- presence of toilet, radio, tv, iron sheets for roof cover, internet access etc. in household (G?, N, V) (s) (*x*)

Poor provision of information or availability of skilled labour

- percent school enrolment rates of girls and boys (G, N, V)[3] (d/p) (*x*)
- rural male and female literacy rate (G, N)[4] (d/p)
- percentage of national budget to agricultural research/training (N) (d/p, r)
- research on resources vs. crops (N) (d/p)
- public expenditure on education (% of GNP) (G)[5] (d/p)
- availability of extension services/agricultural education (N, V, F) (s)
- frequency of extension services/agricultural education (V, F) (s)
- existence of a land information system (provision of regular and up to date information on the state of land and water resources) (N) (s)
- women's indigenous knowledge associated with land management (V, F) (s)
- men's indigenous knowledge associated with land management (V, F) (s)
- indigenous knowledge passed on to younger generations[6] (V,F) (i)
- evidence of inefficient use or overuse of inputs (r)

Cultural practices and spiritual beliefs and taboos

- cultural practices and spiritual beliefs and taboos that may be inhibiting use of technology and information to conserve land and soils (V, F) (d)[7]
- female and male roles in traditional land management and modern land management (V, F) (d)

Poverty

- percentage of rural population below poverty line in relation to agro-climatic zone and soil type (N) (d/p, r)
- percentage of rural population below poverty line (G8[7] (d/p, r)
- household consumption expenditure rates (N) (d/p, r)
- GDP per capita (G) (d/p, r)[9]
- rural poverty headcount index (N) (d/p, r)
- female-headed households (N) (s) (*x*)[10]

Legend

G: Global; N: National; V: Village; F: Farm
d: driving force; p: pressure; s: state; i: impact; r: response
x: a proxy indicator
*: indicator that links biophysical and socio-economic aspects of land degradation

[1] See Murgai *et al.,* ?, p. 7)

[2] Available in FAO's national tabular data for 1965 – 97 (WRI, PAGE Agroecosystems, 2000, p. 4)

[3] Global data available by country (for 1996) in WRI, *World Resources Report 2000 – 2001*, table HD.3 (values missing for some countries).

[4] Global data available on % females and males literate in WRI, *World Resources Report 2000 – 2001*, table HD.3. (missing values for some countries).

[5] Data available in the *World Development Report 2000/2001*, 2001, p. 284.

[6] Shifting agricultural practices from traditional to modern techniques is furthermore making less relevant indigenous knowledge (on traditional agricultural practices) and its transfer to younger generations.

[7] Difficult to access – specific indicators will need to be developed depending on local conditions.

[8] Data available for some countries in *World Development Report 2000/2001*, 2001, p. 280.

[9] See data in WRI, World Resources Report 2000 – 2001, table El.1. (Ekbom and Bojö, 1999).

[10] (Shyamsundar, 2002)

TABLE A6.8
Socio-economic indicators related to lack of opportunity or income

A skewed distribution of opportunities, wealth and income has implications for land degradation by breaking down common property management schemes and by compelling poor small-scale farmers to farm on unfertile land (while large-scale land owners buy and use the best agricultural land). Many poor farmers have few opportunities to improve their livelihoods and improve management of natural resource endowments since they often have restricted access and unclear rights to already marginal land and resources (due to population pressure and limited non-agricultural employment) and lack assets (e.g., credit and cash). These conditions have forced especially poor farmers to migrate from unfertile land and inhospitable surroundings to seek survival elsewhere (rural to urban migration).

Skewed distribution of wealth and poverty

- poverty gap index or income Gini coefficient (G, N)[1] (d/p)
- household consumption expenditure rates (N) (d/p)
- GDP per capita (G) (d/p)

Restricted land and resources or pressure on land

- ratio of actual cultivated land per capita and potential cultivable land per capita (G, N)[2] (d/p) (*)
- ratio of cultivated land and fallow land[3] (V) (d/p) (*)
- ratio of monoculture without fallowing to land in crop rotation (V) (d/p, r) (*)
- length of fallow periods[4] (V, F) (d/p)
- security of land tenure[5] (N, V, F) (d/p) (*)
- government resettlement programs or privatisation schemes (N, V) (d/p)
- number of hectares of agricultural land per capita (G, N)[6] (d/p)
- percentage of farmers cultivating on steep slopes or river deltas (N, V, F) (s, r) (*)
- changes in input/output prices (N, V, F) (d/p)
- land use changes (in hectares) (G, N)[7] (s)
- number of livestock per hectare on grazing areas (G, N)[8] (s, i)
- area covered by pasture/grazing animals (V, F) (s, i)
- number of agricultural workers per hectare (G)[9] (s)
- decline in common property resources[10]:
- decline in percentage of annual household income derived from non-marketed ("wild") goods collected at local commons (V, F) (i)
- change in quantity of annual household consumption that is derived from the commons (V, F) (i)
- amount of time spent by household member to collect fuelwood and water (N, V, F) (i)[11]
- distance walked by household member to collect fuelwood and water (N, V, F) (i)[12]
- change in length of fallow periods (V, F) (r)
- extent of cultivation on open-access areas[13] (V, F) (r) (*)

Legend

G: Global; N: National; V: Village; F: Farm
d: driving force; p: pressure; s: state; i: impact; r: response
x: a proxy indicator
*: indicator that links biophysical and socio-economic aspects of land degradation

[1] Data available by country in the *World Resources Report 2000/2001*, table El.3 (data missing for several countries).

[2] (See Koohafkan, 2000, p. 70 – 71 and Shyamsundar, 2002) Data on percentage permanent cropland and percentage arable land by country available in *World Development Indicators*, p. 126.

[3] (Shyamsundar, 2002)

[4] (Shyamsundar, 2002)

[5] (Shyamsundar, 2002)

[6] Global data available for cropland (in hectares per 1000 people) for 1987 and 1997 in WRI, *World Resources Report 2000 – 2001*, table AF.2.

[7] Global data by country available on land use change between 1992-94 and 1982-84 for cropland, pasture, and forest and woodland in WRI, *World Resources Report 2000 – 2001*, table 11.4 (p. 298). For global land use data could use NOAA's AVHRR (see White *et al.,* 2000, p. 3).

[8] Global data available on number of cattle, sheep and goats, equines, and buffaloes and camels in the WRI, *World Resources Report 2000 – 2001*, table FG.4.

[9] Data available in FAO's national tabular data for 1965 – 97 (WRI, PAGE Agroecosystems, p. 4).

[10] Access to Common Property Resources (CPR) have been documented to provide users incentive and capacity to manage natural resources through collective action (see Lipper, 2001, p. 31).

[11] This indicator is important for understanding land degradation's impact on women and children. National data may be available in the World Bank's Living Standards Measurement Surveys (LSMS) (Shyamsundar, 2002, p. 15).

[12] This indicator is important for understanding land degradation's impact on women and children. National data may be available in the World Bank's LSMS (Shyamsundar, 2002, p. 15).

[13] Open access areas are highly vulnerable to experiencing rapid resource depletion. These areas are often lands owned by the state that has little capacity to monitor and enforce property rights. Poor squatter settlements on open access areas have difficulty and little incentive to organize collective action to manage natural resources in these areas (Lipper, 2002, p. 31).

Table A6.8 (Continued)

- extent of cultivation on marginal land (N?, V) (r) (*)
- number of environmental refugees (G?, N) (r) (*)
- presence and frequency of conflict and violence over land and use of natural resources (V, F) (d/p, r)
- repeated bush fires (V, F) (r)[1]
- existence of manure contracts between farmers and herders (V) (r) (*)
- manure contracts with transhumant herders or cattle owners (F) (r) (*)

Demographic pressure
- rural population growth rate (G, N)[2] (d/p)
- gender balance between urban and rural (N) (d/p)
- rural population density (persons per hectare) in relation to agro-climatic zones and soil type (rural population/land ratio) (N) (s)[3]
- rural population density by arable land (G) (s)[4]
- net migration rate (rural to urban – excludes traditional migratory patterns by nomadic groups) (G?, N) (r)
- population projections (G, N) (r)
- (HIV/AIDS affected people (G, N) (s) (*x*)[5])

Limited employment in non-agricultural sectors
- rural land/labour ratio (N) (d/p)
- unemployment rate (G, N)(d/p, s)
- percentage of agricultural labour force (N) (s)
- percentage of non-agricultural labour force (N) (s)
- school enrolment of boys and girls (G, N, V) (p, s) (*x*)
- quantity of annual income derived from farm (cultivation, livestock) and non-farm activities (N) (s)
- net migration rate (rural to urban – excludes traditional migratory balance between urban and rural) (G?, N) (r)
- (seasonal) migration of men (excludes traditional migratory patterns by nomadic groups) (V) (r)
- changing roles of women and men (V, F) (r)

Lack of assets[6]
- availability of credit schemes (N, V) (d/p)
- male and female access to credit schemes (V, F) (d/p)
- land ownership[7] (N, V, F) (d/p) (*x*)
- access to cash and credit (F) (d/p)
- types and availability of savings (e.g., cash, livestock) (N, V, F) (s)
- presence of banking institutions (V, F) (s)
- distance to banking centre (F) (s)
- number of cattle[8] (N, V, F) (s)
- amount of grain stocks[9] (V, F) (s)
- percentage of rural households with adequate water for livestock (V, F)[10] (s)
- number of rural minors in labour force (N) (s) (*x*)
- mean per capita expenditure of rural population (G, N) (s)

Legend

G: Global; N: National; V: Village; F: Farm
d: driving force; p: pressure; s: state; i: impact; r: response
x: a proxy indicator
*: indicator that links biophysical and socio-economic aspects of land degradation

[1] Indicators of infertile land.

[2] For global data, see World Development Indicators, p. 126.

[3] (Ekbom and Bojö, 1999)

[4] (Ekbom and Bojö, 1999)

[5] Global data available by country in *World Resources Report 2000 – 2001*, table HD.2.

[6] *See World Bank, World Development Report 2000/2001*, 2001 p. 77 (Chapter 5).

[7] Since land ownership is often required for access to credit, this indicator may be used as a proxy for access to credit.

[8] Used as primary source of wealth and savings among most nomadic and pastoral communities (Henninger and Hammond, 2002, p. 20).

[9] Often an important source of savings/insurance in rural households.

[10] Good indicator of the ability of the poor to maintain non-land income generating assets (Shyamsundar, 2002, p. 16).

TABLE A6.9
Socio-economic indicators related to disempowerment

Individuals who are not given a chance to participate in decisions that affect their lives are not given a means to provide critical input on where environmental degradation is occurring and how land may be better managed and soils regenerated. Lack of institutional support and political marginalization also decreases incentive and ability for collective action to manage natural resources and chance for environmental protection (e.g., through the provision of safe drinking water and waste collection).

Presence of institutional support

- percentage of national budget to local-level/people-centred land management and soil conservation initiatives (N) (d/p, r)
- government expenditures in agricultural research and development[1] (G?, N) (d/p, r)
- government subsidies on NRM (N) (d/p)
- occurrence of armed conflict by country and year[2] (G) (d/p)
- easy access to land titles (N, V, F) (d/p)
- presence and number of farmer groups and related committees and associations (V) (s)
- female and male membership (as a percentage of village female and male population) in village committees/ associations/groups (F) (s)
- number and role of NGOs (N) (s)
- ratification of international environmental policies (G) (s)

Presence of infrastructural support, access by rural population to services

- government spending in rural infrastructure (N) (d/p)
- price of transport (F) (d/p, s)
- participation in farmer field days (F) (s)
- transport problems due to bad roads (V, F) (s)
- distance of village from nearest road (N) (s)
- density of road network (km road per ha of agricultural land) (G, N)[3] (s)
- presence of church (V, F) (s) (*x*)
- (percentage) rural population access to safe water (G, N, V, F)[4] (s) (*x*)
- availability of piped water (N, V) (s) (*x*)
- access to electricity (N, V) (s) (*x*)
- city nights lights (G) (s)
- presence of toilet, tv, radio, iron sheets for roof cover, link to internet etc. (G?, N, V, F) (s) (*x*)
- HIV/AIDS affected people (G, N) (s) (*x*)[5]
- existence of an early warning system (e.g., food early warning system) (N) (r)

Good governance: transparency and participation

- presence of decentralization policy (N) (d/p, r)
- replacement of rigid legal measures with local informal arrangements (N, V) (d/p, r)[6]
- presence of village-level dispute resolution mechanisms/institutions/groups[7] (V, F) (d/p, r)
- presence of regular democratic elections for national and local government (G, N) (s)
- number of women in parliament (G, N) (s)
- percentage of press owned by the state[8] (N) (s)
- evidence of merit-based recruitment in government[9] (N) (s)
- existence of legal aid for poor people (N, V) (s)
- perceived extent of corruption (N, V, F) (s)

Legend

G: Global; N: National; V: Village; F: Farm
d: driving force; p: pressure; s: state; i: impact; r: response
x: a proxy indicator
*: indicator that links biophysical and socio-economic aspects of land degradation

[1] See Wiebe *et al.*, 2000, p. 8.

[2] Used as a proxy for the *quality* of the institutional environment (Wiebe *et al.*, 2000, p. 7).

[3] See Wiebe *et al.*, 2000, p. 8.

[4] Global data available by country in WRI, *World Resources Report 2000 – 2001*, table HD.3.

[5] In countries such as Malawi, HIV/AIDS prevalence has had serious consequences on government infrastructure. The deaths of a higher proportion of urban, middle-class individuals (many of which are work in the government) is placing significant strain on government agencies to perform their tasks and mandates. Global data available by country in *World Resources Report 2000 – 2001*, table HD.2.

[6] See World Bank, *World Development Report 2000/2001*, 2001, p. 102 and 104.

[7] See World Bank, *World Development Report 2000/2001*, 2001, p. 102 and 104.

[8] Proxy to indicate freedom of press: higher levels of state ownership are associated with less freedom of the press (World Bank, *World Development Report 2000/2001*, 2001, p. 101).

[9] Merit-based recruitment in government is negatively correlated with corruption (see figure in World Bank, *World Development Report 2000/2001*, 2001, p. 101).

TABLE A6.10
Institutional indicators related to lack of incentive or inadequacy of policies

Policy failures have reinforced land degradation. For example, an individual's incentive to manage land in a sustainable way is reduced by insecure land tenure; inadequate development of natural resource management policies; and incomplete markets for environmental goods and services (where commodity prices do not internalise the cost of environmental degradation). The poorest segments of society usually have the least secure land tenure and property rights and are often compelled to exploit land (e.g., in open-access areas) to meet their livelihood needs. Conversely, secure land ownership provides individuals incentive and lays the foundation for longer-term natural resource utilization.

Land policy and tenure

- security of land tenure and access to land and resources among women and men (V, F) (d/p)[1]
- clarity of land ownership/property rights among women and men (N, V, F) (d/p)[2]
- easy access to land registries and titling services (N, V, F) (d/p)
- existence of land/property ownership mapping/cadastres (N) (d/p)
- land reform and resettlement policies (N) (d/p, r)
- government land privatisation schemes (N) (d/p)
- evidence of inequality in the distribution of property rights[3] (G?, N) (d/p, s, i)
- type of land tenure (V, F) (s)
- existence of sustainable Common Pool Resource (CPR) management institutions (V)[4] (s)
- interaction with neighbours regarding shared use of common land and resources (F)[5] (s)
- changes in land tenure or property rights among women and men (N, V, F) (i)
- percentage of cultivation on open access land, common property and private property) (N, V) (i)

Natural resource management policies

- legislation on Natural Resource Management (NRM) (N) (d/p)
- government expenditure on NRM (N) (d/p)
- government policies that encourage land degradation (e.g., agricultural tax exemption for large-scale farmers, land taxes which provide incentive for land clearing) (N, V) (d/p) (*)
- by-laws on land use and protection (V) (d/p, r)
- presence of NRM institutions (G, N) (d/p, s, r)
- ratification of global environmental legislation (G) (d/p, r)
- SOER reporting requirement (G, N) (s) (*x*)
- Environmental Impact Statement requirement (G, N) (s)
- (structural adjustments influences on land/soil management) (N) (i)

Poor internalisation of land degradation costs in commodity prices or consumer patterns

- presence of consumer subsidies that stimulate land degradation (N)[6] (d/p)
- existence of tradable permits policy (N) (s, r)
- annual gasoline, meat and paper consumption (G)[7] (s)
- use of "green" consumer prices (e.g., "green" and "fair trade" products) (G, N) (r)
- use of green accounting/internalising environmental benefits (goods and services) in national statistics (N) (r) (*x*)
- use of tradable environmental permits[8] (G?, N) (r)

[1] See World Bank, *World Development Report 2000/2001*, 2001, p. 37.
[2] See World Bank, *World Development Report 2000/2001*, 2001, p. 37.
[3] (Bojö *et al*., *Environment chapter in PRSP sourcebook*, 2001, p. 12)
[4] Specific CPR indicators include: consensus-like and collective arrangement to use the CPR, sanctions for violators that use the CPR, existence of conflict-resolution mechanisms, and recognition by the government for community stakeholders to manage the CPR (Ekbom and Bojö, 1999, p. 11).
[5] CPR management among long-time neighbors is driven by e.g., a desire to maintain their reputation as reliable members of the community (Ekbom and Bojö, 1999, p. 8).
[6] (Koohafkan, 2000, p. 76)
[7] Global data by country available *in World Resources Report 2000 – 2001*, table ERC.5.
[8] Will need to be more specific.

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