

LAND DEGRADATION ASSESSMENT IN DRYLANDS

LADA
PROJECT

**MANUAL FOR LOCAL LEVEL ASSESSMENT OF LAND
DEGRADATION AND SUSTAINABLE LAND MANAGEMENT**

PART 1

Planning and methodological approach, analysis and reporting



LAND DEGRADATION ASSESSMENT IN DRYLANDS

**MANUAL FOR LOCAL LEVEL ASSESSMENT OF LAND
DEGRADATION AND SUSTAINABLE LAND MANAGEMENT**

PART 1

Planning and methodological approach, analysis and reporting

general coordinators

Freddy Nachtergaele and **Riccardo Biancalani**
FAO, Rome, Italy

authors

Sally Bunning
John McDonagh
Janie Rioux

editor

Anne Woodfine

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

The views expressed in this information product are those of the author(s) and do not necessarily reflect the views of FAO.

All rights reserved. FAO encourages the reproduction and dissemination of material in this information product. Non-commercial uses will be authorized free of charge, upon request. Reproduction for resale or other commercial purposes, including educational purposes, may incur fees. Applications for permission to reproduce or disseminate FAO copyright materials, and all queries concerning rights and licences, should be addressed by e-mail to copyright@fao.org or to the Chief, Publishing Policy and Support Branch, Office of Knowledge Exchange, Research and Extension, FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy.

@FAO 2011

CONTENTS

Foreword	v
Acronyms and abbreviations	ix
1 Introduction	1
1.1 Purpose of the assessment	1
1.2 Guiding principles	3
1.3 Target users	4
1.4 Structure of the LADA Local Manual	5
2 Conceptual / analytical frameworks	7
2.1 DPSIR framework	7
2.2 Sustainable livelihoods framework	9
2.3 Ecosystem services framework	10
3 Planning the local assessment	13
3.1 Composition of the team, assessment steps and timing	13
3.2 Selection of the assessment areas	14
3.3 Land Use Systems (LUS) and Land Use Types	16
3.4 Sampling strategy	20
4 Land degradation and SLM typologies	31
4.1 Land degradation definitions and processes	31
4.1.1 Soil degradation	33
4.1.2 Vegetation and biodiversity degradation	36
4.1.3 Water resource degradation	37
4.2 SLM technologies and approaches	40
4.2.1 SLM technologies	40
4.2.2 SLM approaches	40
5 Characterisation of the study area	43
5.1 Introduction	43
5.2 Background (secondary) information	44
6 Assessing land resources status and trends, effects on livelihoods and ecosystems services	51
6.1 Assessing effects of land degradation / management on livelihoods and socio-cultural services	52
6.2 Assessing vegetation and biodiversity status and trends	55

6.3	Assessing soil health and soil erosion status and trends	58
6.4	Assessing water resources status and trends	59
6.5	Assessing SLM technologies and approaches	62
	Field form – WOCAT inventory on SLM technologies (Table 8)	64
	Field form – WOCAT inventory on SLM technologies (Table 9)	66
6.6	Assessing effects of land degradation / management on ecosystem services	69
6.6.1	Assessing effects of LD / management on productive services	69
6.6.2	Assessing effects of land degradation / management on regulating and supportive services	73
6.6.3	Assessing effects of land degradation / management on socio-cultural services provided by the environment	74
7	Analysis and reporting results	77
7.1	Introduction	77
7.2	Structure of the assessment report	78
7.2.1	Introduction of the assessment report	78
7.2.2	Methodology	78
7.2.3	Characterization of the study area	79
7.2.4	State of the land resources (and trends)	82
7.2.5	Driving forces & pressures	89
7.2.6	Impacts on ecosystem services	95
7.2.7	Impacts on people and their livelihoods	100
7.2.8	Responses	107
7.2.9	Conclusions and policy recommendations	110
7.3	Establishing and maintaining a LADA-Local database	112
8	Use of land degradation / SLM assessment and monitoring for wise decision making	113
8.1	Drawing conclusions from the assessment findings	113
8.2	Adaptive management and land use / territorial planning	114
8.3	Informed decision making by stakeholders	116
	Annexes	
1.	Fieldwork materials	117
2.	Sustainable Land Management Technologies	121
3.	Case Study of a SLM Technology Assessment	127
4.	Sustainable Land Management approaches	137
5.	Case study of a SLM approach assessment	141
	References	151

Foreword

This document is the first part of a two part manual on local level assessment of land degradation and sustainable land management:

- **Part 1 – Planning and Methodological Approach, Analysis and Reporting**
- **Part 2 – Field Methodology and Tools**

The two parts should be used together as Part 1 provides the background information for the conduct of the methods and tools that are provided in Part 2.

The manual incorporates inputs and feedback from many individuals involved in piloting the local level land degradation assessment tools and methods in the six countries that participated in the **Land Degradation Assessment in Drylands project (LADA)** supported by the Global Environment Facility (GEF) and executed by FAO during the period 2006-2010. It draws on tools developed with the **World Overview of Conservation Approaches and Technologies (WOCAT)** for the assessment of sustainable land management (SLM). It also incorporates feedback from a series of national and inter-country workshops conducted during the period 2007-2010.

The development process was guided by the LADA team in the Land and Water Division of the Food and Agriculture Organisation of the United Nations, Rome, Italy, with substantial contributions from the School of International Development, University of East Anglia, Norwich, UK, under the overall technical supervision of Freddy Nachtergaele, LADA Coordinator and Riccardo Biancalani, LADA Technical Advisor.

Lead authors of the manual were:

- Sally Bunning (sally.bunning@fao.org), FAO Land and Water Division (NRL)
- John McDonagh (j.mcdonagh@uea.ac.uk), School of International Development, University of East Anglia, UK
- Janie Rioux (janierioux@gmail.com), Consultant FAO/NRL

The participatory testing and adaptation of the tools and methods was an iterative process, with the LADA country teams building on a series of inter-country training and review workshops, namely:

- Initial workshop hosted by the University of East Anglia (Norwich, June 2007);
- Pilot Training of Trainers session hosted by Tunisia (Béja, November 2007);
- Mid-term review workshop hosted by Argentina (Mendoza, January 2009);
- Final review workshops hosted by the Universities of Amsterdam and Wageningen respectively (the Netherlands, August 2010).

The final peer review and editing was conducted by Anne Woodfine, independent expert in natural resources management (FAO consultant).

The support of the host and partner institutions in the six LADA pilot countries, which provided policy, technical and co-financing support for the local assessment piloting and workshop venues, is gratefully acknowledged. Insights, experiences and suggestions were provided by LADA country teams in developing this local assessment methodology, notably by:

- **Argentina:** Elena Abraham (Mendoza Region), Stella Navone (Puna Region), Donaldo Bran and Hugo Bottaro (Bariloche) and Esquel (Patagonia), who coordinated the local assessment teams with the institutes of IADIZA, FAUBA and INTA in the regions; supported at national level by Vanina Pietragalla, Maria Laura Corso and Andres Ravelo, Secretaría de Ambiente y Desarrollo Sustentable;
- **China:** Wang Guosheng, Jiping Peng and Kebin Zhang, with inputs during training by Lishui Nie and Tien Huan *et al.*; and overall guidance by Yang Weixi of the National Bureau to Combat Desertification;
- **Cuba:** Candelario Aleman, N. María Nery Urquiza and Fermin J. Peña Valenti, supported by the Agencia de Medio Ambiente, Ministerio de Ciencia, Tecnología y Medio Ambiente;
- **Senegal:** Déthié Soumare Ndiaye, Gora Beye, Abdoulaye Wele, and other team members, Centre de Suivi Écologique, Ministère de l'Environnement, de la Protection de la Nature, des Bassins de rétention et des Lacs artificiels;
- **South Africa:** Liesl Stronkhorst, Agricultural Research Council and Lehman Lindeque, Department of Agriculture, Forestry and Fisheries, Ministry of Agriculture, Forestry and Fisheries, with support from their institutions;
- **Tunisia:** Hattab Ben Chaabane, Rafla Attia, Leila Bendaya, with technical support of IRA (Institut des Régions Arides), Médenine and CRDA (Commissariats Régionaux au Développement Agricole) de Médenine, Siliana and Kasserine, guided at national level by Hédi Hamrouni, LADA Coordinator, with support of the Direction Générale de l'Aménagement et de la Conservation des Terres Agricoles, Ministère de l'Agriculture et des Ressources Hydrauliques.

A number of technical specialists and other staff in their institutions made significant contributions to the development of this manual. In particular, the valuable contributions of three key individuals Malcolm Douglas, Yuelai Lu and Michael Stocking are acknowledged and also two key partner institutions, namely:

- **Centre for Development and Environment**, University of Berne, host of WOCAT (World Overview of Conservation Approaches and Technologies) Secretariat;
- **United Nations University (UNU)** which supported inputs by UEA and use of an early rapid version of the local assessment manual through its SLM project in the Pamir Alai Mountains in Tajikistan and Kyrgyzstan.

Finally, this work was accomplished thanks to the following institutional support:

- **Technical and policy support of the Food and Agriculture Organization of the United Nations (FAO)** which executed the LADA project, in particular by Parviz Koohafkan, Director, Land and Water Division, and the interdisciplinary Project Task Force; and
- **Funding and implementation support of the Global Environment Facility (GEF) and United Nations Environment Programme (UNEP)** respectively to the LADA project.

The manual draws, in particular, on the following references:

- CDE/WOCAT, FAO/LADA, ISRIC (2011) A Questionnaire for Mapping Land Degradation and Sustainable Land Management. Eds.: Liniger, H., van Lynden, G., Nachtergaele, F., Schwilch, G., Biancalani, R. and Woodfine, A.
- Department of Agriculture, Government of South Africa (2009). The core indicators for pasture / range condition scoring in LADA-Local were adapted from the pasture (veld)/ rangeland quality and vegetation assessment used in South Africa. (A list of visual indicators for assessing veld condition trend on farms and extensive grazing areas used with farmers, extension staff and researchers and repeated yearly. Ref. Roberts, 1970; Roberts, *et al.* 1975; Fourie & Roberts, 1977, as described by Jordaan, 1991).
- Douglas, M., (2008; unpublished). Assignment Report from China LADA Local Assessment Training Workshop, 10 -15 October 2008 including Guidelines criteria for the prioritisation of watersheds for improved management;
- FAO. (2009a) Towards defining forest degradation: comparative analysis of existing definitions, Forest Resources Assessment Working paper, 154, Food and Agriculture Organisation, Rome, Italy.
- FAO (2009b) Measuring and Monitoring Forest Degradation through National Forest Monitoring Assessment (NFMA). Eds. Tavani, R.; Saket, M.; Piazza, M.; Branthomme, A.; Altrell, D., Forest Resources Assessment Programme Working Paper 172, Food and Agriculture Organisation, Rome, Italy.
- FAO / TerrAfrica (2011) Sustainable land management in practice: Guidelines and best practices for sub-Saharan Africa (authors Liniger, H., Mekdaschi Schuder, R., Hauert, C. and Gurtner, M.), Food and Agriculture Organisation, Rome, Italy.
- McGarry, D. (2006). A Methodology of a Visual Soil - Field Assessment Tool “VS-Fast” to support, enhance and contribute to the LADA program;
- Stocking, M. and Murnaghan, N. (2001). Handbook for the field assessment of land degradation. Earthscan Publications Ltd, London, UK.

The participatory tools for Sustainable Rural Livelihoods' approaches/analysis draw from several publications, including:

Ellis, F. (1998). Survey article: Household strategies and rural livelihood diversification.

The Journal of Development Studies. Vol.35, No.1, pp.1–38;

FAO Livelihoods Support Programme manuals and guidelines <http://www.fao.org/es/esw/lsp/manuals.html>; and

Scoones, I. (1998). Sustainable rural livelihoods: A framework for analysis. IDS Working Paper. No.72. Institute of Development Studies, Brighton, UK.

The soil and vegetation assessment methodology used in the local assessments in Argentina and South Africa also drew on the Landscape Functional Analysis (LFA) methodology, developed in Australia and adapted in Argentina as the MARAS system. While LFA has not been incorporated in the manual since it was used and validated for LADA Local in only 2 of the 6 LADA countries it presents, however, an acceptable alternative to the proposed LADA-Local VSA Fast soil and vegetation assessments and is posted on the LADA website.

Tongway, D. and Hindley, N. (2004) Landscape Function Analysis: Methods for monitoring and assessing landscapes, with special reference to mine sites and rangelands. CSIRO Sustainable Ecosystems, Canberra, Australia.

Oliva, G., *et al*, 2008 Manual para la instalación y lecturas de Monitores MARAS (Monitoreo Ambiental para Regiones Áridas y Semiáridas), INTA, Proyecto PNUD GEF07/G35.

Also posted on the LADA website is the following wetlands assessment tool that was developed in South Africa and used by LADA-South Africa to complement the LADA Local water resources tools. This would need to be validated in other countries for wider application.

Government of South Africa. (2007). Manual for the assessment of a Wetland Index of Habitat Integrity for South African floodplain and channelled valley bottom wetland types, Department of Water Affairs and Forestry, Pretoria, South Africa.

Acronyms and abbreviations

BOD	biological oxygen demand
DPSIR	Drivers-Pressure-State-Impact-Response (D-P-S-I-R)
EC	electrical conductivity
ES	ecosystem services
FAO	Food and Agriculture Organization of the United Nations
FGD	focus group discussion
GEF	Global Environment Facility
GIS	geographical information system
GPS	Global Positioning System
km	kilometre
l	litre
LADA	Land Degradation Assessment in Drylands
LADA-L	LADA Local
LD	land degradation
LSU	livestock units
LUS	land use system
LUT	land use type
m	metre
MDG	Millennium Development Goal
m	minute
ml	millilitre
mm	millimetre
NGO	non-government organisation
N-LUS	national-land use system
SDC	Swiss Agency for Development and Cooperation
sec	second
SLM	sustainable land management
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WOCAT	World Overview of Conservation Approaches and Technologies



CHAPTER

Introduction

This section explains the purpose and use of the LADA-Local assessment, the guiding principles for the conduct of a local level participatory assessment and the potential target users. It also provides an overview of the scope and structure of the two part manual.

1.1 Purpose of the assessment

This **local level land resources assessment methodology (LADA-Local)** was produced within the Land Degradation Assessment in Drylands (LADA) project. See Box 1 for the LADA project objectives and outcomes and the website www.fao.org/nr/lada for further information.

The main purpose of **LADA-Local** is to provide a standard methodological approach and tool-kit for the assessment of land degradation processes, their causes and impacts at local¹ level in collaboration with local stakeholders and communities. The focus is on human-induced land degradation; however, natural degradation processes are also addressed. For a more balanced and complete understanding, the approach also assesses the extent to which land resources (soil, vegetation, water) and landscapes/ecosystems are being conserved and/or improved by sustainable land management (SLM) practices.

¹ "local level" means at the level of the plot/field/ /farm-household/community.

BOX 1 LADA project (GEF/UNEP/FAO, 2006-2010)

- **Objective 1:** To develop tools and methods to assess and quantify the nature, extent, severity and impacts of land degradation on dryland ecosystems, watersheds and river basins, carbon storage and biological diversity at a range of spatial and temporal scales.
- **Objective 2:** the national, regional and international capacity to analyse, design, plan and implement interventions to mitigate land degradation and establish sustainable land use and management practices.

These objectives are expected to overcome current policy and institutional barriers to sustainable land use in dryland zones.

LADA outcomes

- Standardised methodological and conceptual framework for the participatory assessment of land degradation and its impact in drylands at global, (sub) national and local scales.
- Teams trained and capacity built in country for the conduct of detailed assessments and analysis (based on at least two sites/pilot country and supported by national policy forums to link local issues such as SLM adoption and bye-laws with national planning and policy).
- Detailed local assessments and analysis of land degradation and its impact conducted (balancing the assessment off critical areas for LD with the learning from areas that largely control /prevent land degradation (SLM) and linking LADA-Local information with policy at national level.
- Products and findings of the assessments used for action and decision-making for the control and prevention of land degradation in drylands.

The local assessment results can be used in the context of a monitoring and evaluation programme aiming at improved and responsive decision making on sustainable land management and rural development. More specifically, the assessment can be used to:

- ⊗ conduct integrated, participatory assessments of land degradation / sustainable land management (LADA/WOCAT) to assess and monitor the impacts of various land uses, management practices, also technical and policy interventions;
- ⊗ identify community and natural resources management needs for project development (degradation prevention, mitigation, restoration technologies, approaches and related policies for promoting sustainable land use systems);
- ⊗ make an inventory of baseline conditions in selected areas at the start of a national programme or project; and to subsequently assess progress and impacts (mid term, final and/or as a post-impact assessment);
- ⊗ provide more detailed findings and understanding from selected local assessment areas to feed into national level LD/SLM assessments, in particular those conducted using LADA/WOCAT tools and methods, and thereby inform national agricultural and environmental strategies and reporting on progress and impacts in implementation of the United Nations Convention to Combat Desertification (UNCCD) and other land-related international commitments such as the biodiversity (CBD) and climate change conventions (UNFCCC).

Previous land degradation assessments have not moved much beyond the description and quantification of biophysical processes and their direct effects. The LADA Local assessment methodology aims to deliver an understanding, not only of the state and nature of change in the land resources (soil, water and biological resources) and ecosystems, but also of the drivers of and impacts of land degradation and sustainable land management, the impacts they have on ecosystem services and livelihoods, also the effects of recent response measures adopted by land users and other actors. The premise of this approach is that it is not the degradation of the land *per se* that is the problem, but the impacts this degradation has on things that matter to people: their livelihoods and ecosystem services.

This assessment approach, manual and associated training build on country experiences and are expected to enhance the capacity of users to conduct more integrated and participatory assessments of land degradation and to monitor impacts of interventions or changes in land management more effectively. The manual reflects a substantial shift in attention from the conventional focus on assessing degradation to a balanced assessment that looks at both the negative and positive effects and trends of land use / management on natural resources and ecosystem services.

1.2 Guiding principles

Approximately three to four weeks (full-time) are needed to conduct a complete integrated local level assessment with preparation, field work and interviews with land users and households, validation of findings with the community and the preparation of a consolidated report. A number of principles have informed the development of the approach:

Participatory and robust. The methodology is designed to be integrated, participatory, field-based and robust in order to provide base-line data on land degradation and improvement for planning, priority setting and subsequent monitoring activities. In a number of key steps the approach relies on land users' knowledge for information, notably on the history of land-use, the dynamics of resource change, the drivers and impacts of land degradation and sustainable land management. If the relevance of the assessment is clear, it is more likely that land users will contribute information and respond to the findings. Likewise, the involvement of local policy makers and other professionals increases the likelihood that findings will influence policy processes and the design of future local land resources programmes.

Easy to use and meaningful. Wherever possible, methods and indicators have been selected that are easy to use and interpret. The assessment does not require substantial laboratory-based measurements but provides accuracy and validity through combining quantitative and semi-quantitative field measurements with qualitative information from local informants. Validation is also done through "triangulation"², rather than through large-scale sampling and repeated technical measurements. It is expected that the precision lost in some areas will be compensated for by the broader, deeper understanding of land degradation delivered by this integrated and participatory assessment. There are, however, situations where laboratory tests may be needed, for example to verify soil nutrient deficiencies, soil carbon stocks, water pollutants, also soil and water salinity.

² "Triangulation" is the approach where more than one method is used in a study in order to double (or triple) checks on results. We can be more confident with our information and data if different methods lead to the same result.

Widely applicable core methodology. The methods and indicators have been selected and adapted for use across the main land use systems and ecosystems in dryland areas (arid, semi-arid and sub-humid). Nonetheless, the methods are equally valid in humid areas with minor adaptation required of specific indicators and scores. In the interests of consistency and comparability a “core” methodology, comprising a set of core biophysical and socio-economic indicators and some detailed methods for assessing these indicators are proposed. In some areas and under some circumstances, it may be appropriate to assess the proposed indicators using different or locally established methods, or additional indicators may be required. For example, to generate more detailed information on land degradation processes such as wind erosion or degradation associated with irrigated lands.

Towards an ecosystem approach. The primary emphasis in the empirical measurement is on the assessment of the current status and dynamics of the land resources – soil, water and vegetation - in delivering the main **provisioning services** land-users require from the land and the livelihood implications (food, fodder, fuel, water, income, etc). A second important consideration is the need to identify and evaluate significant impacts of land degradation or sustainable land management on other key ecosystem services, particularly the **supporting and regulating services** that determine productivity and ecosystem resilience (*inter alia* nutrient and organic matter / carbon cycling, maintenance of the hydrological cycle and water supply, also conservation and sustainable use of biological diversity). Besides income and food security, other **socio-cultural services** provided by land use systems / ecosystems are also important (e.g. knowledge management, adaptation to change and organizational capacity of land users).

1.3 Target users

In any assessment, the collection and analysis of data only becomes meaningful if it helps to deliver useful outputs. This manual gives guidance and a recommended structure for analyzing and reporting on the assessment in a form that should be useful to most users. Other common outputs produced from an assessment include policy briefs and baseline data sets against which subsequent changes can be monitored. Additional outputs, tailored to specific stakeholders, may also be produced and these should be identified during the assessment planning stage so that relevant, targeted outputs and recommendations are produced.

Common stakeholders are:

- ⊗ Government departments (agriculture, environment, water, forest, soil, land, community development, statistics etc.);
- ⊗ Local and provincial authorities;
- ⊗ Land users (commercial and subsistence farmers, herders, foresters and users of biomass energy, other resources);
- ⊗ Local institutions (producers associations; water users associations, community leaders, representatives of national farmers unions, cooperatives etc.);
- ⊗ NGOs and projects operating in the selected areas / land resources sectors;
- ⊗ The national and international scientific community.

Consultation with the main stakeholders during the planning phase is also an opportunity to access available data and link to other relevant ongoing land resources activities. In some cases it may be possible to add tools or increase the emphasis on particular components of the assessment to help deliver more targeted or detailed information to meet an identified need.

Some areas that have been little developed in the manual but are referred to include:

- ✘ **land and water pollution:** requiring the development of specific tools (e.g. for heavy metals from mining / industrial activities, arsenic in groundwater supplies etc.);
- ✘ **wetlands condition / health:** a key reference is the wetlands assessment protocol used in and proposed by South Africa (Government of South Africa, 2007). This needs to be piloted and could be adapted for use elsewhere ;
- ✘ **irrigated systems:** the tools can be used for rainfed and irrigated systems, however, a separate manual is being developed specifically for assessing salinity and sodicity in irrigated systems (McGarry, 2011, version 1, working document);
- ✘ **forest degradation:** FAO Forestry Department in 2009 initiated an international process to better understand and develop harmonised forest degradation indicators and assessment methods, as part of the global and national forest resources assessments (FAO, 2009b);
- ✘ **market-related drivers and land tenure conditions:** in certain contexts these may require more specific analysis and expertise, particular when it is found that they are important in driving LD or SLM.

Biodiversity and climate change are referred to some extent but where required / relevant could be easily given more attention in the assessment through some additional observations and questions.

1.4 Structure of the LADA Local Manual

This manual builds on lessons learnt from the pilot countries in testing the methods and tools. It explains the various components of the assessment and provides a detailed section to support the assessment team in integrating, analyzing and reporting the results.

The manual is structured in two parts:

- ✘ **Part 1** – Planning and Methodological Approach, Analysis and Reporting
- ✘ **Part 2** – Field Methodology and Tools

Part 1 comprises 8 chapters providing the background information required for planning and conducting a local level assessment, for understanding the methodological approach and for analysis and reporting of the findings.

1. Introduction
2. Conceptual / Analytical Frameworks (DPSIR, Sustainable Livelihoods Framework, Ecosystem Services Framework)
3. Planning the Local Assessment
4. Land Degradation and Sustainable Land Management Typologies
5. Characterisation of the Study Area
6. Assessing Land Resources Status and Trends, Effects on Livelihoods and Ecosystem Services
7. Analysis and Reporting Results
8. Use of LD / SLM Assessment and Monitoring for Wise Decision Making

Part 2 comprises 7 sections that present the range of tools and methods proposed to conduct a local level assessment in the field with local land users and stakeholders. The land use systems and types being assessed will to some extent determine the precise indicators and tools that are required.

1. Characterisation of the Study Area
2. Reconnaissance Visit and Transect Walk
3. Vegetation Assessment
4. Soil Assessment
5. Key Informant and Land User Interview
6. Water Resources Assessment
7. Livelihoods Assessment

The assessment is an integrated land resources assessment, but for simplification separate protocols are provided for assessing vegetation, soil and water resources status and trends and current SLM practices. It is essential that the findings from these are brought together and analysed by a multi-disciplinary team for the various land use systems / types and integrated with results from the livelihoods assessment with a range of land users/households (selected using wealth ranking) and from the focus group discussions and interviews with key informants.



CHAPTER 2

Conceptual / analytical frameworks

This section presents the three main frameworks that have informed the LADA local assessment methodology, namely the Driving Forces-Pressures-State-Impacts-Responses (DPSIR) framework, the Ecosystem Services (ES) framework and the Sustainable (rural) Livelihoods (SL) framework. The linkages between these frameworks are also explained. In section 7 (Analysis and Reporting Results), detailed advice is given on how the frameworks can be used to help integrate, analyze and report on the assessment findings.

2.1 DPSIR framework

The **DPSIR** (Driving Forces-Pressures-State-Impacts-Responses) framework is used to help analyse the relationships between the **State** (status and trends) of land resources; the direct **Pressures** on land resources; the **Driving Forces** (the indirect drivers that act on the Pressures); the **Impacts** (of changes in the State) on ecosystem services and on people's livelihoods; and possible **Responses** from land users, policy makers and other stakeholders designed to mitigate land degradation, adapt to its impacts or promote SLM. The linkages between framework components are clearly represented in the DPSIR diagram (Figure 1). DPSIR analysis is core to the LADA assessment approach, as it helps the user link all parts of the assessment and guides the synthesis and analysis of the findings. It also complements the ES and SL frameworks that are used to help understand the impacts of current / recent land uses and management practices on ecosystem goods and services and on the livelihoods of local people.

This diagram shows how the DPSIR analysis is associated with the Ecosystem Services (ES) and Sustainable Livelihoods (SL) approaches and gives examples of DPSIR indicators.

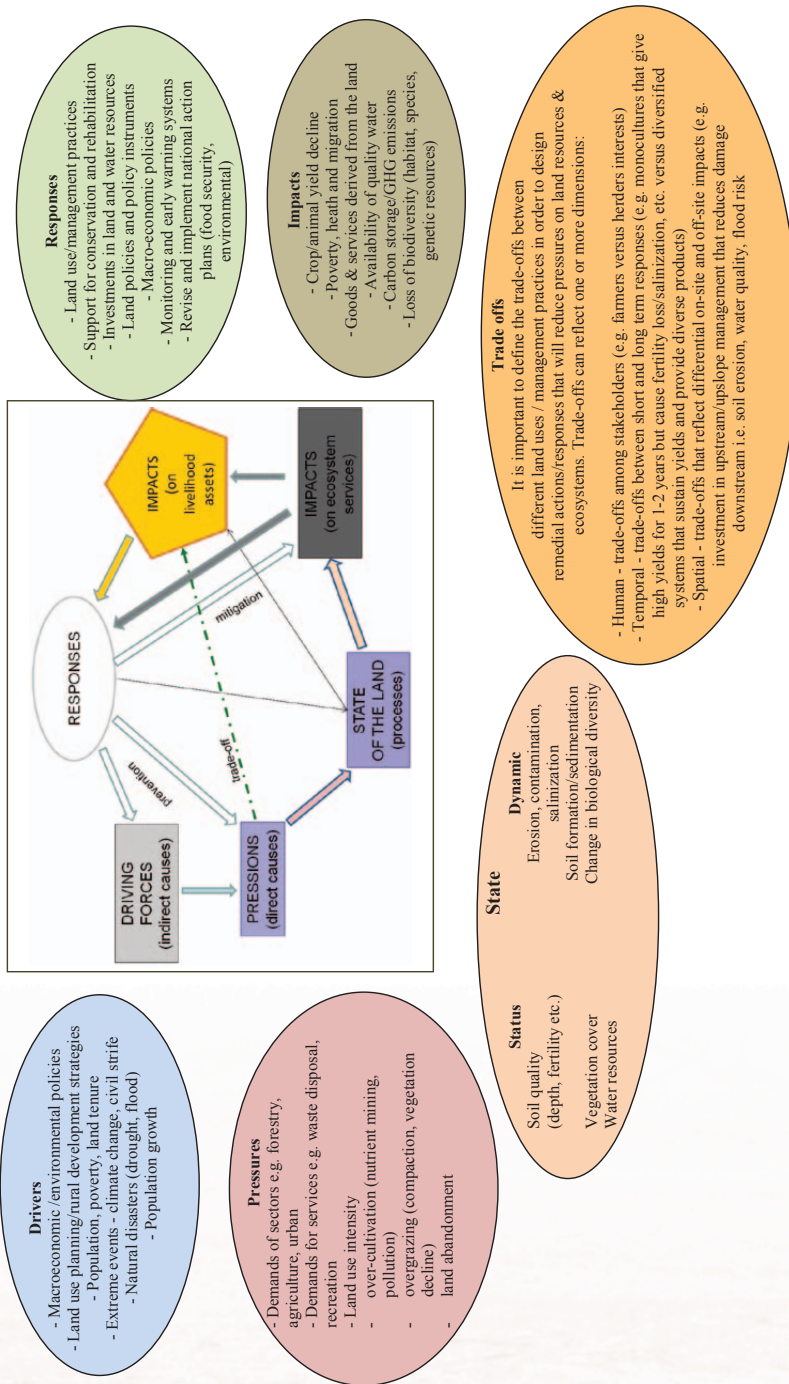


FIGURE 1 LADA local analytical framework: to analyse findings of the local assessment

The objective of much of the primary data collection in the assessment is to generate a picture of the **State** of land resources (soil, vegetation, water) and the nature of and change in these resources. A range of indicators and indices are included to do this, supplemented with information from land-users and data from secondary sources. The same mix of information sources is relied upon to help identify important **Impacts** caused by the State of the land resources on ecosystem services and on livelihoods (see Figure 1). Community and land user interviews are particularly important in providing information on the **Driving Forces** (e.g. indirect reasons for adopting a practice that degrades land resources rather than a more sustainable practice). The most appropriate **Responses**, designed perhaps discourage use of the more degrading practices by land-users or encourage and improve SLM adoption, would generally be identified through discussing the assessment results with a wider group of people than those involved in the assessment, including local policy makers, project officers and government officials.

In summary, users are encouraged to use DPSIR as the main framework to help with understanding, organizing and presenting the assessment results.

2.2 Sustainable livelihoods framework

The sustainable livelihoods framework helps understand how different household livelihoods interact with the natural, socio-economic and policy environment. For specific types of land users, it helps analyse the drivers of land degradation and/or sustainable land management (LD / SLM) and impacts on their livelihoods and vulnerability. The socio-economic divisions such as wealth, main livelihood activities, gender, ethnicity and so forth determine the natural, physical, human, social and financial assets, which influence LD / SLM. The context also determines the key drivers of LD / SLM, as they affect the access people have to key assets, and what they can do with them.

The livelihood strategies and outcomes of individuals and households (right of Figure 2) are shaped /determined by their per capita **Assets base**, which includes Natural, Physical, Human, Social and Financial assets, (see Table 1) also by their **Vulnerability context** (e.g. seasonality, trends and shocks that are beyond the household's control) (left of Figure 2), and by the **Policy and Institutional context** (centre of Figure 2).

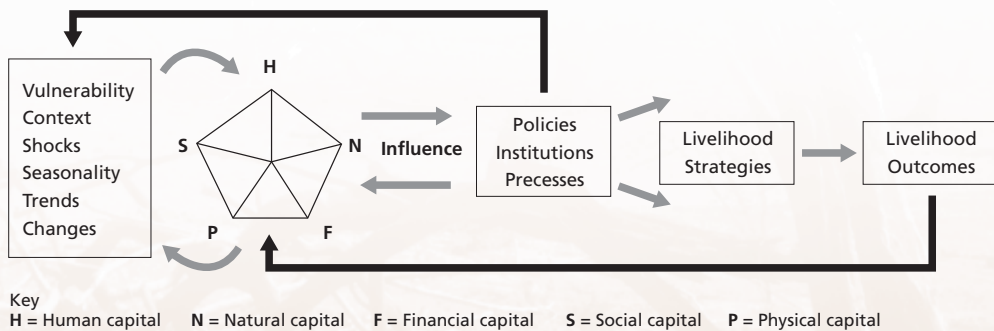


FIGURE 2 The Basic Livelihoods Framework (Source: Ade Freeman, Ellis & Allison, 2004)

TABLE 1 Description of the capital assets

Per capita / Household assets	
Natural capital	The natural resources stocks from which resources flows useful for livelihoods are derived (e.g. land, water, wildlife, biodiversity, environmental resources).
Human capital	The social resources (networks, membership groups, relationship of trust and access to wider institutions of society) upon which people draw in pursuit of livelihoods.
Physical capital	The skills, knowledge, ability to work and good health important to the ability to pursue different livelihood strategies.
Social capital	The basic infrastructure (transport, shelter, water, energy and communications) and production equipment and means which enable people to pursue their livelihoods.
Financial capital	The financial resources which are available to people (whether savings, supplies of credit or regular remittances of pensions) and which provide them with different livelihood options.

The first step in using the sustainable livelihoods (SL) approach is the gathering of initial socio-economic and cultural information during the community focus group discussion, community mapping and wealth ranking exercises. This provides initial information on:

- ⊗ the diversity of land users, land uses and income generating activities;
- ⊗ important socio-economic and environmental changes (recent and historic e.g. markets for cash crops, land productivity decline, climate change);
- ⊗ the vulnerability / resilience of different land user groups (in relation to land degradation, poverty, food insecurity climate change / variability, etc.).

The next step is the conduct of interviews with a range of land users encountered during the transect walks and a sample of households from the various wealth groups, also some key informants (e.g. technical experts, policy/decision makers, workers on ongoing projects). These provide information on the assets base, livelihoods, land management practices as well

as interviewees perceptions of the effects of land degradation and of support measures (policy, legislation, services etc.).

2.3 Ecosystem services framework

Ecosystem services are defined as the benefits that humans receive from ecosystems. These benefits can be direct benefits (e.g. food, fodder, recreation etc.) or they may be indirect (e.g. nutrient cycling, pest regulation and pollination etc.). Four categories are commonly identified: provisioning, regulating, cultural and supporting services.

The Millennium Assessment (WRI, 2005) developed and applied this categorization for the 2005 Ecosystem Assessment (Figure 3).

Supporting services generally change slowly and have an indirect impact on people over a relatively long time frame. Changes in the remaining three categories are more direct and short-term in their impacts on people.

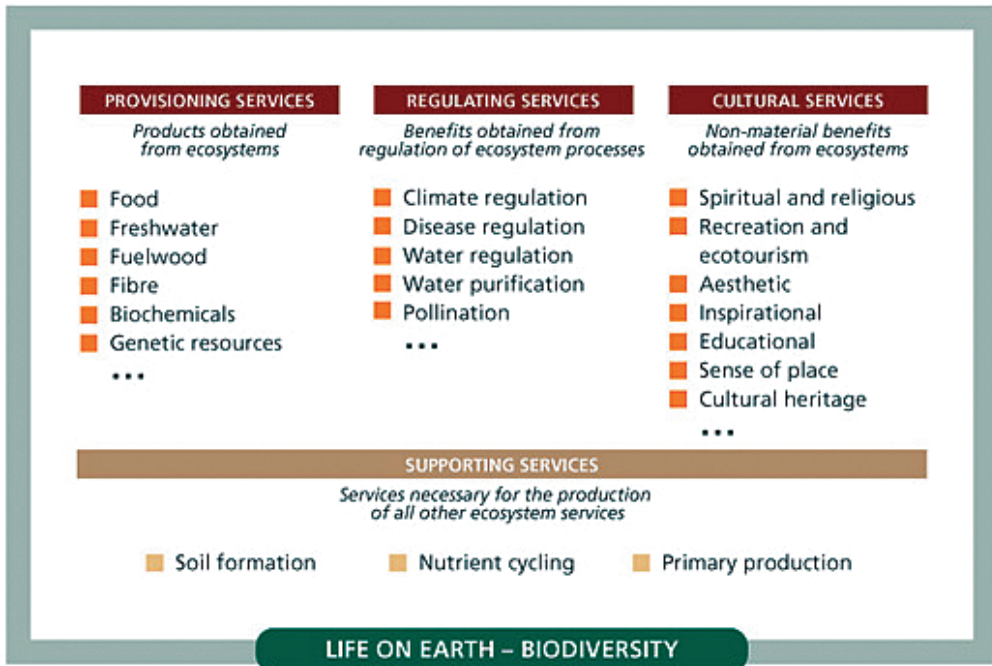


FIGURE 3 Ecosystems Services (Millennium Ecosystem Assessment [WRI], 2005)

The LD / SLM impacts on ecosystem services are assessed by drawing on the findings of the initial reconnaissance visit / transect walk and the detailed site assessments of vegetation, soil and water resources. The following services should be considered, with emphasis placed on those that are particularly important or at risk in the particular study area:

- ⊗ **Provisioning services:** crop and livestock production (food, biomass for energy, fibre, wood), other goods (wild foods, building or craft materials etc.), water productivity, availability of land etc.;
- ⊗ **Regulating services:** ecological processes and their effects on:
 - the carbon cycle i.e. the balance between carbon sequestration on one hand (through biomass production

and organic matter management) and on the other hand emissions of greenhouse gases (CH₄, CO₂ and NO_x) through decomposition of organic matter, burning, intensive livestock, farm mechanisation, etc.;

- maintenance of the hydrological regime (rainfall capture, water regulation and flow, water purification) with impacts on flood and drought severity, incidence and risk;
- pollination, biological disease and pest regulation and risks of crop failure, livestock / tree mortality;
- ⊗ **Supporting services:** (necessary for the production of all other ES) including photosynthesis, biodiversity conservation, soil formation and nutrient cycling;

- ⊗ Cultural services: notably those important for vulnerability / risk aversion, security, enjoyment, status, identity etc.

The effects of changes in these ecosystem services on livelihoods and well-being can be identified. For example, changes in production of food, wood, fibre and fuel and in supplies of freshwater will affect nutrition, health, income and food security, as well as resilience to climate change and perhaps also social relations as access to / competition over natural resources also change.

While in the field and during the analysis of findings, the wider effects of land management on the functioning of the ecosystem and provision of the above ecosystem services can be taken into account. To allow a reasonably rapid assessment, the main focus should be placed on the effects of land use / management on provisioning services and livelihoods (income, food security, vulnerability, etc.). However, also record any significant effects of the current practices (i.e. vegetation cover; soil management) on the key regulating and supporting services notably changes in water regime/ hydrology, in organic matter losses/inputs (biomass and soil) and nutrient losses/inputs.



3

CHAPTER

Planning the local assessment

This section guides users on setting up the assessment team and collection of relevant background / secondary information. It also covers the selection of study area and sampling strategy; discussions and interviews with land users and advises on how to conduct the field work for the assessments.

3.1 Composition of the team, assessment steps and timing

The assessment collects information and data on land use / management and livelihoods; vegetation, soil, water resources, land productivity, also other environmental and social services. In addition, it involves the synthesis and analysis of the findings and the production of outputs.

Ideally the team members should have expertise in all these main disciplines:

- ⊗ soil science and agronomy:
- ⊗ water resources management:
- ⊗ animal production (settled/ pastoral systems, livestock, wildlife, etc.):
- ⊗ social sciences (e.g. land tenure, rights, gender, etc.):
- ⊗ agricultural economics (e.g. costs, benefits, tradeoffs, etc.):
- ⊗ ecology - forest and rangeland management.

A multidisciplinary team will help to ensure that the assessment has both scientific rigour and delivers outputs which are relevant and accessible to all stakeholders. It is most important to include at least one person with experience of socio-economic assessment and use of participatory rural appraisal (PRA) tools such as focus group discussions, community/territory mapping, organizational analysis, household interviews, etc.



PHOTO 1 Local assessment team

Where possible, the team should be made up largely of experts from the local assessment area, however if this is not possible (e.g. lack of capacity or training in the assessment methods), the assessment team should be guided and supported by local representatives, for example, technical staff from the district / provincial offices and relevant projects on the ground.

A team leader is required to coordinate the assessment team and process and to also lead the final analysis of the results and the assessment products (database, report, case studies and policy briefs). Experience of field work, team management, natural resources assessment, data collection and participatory and inter-sectoral assessment are all desirable qualities for the team leader. Moreover good communication, exchange and data sharing between all team members are essential.

It should be possible for a team of approximately five to ten people to implement this assessment in a period of four weeks (full time), including time for analysis, feedback and report writing.

The coordinator of the team should ensure that the required field tools and equipment are procured well before the assessment begins (International ordering can take more than one month). A list of required field equipment (such as GPS, see Photo 1) is provided in Annex 1.

Figure 4 below shows the main steps in the LADA local assessment process.

3.2 Selection of the assessment areas

Local assessment area selection should be driven by the aims of the assessment team or sponsor. In the LADA project, LD / SLM information was required from the local assessment that could be extrapolated to give a picture of land condition



PHOTO 2 Equipment and hand tools

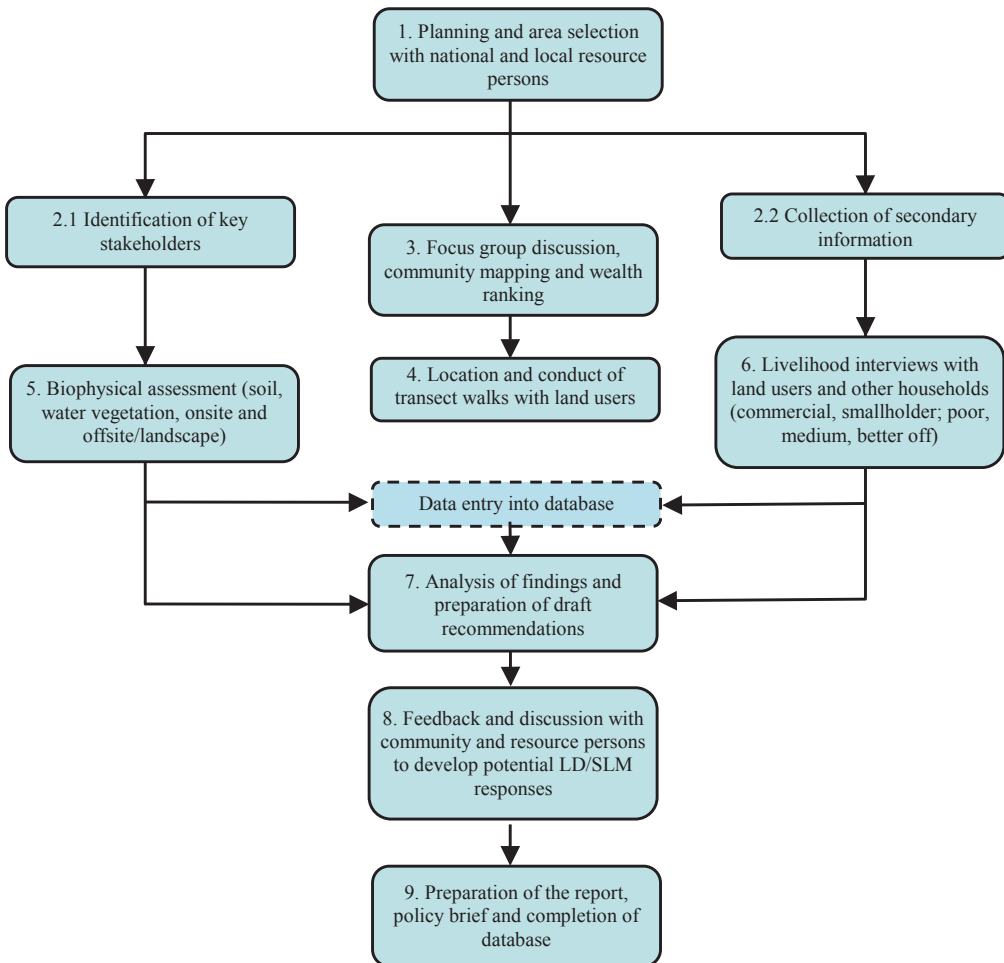


FIGURE 4 Main steps in the LADA Local Assessment

in larger land units or land use systems. Thus it was important for local assessment locations to be representative of these larger areas or systems. In other situations, the users might be interested in conducting the assessments in particular locations for different reasons e.g. concerns over land degradation, a wish to understand apparent improvements in land management, a particular policy or project focus etc.

Local policy makers and other stakeholders should be consulted and involved in the assessment where practicable as they will generally be interested in the assessment activities and results.

The timing of the assessment in terms of seasonality is important and should be agreed with local stakeholders. In drylands, the

vegetation condition may change dramatically between seasons and could influence the team's perception of degradation severity, see Photo 3. If the assessment is done after the rainy season it may be necessary to return to the area in the dry season to validate findings. Importantly, the timing should avoid peak periods for farmers / herders or technical and extension staff.

Linkages should be established between the local assessment and national LD / SLM assessments using LADA-WOCAT methods (using the QM questionnaire, CDE / WOCAT *et al.*, 2011), where it is being or has been conducted - or other natural resources assessments, in order that the findings can be validated and used in support of decision making. See Box 1.

3.3 Land Use Systems (LUS) and Land Use Types

In LADA, the **Land Use system (LUS)** is the basic unit of evaluation for the assessment of land degradation and sustainable land management at global, national and local levels. The LUS classification is based on the actual use of the land. LUS units are mapped and characterised using a number of biophysical and human parameters, including those relating to the land use or farming system, to the resource base/ biophysical attributes and to relevant socio economic attributes (see FAO, 2011). These include:

- ⊗ **Land use / farming system attributes:** dominant crop type / extent, livestock type density, irrigation type/scale, input level (management index);
- ⊗ **Resource base / biophysical attributes:** slope, soil type, rainfall / temperature regime, length growing season, altitude (DEM/ terrain);
- ⊗ **Socio economic attributes:** population density, poverty level, infrastructure, protected areas and urban / rural population.

National LUS classes can be further subdivided at local level through other available information related to land use for example:

D.S. NDIAYE



A. WELE



PHOTO 3 **Field with improved fallow before & 1 month after rains (Diagaly, Senegal)**

BOX 1 National - Local LADA linkages

Where a national land degradation (LD) and sustainable land management (SLM) assessment has been or is being conducted using the LADA-WOCAT mapping method (QM) which is based on a land use systems (LUS) map and selected administrative units (e.g. district or province), the selection of local assessment areas can be guided by the results of this national LD / SLM assessment and in collaboration with decision makers. Such a clear and robust stratification strategy based on the LUS is required, to allow the findings of the local assessment (field level) to be linked to the results of the (sub) national assessment. It is important that the areas chosen for the local assessment should represent the LUS of interest at country level (i.e. a technical sector or policy makers may wish to analyse in more depth the DPSIR relations in specific areas that are degrading (i.e. high potential areas) or areas that are improving with a view to adapting or strengthening the response measures.

Based on the pilot countries experiences in conducting their local assessments and testing the LADA methodology, the selection of the local assessment areas can be done either by targeting a specific land use system (LUS) of interest, or by selecting an area of interest and assessing the main (2-3) LUS within that area. The most suitable approach in a particular situation depends on the heterogeneity of the assessment area in terms of LUS and of the land management practices present within a LUS.

Where both local and national assessments are being conducted, the reasoning behind the sampling should follow this sequence of steps:

1. Based on the LUS map and national assessment of LD and SLM, identify the nationally important LUS i.e. those most requiring in depth investigation;
2. For the selection of your local assessment areas, choose the areas where these important LUS are most represented (1 area can include 1 to 3 important LUS)
3. Depending on the homogeneity or heterogeneity of the LUS, select your study areas (2-6 km) inside that larger local assessment area (20-60km). If very homogenous, one larger study area may be sufficient; if heterogeneous, a few study areas would be needed to well characterize the LUS. (Variability in the LUS itself can be caused by farm size, land tenure, terrain, management (conventional, conservation, organic, extensive grazing, and intensive grazing), etc.)

- ✘ **Land tenure and size of farms:** land areas used for large, commercial farms are often quite distinct from small commercial farms or areas which are mostly used for subsistence farming;
- ✘ **Forest management and exploitation:** countries may have geo-reference information at sub-national level which distinguishes different types of forest management and exploitation (including selective felling, firewood gathering etc);

- ✘ **Water resources and irrigation:** it may be possible at sub-national level to delineate areas which make use of different water sources (rivers, aquifers, man-made reservoirs above or below ground) for different purposes e.g. for irrigation;
- ✘ **Fertilizer use, mechanization and other inputs:** cropland may be further subdivided using information available such as use of inputs by crop (fertiliser, organic matter, herbicides etc.) and seed varieties;

- ⊗ **Recreation areas, parks, reserves, wetlands, etc.:** may be further differentiated and may fall in any land use system. Protected areas data and maps are available from the World Database on Protected Areas.

Table 1 (below) shows the main LUS classes at national level (adapted from South Africa, as shown in the manual for national level land degradation / SLM assessment (QM) CDE / WOCCAT 2011) with some examples of how these can be further differentiated into Land use types depending on resolution (scale) and information availability (using examples from Tunisia).

TABLE 1 Major land use systems and land use types

Code	Land Use Systems (national level)	Land Use Types (LUT) (local level)
F	Forests / woodland (virgin / natural, plantations and protected) used mainly for wood production, other forest products, recreation, protection	
Fn	<ul style="list-style-type: none"> • Natural forests: woods / forests composed of indigenous trees, not planted, including riverine forests 	May differentiate between types of forest and wood land (e.g. evergreen, (semi) deciduous, xeromorphic) and their density (dense / sparse)
Fp	<ul style="list-style-type: none"> • Plantations, afforestation, woodlots: forest stands established by planting and / or seeding during afforestation or reforestation (including plots and wider wind- / shelterbelts) 	
Fo	<ul style="list-style-type: none"> • Other: e.g. selective cutting of natural forests and incorporating planted species 	
PF	<ul style="list-style-type: none"> • Protected area that is forested 	e.g. Forest Reserve
G	Grassland (unmanaged to intensively managed for grazing by livestock and wildlife and protected areas)	
Ge	<ul style="list-style-type: none"> • Extensive grazing land: grazing on natural or semi-natural grass lands, grasslands with trees / shrubs (savannah vegetation) or open woodlands for livestock and wildlife, low livestock density 	Can distinguish e.g. <ul style="list-style-type: none"> • tall / medium / short grassland • forbs
Gi	<ul style="list-style-type: none"> • Intensive grazing / fodder production: improved or planted pastures for grazing / production of fodder (for cut and carry-hay, leguminous spp., silage etc.) (Not annual fodder crops). Moderate to high livestock density 	
PG	<ul style="list-style-type: none"> • Protected grassland (may or may not be used for grazing) 	
S	Shrub land (unmanaged ,extensively managed or protected)	
Se	<ul style="list-style-type: none"> • Extensive grazing land: grazing on natural or semi-natural shrub lands, shrub lands with trees / shrubs unmanaged or extensively managed with low livestock and wildlife density 	e.g. by type and density <ul style="list-style-type: none"> • Bush / Sparse Bush / Dwarf Bush / Sparse Dwarf Bush • Garrigue • Tundra • Evergreen / Semi-deciduous / Deciduous / Xeromorphic
Si	<ul style="list-style-type: none"> • Intensive grazing: on shrub land with moderate or high livestock or wildlife density 	
PS	<ul style="list-style-type: none"> • Protected shrubland 	
	May or may not be used for grazing or browsing	

TABLE 1 Major land use systems and land use types (continued)

Code	Land Use Systems (national level)	Land Use Types (LUT) (local level)
C	Agriculture / cropland: Land used for cultivation of rainfed or irrigated crops (field crops, orchards).	
Ca	<ul style="list-style-type: none"> Annual cropping: land under temporary / annual crops usually harvested within one year, or maximum of two years (e.g. maize, paddy rice, wheat, vegetables, fodder crops such as maize, oats) May be sub divided into rainfed or irrigated	e.g. <ul style="list-style-type: none"> Horticulture Cereals, etc
Cp	<ul style="list-style-type: none"> Perennial (non-woody) cropping: land under permanent (not woody) crops that may be harvested after 2 or more years, or only part of the plants are harvested May be sub divided rainfed / irrigated	e.g. <ul style="list-style-type: none"> Sugar cane, Banana Sisal Pineapple etc.
Ct	<ul style="list-style-type: none"> Tree and shrub cropping: permanent woody plants with crops harvested more than once after planting and usually lasting for more than 5 years (e.g. orchards / fruit trees, coffee, tea, vineyards, oil palm, cacao, coconut, fodder trees) May be sub divided rainfed / irrigated	e.g. <ul style="list-style-type: none"> Olive orchards Vineyards etc.
Cai	Large-scale irrigation:	<ul style="list-style-type: none"> e.g. public or private sector; may include Oases
Cpi	<ul style="list-style-type: none"> Annual cropping 	
Cti	<ul style="list-style-type: none"> Perennial cropping Tree or shrub cropping 	
Co	<ul style="list-style-type: none"> Other irrigated areas 	<ul style="list-style-type: none"> may include Oases
PC	Protected areas used for cropping	
M	Mixed land use systems/ types: a mixture of land use within the same land unit.	
Mf	<ul style="list-style-type: none"> Agroforestry: combination of planted crops and trees 	
Mp	<ul style="list-style-type: none"> Silvo-pastoralism: forest and grazing land 	
Ma	<ul style="list-style-type: none"> Agro-pastoralism: cropland and grazing land (including seasonal crop-livestock change) with moderate or intense livestock density and in some cases irrigated crops 	
Ms	<ul style="list-style-type: none"> Agro-silvopastoralism: cropland, grazing land and trees (including seasonal change) 	
Mo	<ul style="list-style-type: none"> Other: other mixed land 	
B	Sparsely vegetated or bare land	
Bu	<ul style="list-style-type: none"> Unmanaged: bare lands, deserts, glaciers 	
Bt	<ul style="list-style-type: none"> Pastoral or agropastoral: e.g. transhumant systems with low, moderate or high density livestock during very short period 	
PB	<ul style="list-style-type: none"> Protected bare or sparsely vegetation area 	e.g. national park

TABLE 1 Major land use systems and land use types (continued)

Code	Land Use Systems (national level)	Land Use Types (LUT) (local level)
O	Other land use:	
Ou	<ul style="list-style-type: none"> • Urban: Settlements, infrastructure networks: roads, railways, pipe lines, power lines 	
Oi	<ul style="list-style-type: none"> • Mines and extractive industries, quarries, 	
Wa	Natural and artificial water bodies	
Wu	<ul style="list-style-type: none"> • Natural inland water bodies unmanaged (inland natural lakes, permanent and seasonal rivers, streams) 	
Wf	<ul style="list-style-type: none"> • Inland water bodies used for food production: natural lakes, rivers, streams and ponds used for aquaculture and fishing 	
Wo	<ul style="list-style-type: none"> • Other: Waterways, drainage lines, canals, ponds, dams (man made) 	
PO	<ul style="list-style-type: none"> • Protected areas of open water 	
Wt	Wetlands	
	<ul style="list-style-type: none"> • Unmanaged wetlands, swamps, bogs etc not managed 	
	<ul style="list-style-type: none"> • Mangrove 	
	<ul style="list-style-type: none"> • Wetland with agricultural activities 	
PW	Protected wetland	e.g. Ramsar designated

Protected areas or wetlands may be subdivisions under the other LUS (forest, grassland, agricultural, shrub etc.). However they are shown here as a separate LUS to emphasize that their conservation and sustainable use is very important in drylands and to ensure they are not neglected.

The following sequence of photos (4-8) shows a range of diverse land use types in drylands in the pilot LADA countries.

3.4 Sampling strategy

The following 3-tiered sampling strategy is recommended where there is a need to extrapolate findings up to a sub-national (e.g. provincial) or national level:

Local assessment area (Tier 1): The first sampling tier below national level. The local assessment areas should / are likely to be selected to inform stakeholders about land resources in the main LUS within a country. The areas are typically geographically defined units: administrative units such as districts, or biophysical units such as watersheds. The choice of these areas should be made on the basis of the LADA / WOCAT national assessment results, and / or discussions with policy makers. They could be areas of economic importance, of high potential, of rapid change, or selected in specific agro-ecological zones and with specific types and levels of degradation. The selection may depend on logistics (i.e. not too remote to reduce time and cost), recent projects or investments (i.e. to assess their impacts) or other factors. It is essential that areas are representative



PHOTO 4 **Wooded savanna used for agro-pastoralism, Touba Ndar Fall area, Senegal**



PHOTO 5 **Wooded vegetation and bare rock surfaces in drylands in Guantánamo, Cuba**

of the issues / areas of national priority concern and interest with respect to land degradation and / or SLM so that the findings will have broad relevance. One local assessment area can be effectively a sample of one or a few nationally important LUS. They can be quite large, for instance hundreds of km² where the landscape is very homogeneous. They will often be quite

heterogeneous, including several land use types, land management practices, degradation processes and SLM measures, also a range of impacts on people and ecosystem services.

Study area (Tier 2) Within the local assessment areas, a few study areas for the field level assessments should be chosen to assist cross-



PHOTO 6 Irrigated cropping in dryland in Xiaobazi, Fengning, China



PHOTO 7 Grassland in Camagüey-Las Tunas, Cuba



PHOTO 8 Sparsely vegetated dryland and bare rocky slopes in Argentina

checking between local and sub-national assessment results and to enable the findings to be brought to a level at which substantive decisions can be made. The most important consideration in choosing the study areas is that they should be representative of the local assessment area and, where a national LADA assessment has been conducted, also representative of the selected Land Use Systems (LUS) present within the local assessment area. The ability to extrapolate the assessment findings from local level to provincial level and above depends on this representativeness. As the local assessment areas are often quite large, in general, it will be necessary to select two to four study areas in order to capture the diversity of LUS, land use types and management practices, also LD / SLM situations within each local assessment area.

The study area may contain a single or several settlements / communities, with distinct community territories (delimited) but often with overlapping resources use arrangements (e.g. for water, grazing and fuel wood). In other cases, the settlement pattern may be dispersed households or clustered in larger family units and with varying degrees of authority (weak to strong) in terms of natural resources management. In drylands, a dispersed settlement pattern is quite common to reduce pressures on fragile resources. Land-users may be sedentary or mobile and the mobility may be permanent (i.e. nomadic) or seasonal (agropastoral). It is important for the assessment team to think about this pattern in the planning stage, in order to achieve a representative sample of the local population and LUS.

The community or local organizational unit is likely to be an important part of the sampling strategy, as the rules and systems regulating access and management of land resources are often organized at local / community level.

Thus even if the study area contains several communities, some community level data collection and analysis is required to fully understand such issues.

An appropriate study area could be:

- ⊗ a delimited territory (community, local organization / grouping of land users);
- ⊗ a territory shared by 2 or more communities (NB the boundaries may vary according to the use i.e. the community land may not have the same boundaries as the land area used for extensive livestock watering and grazing);
- ⊗ a small catchment or watershed or selected landscape unit;
- ⊗ a randomly selected area within the local assessment area (LAA).

Transects and Detailed Assessment Sites (Tier 3): An effective way to sample the study area, the selected LUS, the landscape and how it is used by the land users and the wider local population / community is through a transect-based sampling approach. Transects should be selected to cross the landscape (maybe from a higher to a lower elevation or from a settled community to a more remote area) and to cut across a range of land use types and land users (commercial, smallholder; farmer, herder, mixed; land owner, tenant, farm labourer etc.).

Transects

- ⊗ Transects do not need to follow a straight line. They are used to verify features raised in the local / community discussion and to identify sites for detailed assessments. They are appropriate for use in detailed quantitative sampling.
- ⊗ The alignment of transects should be chosen to provide an overview or



PHOTO 9 Transect cutting across a landscape and village

characterisation of the study area, including the landscape / natural resources and the human management context within which land degradation and sustainable land management (LD / SLM) are occurring. This characterisation should enable the team to confirm that the study area is representative of the LAA and of the national level land use systems (LUS) within it.

- ⊗ The characterisation will, in turn, provide the team with a rational basis for selecting the location and number of sites along each transect for the detailed assessments (i.e. based on the different land users, land use types and management practices and SLM interventions).

There are two options for locating the transects:

- ⊗ In a more diverse terrain (e.g. varying topography and LUS) a transect of several kilometres in length can be

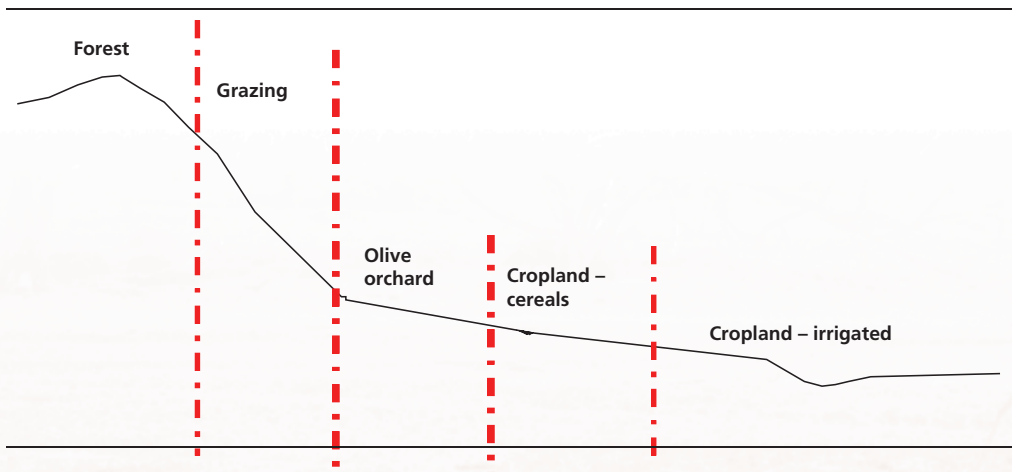


FIGURE 5 Schema of a transect crossing different land use types in Tunisia

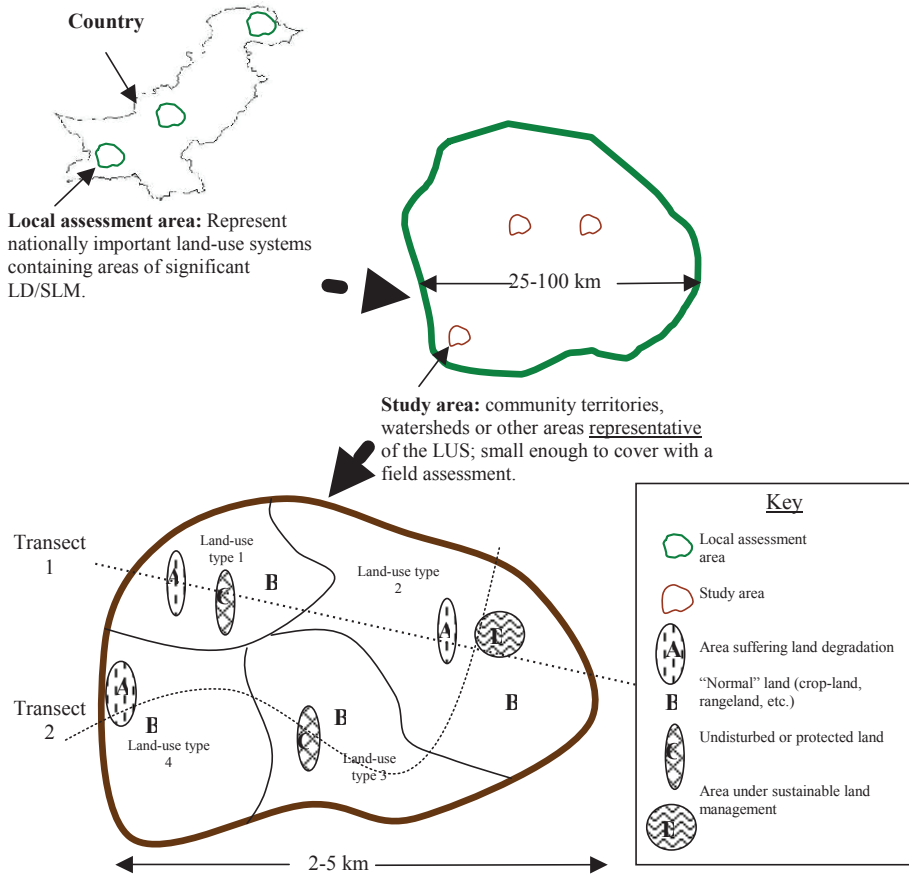


FIGURE 6 The sampling strategy of the local assessment

selected to cut across the various main land use systems / types and thus the main types of degradation and SLM practices in the study area; (see Photo 9 and Figure 5).

- ✘ In a very flat / homogeneous landscape (e.g. the groundnut plains of Senegal), it may be preferable to locate, using the information provided during the focal group discussions (FGD) and community mapping, a series of short transects to represent different land use

types and land user types that are found in the local assessment area.

Comparison is a key feature of the assessment, for example to compare areas that are showing strong / moderate signs of degradation with areas where SLM practices are used and showing few or no signs of degradation. Through discussion on the ground with the land users the effects of the land use and management practices used in the area (i.e. causes of LD) can be compared, for example, a degraded area (A) on one farm

BOX 2 Number of sites for detailed assessment and number of interviews

This example relates to the study area in Figure 3 above in which there are 4 land use types (LUT) (which is higher than the norm but illustrative of the possible complexity):

- In LUT 1, a three way LD / SLM comparison is possible: between degraded land (A) and “normal” land (B), and natural / undisturbed vegetation (C): 3 sites replicated 3 times = 9 sets of measurements
- In LUT 2 a three way comparison is also possible: A with B with an area under sustainable land management (D) = 9 sets of measurements
- In LUT 3 a two way comparison is possible: B with C = 6 sets of measurements
- In LUT 4 also a two way comparison is possible: A with B = 6 sets of measurements.

In this case, a total of 30 sets of biophysical measurements are required to sample this area (9+9+6+6). Interviews with up to three land users per LUT would be required, depending on whether the same land user manages more than one of the sites A, B, C. Thus a total of around 9 livelihoods interviews should be conducted in this study area with the land users, in addition to some additional interviews with local informants and other stakeholders (e.g. hired labourers / herders).

caused by poor farming practices (burning of residues, repetitive tillage etc.) can be compared to a demonstration area under conservation agriculture (D1) and to a good farmer using conventional tillage but with organic matter management from stall fed livestock (D2).

Triangulation is used to address such observations on the ground, with information from land users encountered during the transect walk and with information gathered through household interviews and discussions with key informants.

Sites/plots for detailed assessment

Comparison is at the heart of the sampling strategy. Detailed assessments are conducted in areas of LD, SLM and undisturbed or protected land and then results from these are compared. For example, in Figure 6, A, B and C are compared in land-use 1; A, B and D are compared in land-use 2, etc. The number of comparisons possible will depend on the heterogeneity of the study area (see Box 2).

Photo 10 shows the differential vegetation quality on both sides of a fence (i.e. more woody and drier vegetation on the right). Such a barrier which may result in differential grazing patterns, for example, provides a useful comparison.

The objective with the detailed site assessments is to generate an in-depth understanding of each of the main types / processes of land degradation and the main land management practices in the study area, in which land use system(s) / type(s) they occur and to provide an analysis of their drivers and impacts. It is likely that there will be several or perhaps many distinct land-use types (LUT) present within a study area and these will depend on the diversity of the terrain and the range of land users (land holding size, assets, level of education / training, also other constraints and opportunities such as markets and land tenure security etc.).

As far as possible, the plots / sites should provide a comparative element to the sampling (i.e. degraded land can be compared with land that is not degraded or land under specific



PHOTO 10 Fencing showing differential degradation (Bariloche, Argentina)

sustainable land management (SLM) practices). The detailed measurements of soil and vegetation, in particular, should be replicated 2-3 times in each site / plot. The total number of sets of measurements required in the detailed assessment is typically in the region of 20-40 per study area, depending on the diversity of land use and management practices in the area.

If there are available aerial photographs and remote sensing images (such as NDVI), which provide a time-series picture of land degradation and conservation / improvement (over a 10-50 year period), these can help identify study areas, guide the location of transects and those sites / plots of most “interest” for the detailed assessments. For example, there may be areas where there has been a recent marked decline in quality of land resources (such as vegetation),

a dramatic change in land-use (e.g. intensified cultivation in marginal areas) or areas where sustainable management practices are being used and land restoration / rehabilitation has resulted in significant improvement in the quality of land resources (soil, water, vegetation and biodiversity).

In this manual, the indicators and methods for the assessment of vegetation and soil and water resources are presented sequentially as Tools 1.1 to 7.1, in Part 2 Field Methodology and Tools of the LADA local manual (FAO *et al.* 2011b). However, in reality the team members will assess both soil and vegetation condition / state (which are intimately interrelated) in relation to the land use practices (degradation processes or sustainable land management) at each selected detailed assessment sites. A simple scoring

system is provided for soil health, soil erosion and pasture / range condition, but not for crop or forest condition.

A visual, qualitative method is proposed in the manual for assessing pasture/range condition in LADA-L. However, further **detailed vegetation assessments** can be conducted, if countries wish, building on LADA pilot country experiences/ research with **Landscape Functional Analysis**

(**LFA**) **methods** (Tongway and Hindley, 2004), notably i) ecological monitoring of rangelands and wetlands in South Africa, and ii) use of MARAS methods for environmental monitoring of arid and semiarid regions in Argentina. Both experiences used fixed transects with indices of landscape organisation, vegetation and soil (e.g. recording patches, size, distances, basal cover, litter, nutrient recycling) and indicator and alien species in order to assess

TABLE 2 Definitions and hierarchy of mapping and sampling units

Level of sampling/unit	Size / number and definitions
Local Assessment area (LAA) (first tier)	Two to six areas per country. Each local assessment area could be anything from a single watershed to a region of several hundred km ² . They should be representative of one or more important land use system (LUS) and will be areas of significant LD / SLM activity and impact.
Land Use System (LUS)	The generalized input and management actions designed to obtain goods and services from the land including these goods and services (FAO, 2007). The study area, which contains the sites where transects and field sampling is conducted, should be representative of the given LUS. <i>Low resolution (scale 1: 250 000-1:500 000)</i>
Study Area (second tier)	Two to four locations per LAA to ensure that the area is well represented. Size variable. The study areas must be representative of the local assessment area, containing as many of the main LUTs (as variants of the LUS) and forms of LD / SLM present in the LAA as possible. A study area may represent a community and the territory it occupies or it may have some other delimitation depending on the local environment.
Land Use Type (LUT)	The use to which land is put which may reflect the arrangements, activities and levels of inputs by the land users. (The WOCAT classification system is used in LADA-L). <i>High resolution.</i>
Sites/field plots for detailed assessments (third tier)	At intervals along transects, detailed assessment sites will be identified, at each site: Three pairs of plots per land use type (LUT) depending on the number and complexity of the LUT.
Land Unit (LU)	An area of land defined in terms of biophysical land qualities and characteristics that may be demarcated on a map. It may be smaller or larger than the LUT.
Land use	Human activities which are directly related to land, making use of natural resources or having an impact upon the land.
Land cover	Vegetation (natural or planted), water or man-made structures (buildings, infrastructure, etc.) that cover the earth’s surface.

heterogeneous morphological characteristics (e.g. bare patches in landscape and grass cover) and relate land use/pressure to effects on vegetation and landscape functionality. Where such a combined soil and vegetation analysis is conducted using Landscape Functional Analysis (LFA) methods it would be useful if results could be compared with the tools provided in this manual to provide feedback to LADA.

Assessment of specific SLM practices

A specific assessment should be made of a few key SLM Technologies and Approaches (see Annexes 2 and 4) that are identified for specific consideration by land users and resource persons in the study area (e.g. those most commonly adopted and / or most effective and / or problematic in terms of skills, cost, maintenance, etc.). These SLM technologies may be related to specific LUS / LUT and land user groups.

The SLM assessment is conducted using the tools developed by the World Overview of Conservation Approaches and Technologies (WOCAT) namely the **Technologies questionnaire (QT)** and the **Approaches questionnaire (QA)**. Examples of case studies resulting from the information generated through these questionnaires are provided in Annexes 3 and 5. For each SLM technology / practice assessed, there should be a related approach that is also assessed.

Table 2 shows the hierarchy of mapping and sampling units from the local assessment area to the land use systems, the specific study area, transects, detailed sampling sites along the transects and SLM technologies and approaches in the study area.

4

CHAPTER

Land degradation and SLM typologies

4.1 Land degradation definitions and processes

When land is degraded, its productivity is reduced and many other ecosystem services are deleteriously affected. Land degradation may be primarily caused by natural processes, related to the characteristics of the given land resources and ecosystems. However, human activities often accelerate these degradation processes, leading to a rapid decline in the quality and quantity of the land resources and the ecosystem services flowing from these. Drylands are fragile and particularly susceptible to land degradation.

There are many definitions of land degradation:³

- LADA defines land degradation as: *“The reduction in the capacity of the land to provide ecosystem goods and services and assure its functions over a period of time for its beneficiaries.”*
- UNCCD defines land degradation in the context of drylands as: *“a reduction or loss, in arid and semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns.”*

These definitions provide a broad view on the nature of land resources (they include soil, vegetation and water) and the range of products, goods and services people obtain from the land.

³ There is sometimes confusion between the terms degradation and desertification, whereby UNCCD, UNEP and GEF define desertification as *“land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities”*.

Land degradation is caused by a variety of complex interrelated degradation processes. These can be grouped into three major land degradation types, each of which can be subdivided according to a specific sub-set of degradation processes, namely:

- ⊗ Soil degradation;
- ⊗ Vegetation degradation;
- ⊗ Water resources degradation.

A number of these degradation types and processes are likely to occur in a specific site or area and are caused by the same land uses and management practices but they may be more easily assessed and the causes understood, by assessing them one by one – soil- vegetation- water - and then pulling the information together for the land use and livelihood system.

The assessment team needs to identify the main LD / SLM processes occurring across the study areas and to assess the extent and degree of their impacts in each of the main land use systems and land use types.

In addition to direct effects of land use and management practices, three specific drivers need to be given due attention as they often lead to a lower productive potential, notably: i) land use change ii) contamination / pollution of water and soil from other sources and iii) climate change and variability.

Observations of the effects of land use type and management practices (e.g. burning, overgrazing etc.) on soil, water and vegetation indicators need to be triangulated and supplemented with feedback from land users and local key informants explaining reasons for changes in land use or management, also any constraints to the adoption of SLM practices. The process of identifying the main drivers and pressures of land degradation with the land users helps to highlight the SLM “bottlenecks”, broadening the scope and relevance of the assessment for land use planning.

TABLE 3 Soil degradation types and processes

Soil degradation types	Key processes
Degradation of soil biological properties	Reduction in numbers and activity of beneficial soil organisms (<i>bacteria, rhizobia, mycorrhiza, earthworms, termites etc. and associated loss of function</i>)
	Increase in numbers and activity of harmful soil organisms (<i>nematodes, parasitic weeds etc. and associated pest / disease damage</i>)
Degradation of soil chemical properties	Decline in number and availability of soil nutrients (<i>N,P,K, secondary and trace elements through leaching, gaseous losses, removal in harvested products etc.</i>)
	Changes in soil pH (<i>acidification or alkalisation</i>)
	Chemical imbalances and toxicities (e.g. <i>through application of inappropriate types and quantities of fertiliser, pesticides etc.</i>)
	Salinization (<i>build up of salts through poor irrigation practices in crop lands and poor grazing practices in grasslands</i>); and sodicity.
	Chemical pollution (e.g. <i>from over use of agro-chemicals, plastic mulches or poor management of industrial and mining wastes</i>)

4.1.1 Soil degradation

Soil degradation occurs when there is a decline in the productive capacity of the soil as a result of adverse changes in its biological, chemical, physical and hydrological properties and/or

attributed to the removal of soil through erosion by water or by wind or by mass movement. Sheet, rill and gully erosion by water, also the scouring and re-deposition of soil by wind and landslides are some of the most visible symptoms of soil degradation, but other less

TABLE 3 Soil degradation types and processes (continued)

Soil degradation types	Key processes
Degradation of soil physical properties	<p>Surface crusting and compaction (e.g. through the impact of raindrops, animal hooves and farm machinery) and burning</p> <p>Loss of topsoil structure (e.g. through excessive tillage and loss of soil organic matter)</p> <p>Sub-soil compaction (e.g. due to the passage of heavy farm machinery and / or ploughing to a constant depth)</p> <p>Reduced soil rooting depth (erosion)</p> <p>Loss of soil fines (erosion of silts and clay) leaving sandier and stonier soils</p>
Degradation of soil hydrological properties	<p>Waterlogging (rise in the water table close to the soil surface due to poor irrigation practices, or loss of deep rooted vegetation whose water needs would have kept the water table low or reduced soil permeability)</p> <p>Aridification (decrease in soil moisture availability, typically due to reduced rain water capture and infiltration following loss of vegetation, deep rooting and deterioration in the soil physical structure including wind blown deposition)</p> <p>Reduced plant water uptake due to soil salinization</p>
Soil erosion	<p>Soil erosion by water (splash, sheet, rill and gully erosion)</p> <p>Soil erosion by wind (removal and re-deposition of soil particles, abrasion by transported materials and formation of mobile sand dunes)</p> <p>Gravitational erosion (mass movement through landslides, slumps, earth flows and debris avalanches)</p> <p>Freeze/thaw erosion</p>
Soil pollution	<p>Soil chemical imbalances and nutrient toxicities (e.g. due to the application of inappropriate types and quantities of fertiliser)</p> <p>Build up of inorganic pollutants in the soil (e.g. as a result of over use of agro-chemicals and deterioration, in the topsoil, of residues from use of plastic mulches)</p> <p>Accumulation of pollutants / toxicities of organic origin following the planting of certain crops (tobacco, eucalyptus, Jatropha spp. etc)</p> <p>Emissions of toxic chemicals (e.g. from industrial smoke from heavy industry settling on the soil surface (downwind))</p>

visible forms of degradation of soil properties are even more widespread and sometimes more serious, notably depletion of nutrients and soil organic matter decline.

The key processes that are responsible for soil degradation are listed in Table 3. It should be recalled that soil conservation and improvements and their impacts should also be assessed; thus the indicators can show negative or positive changes or trends or stability.

Several of these degradation types and processes may occur simultaneously and they all result in a decline in soil productivity (i.e. the reduced capacity of the soil to support plant growth and to sustain yields of food and fodder crops, to sustain livestock productivity on pasture and rangelands and to sustain forest productivity). They also result in reduced soil resilience of the soil (i.e. capacity to support intensive management practices year after year and to withstand extreme events such as rainfall or drought).

Soil salinization is a particular type of dryland degradation that deserves specific attention. Soil salinization often restricts options for cropping and forestry, also affecting the quality of grazing in a given land area, as a limited number of plant species grow well on saline soils. It also negatively affects the quality of shallow ground water and surface water resources, such as ponds, sloughs and dugouts.

- ⊗ **Saline soils** occur where the supply of salts, for example from rock weathering, capillary rise, rainfall or flooding, exceed their removal by plant uptake, leaching and flooding. Thus salinization on the soil surface occurs where the following conditions occur together:
 - the presence of soluble salts in the soil (e.g. sulphates of sodium, calcium and magnesium;

- a high water table;
- a high rate of evaporation; and
- low annual rainfall.

- ⊗ **Sodic soils** contain a higher amount of sodium attached to clay particles. When in contact with water, a sodic soil swells and disperses into tiny fragments. On drying these tiny fragments block the soil pores, causing problems of crusting, hard-setting, poor infiltration and water-logging.

Excess salts hinder crop growth, not only by their toxic effects, but by reducing water availability, regardless of the total amount of water actually in the root zone. Salts in the soil increase the effort plant roots must make to take up water. High levels of salt in the soil have a similar effect as drought, reducing availability of water for uptake by plant roots, reducing plant growth and yields.

Soil erosion is a major form of land degradation. It comprises various processes that are described separately below; however, any one of these processes may occur in the same locality, either in combination or at different times of year:

- ⊗ **Soil erosion by water** is often quite widespread and can occur in all parts of drylands where rainfall is sufficiently intense for surface runoff to occur⁴. This category includes processes such as splash, sheet, rill and gully erosion.
 - Splash erosion is commonly the first stage of water erosion and occurs when rain drops fall onto the bare soil surface. Their impact can break

⁴ Although the total annual rainfall in dryland areas may be low, the amount and intensity of rainfall received during an isolated storm event can result in high rates of surface runoff and hence severe water erosion.

- up surface soil aggregates and splash particles into the air.
- As water runs over the soil surface it has the power to pick up particles released by splash erosion and the capacity to detach particles from the soil surface. This may result in sheet erosion, where soil particles are removed from the whole soil surface on a fairly uniform basis.
- Where runoff becomes concentrated into channels, rill and gully erosion may result. Rills are small rivulets of such a size that they can be worked over with farm machinery. Gullies are much deeper (often being several metres deep and wide) and form a physical impediment to the movement across the slope of farm machinery, even people and livestock.

Soils that have lost organic matter and had their structural stability degraded through excessive tillage are more vulnerable to water erosion. Likewise surface and subsoil compaction reduces the amount of rainfall that can infiltrate into the soil, leading to increased surface runoff and increased risk of water erosion.

- ⊗ **Soil erosion by wind** is also widespread throughout drylands that are exposed to strong winds. It includes both the removal and re-deposition of soil particles by wind action and the abrasive effects of moving particles as they are transported. In areas with extensive loose, sandy material, wind erosion can lead to the formation of mobile sand dunes that cause considerable economic losses through engulfing adjacent farm land, pastures, settlements, roads and other infrastructure. Wind erosion occurs:

- In farmland areas when soil is left bare of vegetation and the topsoil has been reduced to a fine tilth as a result of cultivation;
- In overgrazed grassland areas that have lost their protective vegetative cover;
- In forest / woodland areas following the cutting of trees and shrubs, in particular following the removal of the leaf litter and herbaceous ground cover.

In temperate climatic zones, the risk of wind erosion is highest in spring, prior to the onset of the summer rains, due to the combination of strong winds, dry topsoil, poor vegetative ground cover, also a lack of leaves on the trees in windbreaks planted to protect croplands.

In those parts of the tropics and sub-tropics with distinct wet seasons and dry seasons, the risk of wind erosion is highest in the latter part of the dry season when the topsoil is at its driest and the vegetative ground cover has died back.

- ⊗ **Gravitational erosion** tends to be more localised in regions with steep, rocky slopes and in mountain ranges. On sloping land when soil is saturated, its weight increases and the downward forces of gravity will induce a relatively large down-slope movement of soil and / or rocks (e.g. landslides, slumps, earth flows and debris avalanches). This mass movement of material may be very rapid and involve large volumes of soil, but is usually limited to isolated and localised events. Landslides may be natural events, however, their frequency and severity is likely to greatly increase following deterioration or loss of the natural vegetative cover by logging, overgrazing and / or clearing for cultivation. This

manual does not cover the assessment of landslides and mudflows.

- ⊗ **Freeze - thaw erosion** is restricted to high altitude areas and areas with cold climates. It occurs when water in the topsoil initially freezes and expands, then melts, damaging topsoil structure and enabling loosened surface soil particles to be carried away in melt water runoff. It is primarily a natural process rather than one which is accelerated by particular human activities. Its assessment is not covered in this manual although it was identified as an important form of erosion in colder parts of China.

Soil pollution also deserves consideration, as agricultural and industrial pollutants may contaminate the soil and affect plant growth and productivity, which may in turn contaminate water resources through leaching and runoff. No specific tools are included in this manual for assessing soil pollution; however, the team should look out for and if necessary identify suitable tools if there is substantial evidence or information for the problem. Examples of soil pollution include:

- Certain crop inputs can build up chemical imbalances or toxicities in the soil, notably mineral fertilisers, pesticides and inadequately treated organic waste / sewage sludge.
- Certain plants result in the accumulation of pollutants / toxicities of organic origin due to the production of organic chemicals in their roots or leaf litter that inhibit the growth of other plants, or result in other negative changes in soil properties (e.g. increasing soil acidity as can occur under pine plantations).

- Uncontrolled discharge of pollutants can contaminate water sources and also the land (e.g. when the water is used for irrigation purposes, or flooding takes place, or through erosion (by wind and/or water) and subsequent deposition of the material from spoil heaps and other wastes associated with mining and quarry operations).

4.1.2 Vegetation and biodiversity degradation

Vegetative growth in drylands tends to be limited by a range of natural factors, notably extreme temperatures, low and erratic rainfall, low soil water availability and shallow soils with low inherent fertility. In response, a number of highly specialised vegetation types have evolved and adapted to the local climate, topography and soils. Vegetation degradation involves a combination of processes that may be natural, notably climate change which may lead to a loss of certain species and habitats, reduced biomass due to reduced moisture availability, or encroachment by invasive species. However, vegetation degradation is generally induced by human activity, through the over use or mis-management of forests, grazing and croplands, uncontrolled burning or introduction of pests and diseases.

In assessing vegetation degradation, study should focus on the adverse changes in the quantity, quality and diversity of the plants that are found in grassland, forest and woodland areas. The degradation processes are summarised in Table 4. However, for better understanding of causes / drivers and impacts of LD / SLM, degraded areas should be compared with areas that appear to be less degraded / under better management practices, therefore these indicators could show negative or positive changes or trends.

TABLE 4 Vegetation and biodiversity degradation types and processes

Vegetation and biodiversity degradation	Key processes
Degradation of vegetation quantity and quality	<p>Reduction in vegetative ground cover – <i>with expanding areas of bare ground in formerly vegetated areas</i></p> <p>Reduction in vegetation biomass – <i>with fewer plants, at lower density, with reduced vigour and growth producing fewer leaves, stems, flowers, fruits, seeds, etc. (resulting in reduced yield of grassland, forest and woodland products)</i></p> <p>Reduction in the quality of the vegetative biomass – <i>where plant species of high value (for fodder, timber, fuelwood, food, medicines etc.) have been replaced, to a lesser or greater extent, by species of lower, or no value; or</i></p> <ul style="list-style-type: none"> • <i>parts of the plants have been damaged or their health affected through excessive removal of specific parts (for timber, fuelwood, fodder, fruits, food, medicine etc.)</i>
Degradation of plant diversity	<p>Reduction in species diversity and / or abundance</p> <ul style="list-style-type: none"> • <i>reduced numbers / populations of specific species in natural plant communities; or,</i> • <i>reduced diversity of local crop varieties and land-races</i> <p>Reduction in habitat for associated species (<i>pollinators, beneficial predators etc.</i>) <i>with consequent decline in related functions and resilience</i></p>
Degradation of animal productivity	Reduction in livestock (or wildlife) stocking capacity and productivity (due to reduction in biomass and feed quality)

The timing of the assessment is important, as the vegetation may appear very degraded in the dry season but will recover astonishingly fast during the rains. It is for this reason that the assessment team is encouraged to return and take photos at various times of the year, as illustrated by photos 11 and 12 which are taken during the rains and in the dry season.

Vegetation types are often closely related to the geology, soil types and terrain (topography) as shown by Photo 12 with distinctive vegetation of the basaltic plateau in Argentina.

4.1.3 Water resource degradation

There are various processes of water resources degradation, including changes in water quantity, quality and alterations in the hydrological regime. These are described in Table 5. As in the vegetation assessment, conservation or improvements in water resources should also be assessed; therefore these indicators can show negative or positive changes.

Degradation of water resources in terms of quantity, quality and flow regime will lead to reduced productivity of the aquatic system in terms of fish and other useful aquatic species and products. It also affects the availability of clean drinking water for consumption by humans, livestock and wildlife.

D.S. INDIAYE



a

A. WELE



b

PHOTO 11 Wet and dry season differences Senegal: a) Dried pond (Diabal) and b) large shallow pond, Niakha



PHOTO 12 Vegetation type on basalt plateau (Bariloche, Argentina)

TABLE 5 Water resources degradation types and processes

Water resource degradation	Key processes
Degradation of surface and ground water resources and change in hydrological regime	<p>Increased fluctuation in quantity of surface water flow (<i>leading to increased storm peak flows and reduced dry season flow as a higher proportion of the rain falling during storm events is lost rapidly as surface runoff rather than infiltrating into the soil</i>)</p> <p>Increased incidence of downstream flooding (<i>as upstream areas become degraded and can no longer absorb the volume of rainfall received during storm events</i>)</p> <p>Drying up of water sources (<i>rivers, springs, lakes, ponds, boreholes etc.</i>), (e.g. <i>more frequently and for longer periods as water is lost in surface runoff rather than infiltrating to replenish groundwater levels</i>)</p> <p>Reduced groundwater recharge (e.g. <i>due to increased surface rainwater runoff or reduced rainfall</i>)</p> <p>Lowering of the ground water table (e.g. <i>due to reduced recharge and increased extraction</i>)</p>
Degradation of water resources quality and storage capacity	<p>Increased sediment load in streams and rivers (e.g. <i>due to increased soil erosion in their catchment areas</i>)</p> <p>Reduced water storage capacity (e.g. <i>due to sedimentation of reservoirs</i>)</p> <p>Increased salinity of surface and groundwater resources (e.g. <i>due to excess salt flushing from irrigated areas</i>)</p>

TABLE 5 Water resources degradation types and processes (continued)

Water resource degradation	Key processes
Water pollution	<p>Pollution of surface and ground water resources (e.g. from leaching or discharge of human and animal wastes, agro-chemicals, industrial and mining wastes) affecting the water quality for human and animal consumption, for agro-industry and irrigation</p> <p>Decline in aquatic life and diversity due to water pollutants, with associated loss of key species in food web and reduced ecological resilience</p>

4.2 SLM technologies and approaches

4.2.1 SLM technologies

The following SLM technologies or management practices are widely known in all regions of the world. The findings of more detailed assessments of these practices in the local assessment area and their impacts on livelihoods and ecosystem services can validate the national assessment findings and provide further information for decision makers on the effectiveness of practices that are being promoted with government, NGO and / or private sector support.

1. Integrated soil fertility management (ISFM)
2. Conservation agriculture (CA)
3. Organic agriculture
4. Rotational cropping systems
5. Integrated crop-livestock management
6. Sustainable grazing land management
7. Pastoralism and rangeland management
8. Agroforestry
9. Sustainable planted forest management
10. Sustainable forest management (drylands and rainforests)
11. Cross-slope barriers on sloping lands
12. Rainwater harvesting
13. Surface and ground water management
14. Smallholder irrigation management
15. Water quality improvement
16. Gully control and other land

rehabilitation measures

17. Sand dune stabilization
18. Riverine and coastal bank protection
19. Protection against natural hazards
20. Waste management
21. Biodiversity conservation and sustainable use
22. Protected areas

Annex 2 provides brief descriptions of these various technologies and Annex 3 a case study.

4.2.2 SLM approaches

A SLM Approach defines the ways and means used to promote and implement a SLM Technology (be it project / programme initiated, an indigenous system, a local initiative / innovation) and to support it in order to achieve better and more widespread sustainable land management. It may include different levels of intervention, from the individual farm, through the community level to the extension / advisory system at provincial or national levels. It may be set within an international framework. Critical analyses of approaches should assist in answering questions about how land users learn about improvements or 'new' technologies, how they obtain skills to apply them, how they are stimulated to adapt technologies and innovate, also how they gain access to the required inputs, equipment and financial resources.

SLM approaches commonly stimulate the adoption and spread of improved SLM through addressing the problems and root causes of land resources degradation and low productivity that can be highlighted through the livelihoods assessment, for example:

- ⊗ Lack of technical knowledge (human capital);
- ⊗ social inequity (social capital);
- ⊗ poverty / lack of cash to invest in SLM, limited access to external inputs (financial capital);
- ⊗ conflicts over resource use, limited land resources (natural capital);
- ⊗ lack of access to markets (remoteness, poor infrastructure) and to services (physical capital);
- ⊗ lack of adequate policy and institutional support, with appropriate laws and regulations.

Common SLM Approaches include:

- ⊗ Participatory research and development (PRD) which includes Participatory Learning and action (PLA):

- ⊗ Participatory land use planning (PLUP)
- ⊗ Integrated watershed / landscape management (IWM)
- ⊗ Community-based natural resource management (CBNRM):
- ⊗ Community development / investment funds:
- ⊗ Extension, advisory service and training
- ⊗ Innovative extension approaches that empower farmers' groups and innovators
- ⊗ Payments / Rewards for ecosystem services (PES)

Annex 4 provides brief descriptions of these various SLM approaches and Annex 5 a case study.

These lists and descriptions draw from the LADA-WOCAT national assessment manual (CDE / WOCAT *et al.* 2011) and two WOCAT publications: the "SLM in Practice" handbook (FAO / TerrAfrica, 2011) and "Where the land is greener: Case studies and analysis of soil and water conservation initiatives worldwide (WOCAT, 2007)



5

CHAPTER

Characterisation of the study area

5.1 Introduction

Characterisation of the study area requires the team to:

- Identify key stakeholders, relevant projects and NGOs located in the area;
- Conduct a reconnaissance field visit, ideally before the Focus Group Discussion (FGD, Tool 1.1 in Part 2) with the selected land users / village / community. A walk or drive around the area with a few key informants will help the team (especially if not composed of local experts) to familiarise themselves with the study area, land uses and the extent and severity of degradation. If this takes place before the FGD, it can reveal interesting land resources features and observations to catalyse discussion with the community. It can also help in subsequent selection of relevant areas and precise locations / directions for the transect walks to cut across the various land uses, land user types and degradation / SLM features. Along each transect, a certain number of detailed site assessments will be conducted which will help to relate detailed investigations to the wider landforms or land use system(s);
- Collect and review available secondary information sources. More details and a list of recommended secondary information is provided in section 5.2 (below).

5.2 Background (secondary) information

Timeline and trends: The results from such a rapid assessment of local land resources and livelihoods need to be contextualized in regard to the current situation and trends over recent years, but also taking into account the history of land use and interventions in the area. Thus, while the local assessment focuses specifically on the last ten (or so) years, historical drivers of major land use changes should also be described as this may help explain the current situation, see Figure 7.

This requires a review of existing and ongoing land use and land resources interventions, also a review of the settlement history (50 years or so, the period depending on the context). The resulting time line and understanding of land use and socio-economic changes may explain to some extent the current land use patterns and behaviour. Such a review is best conducted with local authorities and technical institutions or projects working on land resources management in the area.

Background studies and statistical data: It is also important to review relevant policy, socio-economic and technical information for the study area(s) such as policy documents, development statistics and natural resources studies / data (e.g. on poverty, land tenure

and access to resources), also trends in crop, livestock and forest production and in ground and surface water resources.

Maps and Images: Maps, aerial photos and satellite images are important tools for use in the field during the local assessment of land degradation and sustainable land management. See Fig. 8. They serve many purposes:

- ⊗ As a basis for discussing and drawing sketch maps with local participants;
- ⊗ To help inform the assessment team on characterisation of the assessment area (topography, soils, vegetation cover, land use, infrastructure etc.);
- ⊗ To help acquire a semi-quantitative assessment of some features of the landscape, such as share of various vegetation or land use types, population density, distance / access to roads, water points and other infrastructure;
- ⊗ To compare situations over time (e.g. between seasons and years) and in space (e.g. an exploited area with a protected area) in order to help establish trends of degradation, stability or improvement.

The use of a camera to take landscape and site photographs is very valuable as part of the assessment, as this helps to document the situation at time “x”, to compare sites and

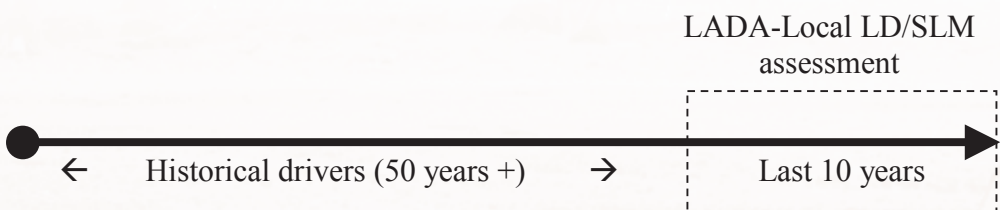


FIGURE 7 Time line of the LADA assessment



FIGURE 8 Use of Google earth, satellite images and aerial photos

monitor change. Photographs are valuable to present to a range of audiences to visualise differences and changes over time.

Natural resources information on the study area: After the community mapping and a reconnaissance visit and before the transect walks, a series of secondary information needs to be collected and reviewed for the study area. This will help back-up observations with reliable information and generate a better understanding of land resources status and trends (degradation, conservation, improvement).

The team should identify and review available:

- ⊗ Maps, satellite images and photos;
- ⊗ Climatic and meteorological records;
- ⊗ Human population and poverty statistics (census reports etc).
- ⊗ Databases, reports and statistics on:
 - Natural disasters;
 - Land and land use types;
 - Land tenure;
 - Farming system information (including agricultural census /crop yield data);
 - Livestock and wildlife statistics;

- Soil, vegetation and water resources;
- Economy and livelihood;
- Institutions, policies, regulations, by-laws.

There are some challenges in assessing vegetation and water resources in drylands, in particular due to the large inter-annual and seasonal variations. Assessments carried-out at a single point in time are incomplete unless they are backed-up by adequate secondary information on climatic trends, rainfall variability, population changes and so forth.

Such information is useful supportive information for the assessment report as shown in Figures 9 which shows population trends and Figures 10a and 10b which present long term records of total annual rainfall over 35 years and average monthly minimum and maximum temperatures and average rainfall and temperature.

In particular, it is important to use secondary (background) information to assess:

- ⊗ **Changes in climatic conditions, seasonality and trends** (rainfall and temperature data, evaporation, drought and flood frequency and severity, storms, strong winds and dust storm events). This information over a reasonably long period (20 or ideally 30 years) should be plotted on a graph to be shared and discussed with land users / informants (for example as part of the study area characterisation with informants, Section 5.1 above). This will help, in particular, to clarify differences between reality and perceptions in regard to rainfall amounts and variability, also occurrence and severity of extreme events. For example, often changes in land management and resulting soil quality, vegetation cover and water availability make land users believe that decline in rainfall has been

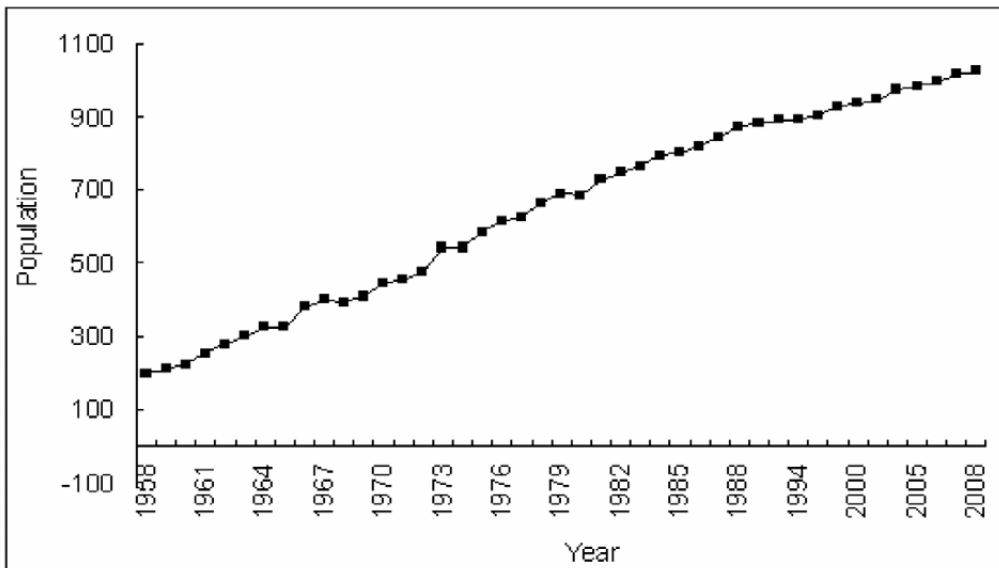


FIGURE 9 Population change of Ulan'aodu, Wengniute Banner (1958-2008)

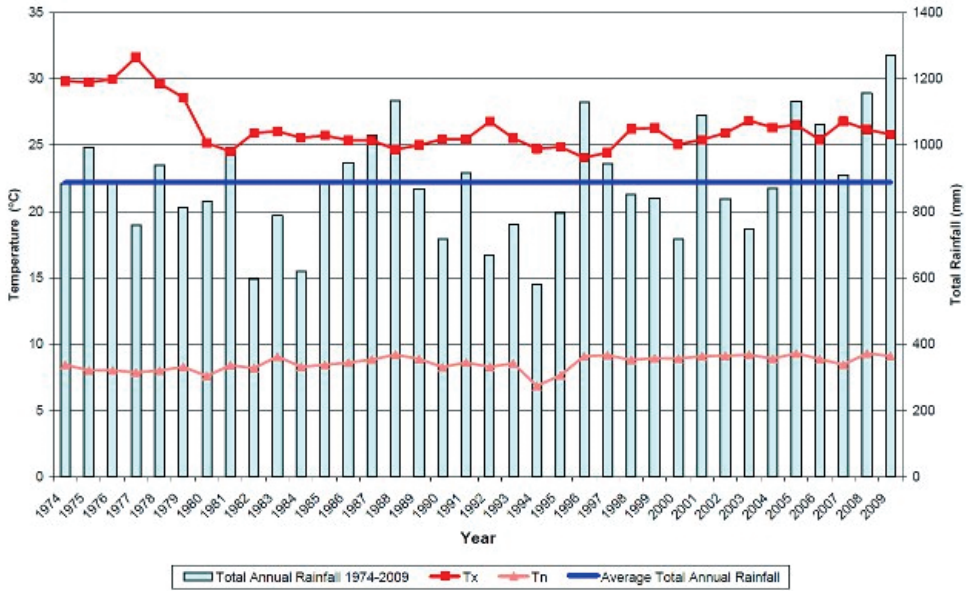


FIGURE 10a Long term record of annual rainfall (total, max. and min.) and temperature (Kwa-Zulu, South Africa)

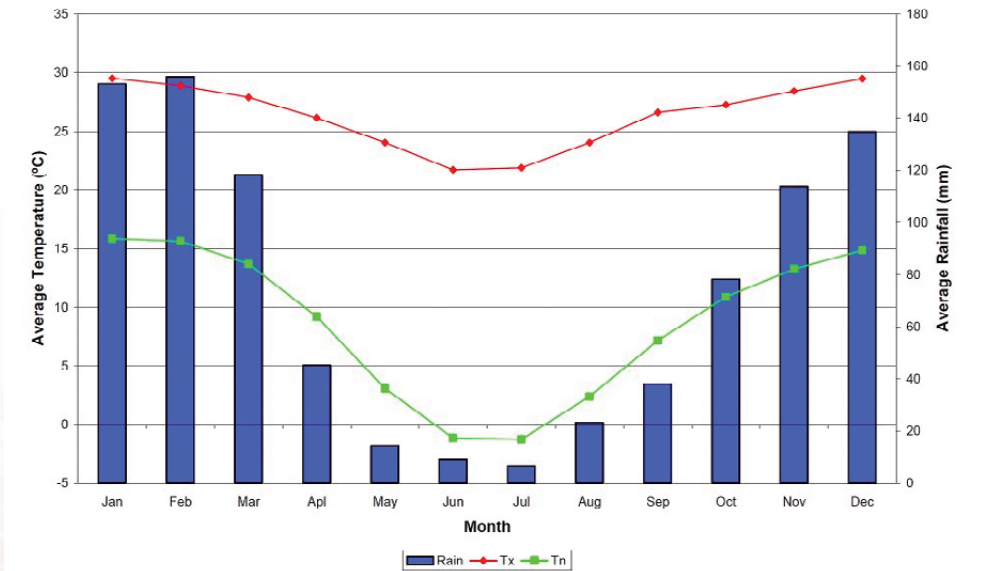


FIGURE 10b Long term monthly averages (36 years climatic data) Kwa-Zulu, South Africa

more dramatic than it has actually been. The graphs facilitate discussion of the effects of land management practices on rainwater retention, recharge of ground and surface water supply, drought and flood events and risk of natural disasters.

- ⊗ **Changes in intensity of management** in croplands, grazing lands and forests/ woodlands, where possible, in relation to demographic changes and market forces, also their implications on land resources and livelihoods (e.g. human population density, livestock numbers / stocking density by type; cropping system, inputs use, crop, livestock and forestry productivity; land fragmentation, diversity of products for consumption and sale, access to markets etc.)
- ⊗ **Status and trends of water resources (supply / quality in relation to demand)** – the spatial distribution, quantity and quality of natural and man-made ground and surface water sources, uses (domestic, livestock, irrigation, other) and changes in demand (surface and groundwater extraction e.g. irrigated area, number of extraction points (dams, boreholes, wells pump capacity etc.). Water is intimately interrelated with vegetation and soil resources. This is why it is invaluable for the water resources assessment to triangulate visual observations and field measurements (soil, water, vegetation) with secondary data and with more qualitative information from land-users, and key informants in order to build up a reliable picture of water resource state and dynamics, the seasonal fluctuations and the longer term changes over time and the effects of soil and vegetation management.

⊗ **Natural resources policies and institutional arrangements**, including:

- Land tenure arrangements and access rights, land availability / shortage, land policy, legislation and other relevant institutional issues (e.g. land use plans);
- Water allocations, access and costs, institutional rules and arrangements, water policy, legislation and other relevant institutional issues (e.g. water management plans);
- Energy sources, availability / shortages, access and costs, policies, legislation and other institutional issues including bioenergy.

A more complete list of secondary information sources 1 to be collected and reviewed prior to and during the assessment, as relevant and available is provided in Table 6.



TABLE 6 List of secondary information for collection and review

Categories	Contents
Maps, satellite images and photos	<ul style="list-style-type: none"> • Maps: administrative boundaries, soil, terrain, land-use, vegetation, watersheds, agro-ecological zones, land use systems (LUS), roads etc • Aerial photographs • Time series satellite images (SPOT-NDVI) • Land use and water resources plans
Climatic (including natural disasters) and meteorological records	<ul style="list-style-type: none"> • Rainfall amounts and variability; temperature; humidity • Trends in rainfall and temperature over recent decades • Incidence and impacts of drought and flooding etc. • Information and studies on the impacts of climate change including likely future impacts on water resources (Sources: National Meteorological Office, projects, IPCC 2007 reports)
Human Population	<ul style="list-style-type: none"> • Total population and recent trend(s); age, gender and ethnic minority distribution • Household and family composition information • Employment by sector; labour force; migration information; settlement patterns etc. • Poverty and food security etc.
Land use types	<ul style="list-style-type: none"> • Size of land use types in the local assessment area and community territory; farm land and protected areas • Areas and proportions under different land use types (including forest and protected areas) • Land cover and land resources surveys, etc.
Farming system information	<ul style="list-style-type: none"> • Existing agricultural plans, programmes and projects • Crop and livestock and forestry systems information • Presence & extent of local and introduced practices for land management / land degradation control • Information on livestock numbers, distribution, ownership, actual and recommended stocking densities, management
Water resources	<ul style="list-style-type: none"> • Water resources records over the last decade (Sources: water boards / authorities) to show <ul style="list-style-type: none"> - water flow regimes in rivers - water storage capacity and water levels of lakes, dams and reservoirs - sedimentation load / rates • Incidence of water borne diseases and pollutants (Sources: health sector and water authorities) etc.
Economy and livelihood	<ul style="list-style-type: none"> • Household income information; composition of income (i.e. contribution from farming and other activities) • Household consumption information • Poverty and food security profiles (proportion of population below poverty line, % of food insecure, malnutrition etc.) • Credit / loan availability, etc.
Land Tenure	<ul style="list-style-type: none"> • Information on land-holdings: ownership, size and distribution • Type and prevalence of renting/leasehold arrangements • Legal status of holdings (civil, cooperative, government arrangements, titles) etc.

TABLE 6 List of secondary information for collection and review (continued)

Categories	Contents
Institutions, policies, regulations, byelaws	<ul style="list-style-type: none"> • Relating to land, agriculture, livestock, water resource, environment, rural development, technical sectors, extension • Relating to implementation of the multilateral environmental conventions (UNCCD, UNCBD, UNFCCC, Ramsar, etc.) • Access to services ((official/informal), private / public sector), application / effectiveness of regulations / policies, mandates / capacities of actors, etc. • Presence, roles and activity of NGOs, community based organisations in their implementation, etc.
Basic infrastructure and investments	<ul style="list-style-type: none"> • Road and market access; input supply • Schools; health centres; • Water points (wells, boreholes, piped / tap water); • Irrigation systems; reservoirs;
Planning reports and other relevant documents	<ul style="list-style-type: none"> • Land use planning; water resources planning; agriculture and forest management plans; livestock / environmental management; etc.



6

CHAPTER

Assessing land resources status and trends, effects on livelihoods and ecosystems services

This Chapter presents the components of the assessment. It first presents the livelihoods assessment and provides some key questions that may help the assessment team to identify inter-relations between livelihoods and land resources / ecosystems status and trends. The team should review and add to these questions, so that they are appropriate to the local context. The main assessment indicators are then presented for use in selected land use systems / types, vegetation and biodiversity, soil properties and soil erosion, water resources and the trends (degradation, conservation and restoration). The main aspects involved in the assessment of SLM technologies and associated approaches are also presented. Finally, the methods are presented for identifying what are the main effects of land use practices on the range of ecosystem services: the provisioning services (i.e. productivity), the regulating and supporting services (i.e. ecological services) and the socio-cultural services (i.e. household / societal co-benefits from SLM).



PHOTO 13 **Comparison of hot and 'bright' spots (Cuba, Guantánamo)**

The above photo shows a study area in Cuba in which very degraded areas (hotspots) are juxtaposed with areas that appear to be under sustainable land management (bright spots).



PHOTO 14 **Land user in Esquel, Patagonia, Argentina**

These are under different land use systems, so they are difficult to usefully compare except by discussing them with land users and understanding the difference in the drivers and pressures that lead to LD or SLM (tenure, population, pressure, governance etc)

6.1 Assessing effects of land degradation / management on livelihoods and socio-cultural services

The land users' capacity and interest to practice sustainable resources management and minimise degradation of natural resources and ecosystems depends on many considerations including their assets base and rights over resources, education and know-how, relative wealth, access to services, as well as the enabling policy and legal environment. The assets base of different household categories can be shown on a pentagon diagram See Figure 2 and Figures 18 and 19.

Particularly with poor land-users in marginal areas (common in the drylands), it is the factors relating to resource and market access, supporting institutions and the characteristics of poverty itself that influence the perspective land-users (male and female) have on their land resources and their capacities to practice sustainable land management. Some assets that open up opportunities for people are: credit, education and labour, secure land tenure, rights to use natural resources (e.g. harvesting fuel wood) and road access to market. Access to assets is important; but also important is the ability to use the assets productively and sustainably, which depend on the vulnerability and institutional context.

Land-users create many of the pressures on the land resources (that affect the condition or state) and they also suffer the consequences of the impacts on productive, ecological and socio-

cultural services. In turn, land users can improve and restore land resources with beneficial effects on ecosystem function and services. The livelihoods component of this assessment provides detailed information in both these areas. It helps to understand the extent to which land degradation / sustainable land management practices affect rural household food security, for example, by:

- ⊗ reducing subsistence food production;
- ⊗ reducing food purchases;
- ⊗ reducing household incomes due to increased need for purchased farm inputs, increased share of food purchased and increased food prices;
- ⊗ reducing agricultural employment;
- ⊗ negatively affecting health due to reduced water quality or nutrition;
- ⊗ reducing the supply and quality of water for domestic use as well as irrigation;
- ⊗ reducing access to water.

The livelihoods assessment also improves understanding of how socio-economic, cultural and institutional factors influence land-users' views and management of their land resources. Indeed, a decline in the socio-cultural and economic functions of land resources is considered an important aspect of land degradation.

Livelihoods household interviews (see Tool 7.1 Part 2) should be conducted with the main land users located along the selected transect and also with a sample of each category of households / land users that have been identified during the community focus group discussion and wealth ranking exercises.

This livelihoods component tries to answer questions such as:

- ⊗ **Who is being affected by land degradation? Who is practising / benefiting from sustainable land management (SLM)**

and who is not (wealthy / poor, men / women)? and Why?

It is common to find a very diverse and patchy engagement in SLM by communities and it is important to find out why this is.

- ⊗ **How does land degradation / engagement in SLM (prevention and restoration) relate to specific livelihood features and strategies (risk aversion, market orientation, diversification, etc.)?**

“Good” and “bad” land management often fits within a quite deliberate livelihood strategy. Understanding the key elements of this strategy can explain behaviour and help guide support interventions.

- ⊗ **What are the important socio-economic, institutional and policy drivers for land degradation, SLM and dryland development (e.g. population pressure, tenure security, effectiveness and fairness of local governance, markets / market access, infrastructure, national / regional policies).**

The key drivers will differ from place to place. It is important throughout the socio-economic component of the assessment to think about what are the main drivers of behaviour leading to land degradation, and also what are the main incentives for practicing SLM.

- ⊗ **How does policy affect land degradation and facilitate or hinder engagement in land degradation control / SLM?**

Policy influences fall within the “institutional” question above but there should be a direct consideration of the impact of national and regional policies on land management. There will almost always be a particular policy or policy process (or a policy vacuum, implementation gap, perverse outcome etc.) affecting the behaviour of land-users with respect to their land.

- ⊗ **In addition to the natural resources assets, what roles do social (i.e. community organisation), financial, human (i.e. capacity, know-how) and physical (i.e. infrastructure) forms of capital (assets) play at the local level in influencing perspectives on land and its management?**

The livelihoods approach helps to adequately address all these aspects and gives great emphasis to the role of asset access and ownership in influencing land management behaviour.

- ⊗ **What are the important trade-offs land-users make between the different assets to which they have access and how do these affect land management?**

This question highlights again the importance of understanding the strategy of the land-user. Particular trade-offs frequently form part of adopted land use strategy.

In addition to the community focus group discussions (see Part 2, Tool 1.1) and the household livelihoods interviews (Tool 7.1), it is important to conduct a small number of key informant interviews (Tools 5.1 and 5.2). These might be with local government officials (at community, district or regional level), NGO staff, experts from concerned technical services (land, water, agriculture, forestry) or managers of protected areas. Such informants will not only provide useful contextual information but also help verify or explain some of the assessment findings. For example, important links between national activities / policies and LD / SLM might be made by community members and could need to be explored in greater depth. There is also considerable scope for discussion of possible responses to land degradation with local government or project representatives.

Peoples' livelihoods are determined by their assets base and their strategies and these are

influenced by the vulnerability context and institutional processes. Vulnerability is a dynamic and multi-dimensional process and influences individuals'/households' assets and strategies and it is also influenced by livelihoods outcomes (food, products, income, well being etc.). Vulnerability is a function of exposure to risk, sensitivity of the socio-ecological system and its adaptive capacity.

Land degradation, deforestation, overexploitation of natural resources and loss of biodiversity will in most cases be aggravated by climate change / increasing weather variability and may impact on:

- ⊗ livelihoods - through affecting
 - soil moisture and water supply, increasing risk of crop failure and animal mortality, food insecurity, loss of income, increasing poverty; and
 - long term livelihood strategies - affecting viability and reliability of rainfed agriculture, pastoral systems, produce for markets and trade.
- ⊗ ecosystem services - through increasing risk of erosion, landslides, flooding, drought, pest and disease outbreaks; and
- ⊗

All of these will be in turn affected by policies, regulations and market forces.

The adaptive capacity of land users depends on their livelihoods assets (natural, physical, human, social and financial) and livelihood strategies and it determines the way they will cope with environmental, climatic and market related changes. Adaptation capacity is weakened by poverty, ill-health, recurrent drought or floods, energy shortage and so forth. Alternatively it may be strengthened by, for example, strong organisations, knowledge and education, economic opportunities and supportive policies such as incentive measures for SLM.

An overall analysis of the findings and understanding that is obtained from the household livelihoods assessment and interviews of key informants should help to:

- ⊗ understand the behaviour of different land users (constraints, opportunities) and the effects of their management practices (degradation, natural resources conservation) in various land use systems;
- ⊗ assess the effects of current policies, strategies, legislation, institutions, services and projects; and,
- ⊗ develop recommendations for enhancing the adoption of SLM practices and reducing land degradation (incentive measures, capacity building and support for uptake of SLM technologies and approaches).

6.2 Assessing vegetation and biodiversity status and trends

Vegetation degradation is an important aspect of land degradation although more attention has been paid in the past to soil and water degradation. Vegetation degradation or improvement needs to be assessed (see Part 2) in:

- ⊗ **Grasslands and rangelands**, which cover a large share of drylands and are largely used for livestock production by agro-pastoralists and pastoralists (Tool 3.2);
- ⊗ **Forests and woodlands**, which may cover a smaller land area but are vital for the protection of watersheds / watercourses and the provision of wood and diverse non-wood forest products (Tool 3.1); and
- ⊗ **Croplands**, where the crops themselves can be assessed as well as the trees, shrubs and herbaceous species that are maintained on the farm, along borders of fields and around homesteads, for various purposes (wood, forage, fertilizer, windbreaks, shade) (Tools 3.3 and 3.4).

In this assessment, a specific protocol is used for assessing and scoring grazing quality and vegetation degradation in grasslands and rangelands (Tool 3.2) as this is crucial for livestock production upon which so many land users in drylands rely.

Detailed assessments of forests and woodlands should also be conducted where particularly important for livelihoods in a given assessment site or study area. As with grasslands, a similar protocol for scoring forest quality and degradation could be developed for forest land, in collaboration with the FAO National forest assessment and monitoring programme (FAO, 2009a & b). However, for cropland this might be more difficult to develop a standard protocol as there is such a huge range of cropping systems.

In croplands, rather than associated natural vegetation, it is soil health, adapted crop species / varieties and effective use of rainwater or irrigation that are the main factors affecting crop productivity. However, the importance of associated vegetation should not be underestimated as it is often vital for household energy, for forage for livestock in mixed crop-livestock systems, for organic matter to replenish soil nutrients and soil organic matter, for windbreaks to reduce damage by wind erosion and for shade for crops, livestock and people.

The timing of the assessment in terms of rainy and dry seasons is very important in drylands as the situation on the ground will appear very different. Comparison between degraded and better managed sites is essential to avoid the tendency to overestimate degradation in the dry season and underestimate in the rainy season. If possible, the team should visit the local assessment area during both rainy and dry seasons to validate findings. It is useful to take photos of the same site in the different seasons. See Box 4.

BOX 4 Seasonality and rainfall inter-annual variability

Vegetation growth is dynamic and determined by meteorological factors as well as pedological factors and topography. A good understanding is required of variation in plant growth and characteristics between seasons, months and years (through secondary information and key informants).

In arid and semiarid rangelands in particular, vegetation degradation is difficult to assess because of important seasonal and inter-annual variations in rainfall and in some areas temperature (e.g. at high altitude), landscape diversity and the problems of sampling very large areas, as well as issues of livestock mobility.

The six most important indicators of vegetation degradation or improvement in crop, grass and forest lands are:

1. Change in vegetation cover;
2. Change in vegetation / landscape structure and plant community composition;
3. Change in habitat and species diversity;
4. Change in abundance of indicator species (as indicators of high or low pasture quality or poor soil quality and invasive species);
5. Change in vegetation health and biomass, with associated change in animal health and productivity;
6. Extent and effects of vegetation management and its use.

1. Vegetation cover directly affects rainfall infiltration and runoff, thus erosion rates, as well as soil organic matter and nutrient levels, hence will affect productivity, the wider hydrological cycle and the ecosystem's capacity to cope with climate change especially drought (increased rainfall variability and temperatures).

2. Vegetation / landscape structure and plant community composition influences water availability, soil productivity and erosion risk. For example:

- A multi-storey agroforestry system with trees, cereals and a cover crop will intercept and make better use of rainwater in the deep soil profile and hence protect the ground from erosion more than a field of cereals;
- Compared to grassland, a wooded savannah provides shade and exploits the deep soil profile for water and nutrients, providing a cooler microclimate;
- Bush encroachment may increase total biomass, but it also reduces grazing productivity and access to water by livestock.

3. Habitat and species biodiversity degradation can be assessed at three levels:

- Change in **habitat diversity** is evident from a change in the variety of habitat types in the study area, which may be due to fragmentation of farms, fields and grazing lands, reduced farm size and increased pressure on resources (e.g. through burning, deforestation for fuelwood, etc.). Land use intensification reduces land users' options to maintain natural vegetation on their farm and in the wider landscape. Implications include loss of wild foods and other useful plants

(medicines, building materials, fibres etc.) and loss of ecological functions such as pollination and beneficial predation;

- Change in **species diversity** means a change in the number of species in a given area, i.e. loss of certain key animal, plant or microbial species, and /or a reduction or increase in species numbers. It can be measured at a particular site and time of year, in a particular season in pasture / range / cropland or over a year or several years (e.g. a crop or grazing or forest rotations). The implications of biodiversity loss could include reduced adaptive capacity and increased vulnerability to pests, diseases, drought or other aspects of climate change;
- Change in **genetic diversity** means fewer plant varieties or livestock breeds being used in a given area, contributing to reduced adaptive capacity and ecosystem resilience, thus reduced future options, especially in facing climate change.

Particularly in marginal areas, maintaining diversity of genetic resources (the gene pool) plays an important part in traditional livelihood strategies of dryland populations by contributing to the stability of yields of crop or livestock enterprises, adaptation to change, and meeting the multiple needs of local communities for a range of plant and animal-derived food and other products. The number of species used and conserved through traditional farming systems and the diversity within them is usually much greater than is the case in commercial and large-scale crop, grazing and forest / woodland systems. Much of the information on trends in species and genetic diversity and in loss of ecological functions due to reduced pollination or natural pest control can be obtained from the land users and community discussion. Change in habitat diversity can be backed up by maps and satellite images.

4. Plant indicator species can indicate various aspects which relate to land resources quality, notably:

- Change in extent and effects of invasive species - these may be “colonising” species that benefit from the reduced competition that follows habitat degradation or they may be more tolerant of grazing, burning or other (poor) management practices;
- Change in share of nutritious and palatable pasture / browse species or noxious / unpalatable species for livestock;
- Change in weed species i.e. those that reflect declining fertility and soil organic matter (e.g. the parasitic witch weed (*Striga* spp.) that infects the roots of millet, sorghum, maize and sugar cane in semi-arid Africa);
- Change in useful species (e.g. those that provide fuel wood, thatching grass, medicinal plants, wild foods etc.).

5. Vegetation and animal health and productivity are interrelated. In cropping and forest systems, vegetation health and productivity are largely determined by soil properties, but can also be assessed through crop / tree measurements and identifying symptoms of crop nutrient deficiencies or damage by pests or diseases. In pasture and rangelands, vegetation quality is the most important component of the land for pastoralists and agro-pastoralists, as it is directly linked to livestock productivity which is their main livelihood activity. After assessing vegetation degradation in pasture and rangelands it is important to look at the effects of this degradation on livestock productivity. It is important to identify any relationships between intensity and type of management practices and the condition (health) of the pasture / rangeland or wood / forest land, as well as its sensitivity / resilience to degradation.

6. Vegetation management and use: It is important to assess changes in intensity of use of the vegetation, the management practices being used, their effects on resources and the use of the range of products that are obtained from the land. For example:

Management practices

- thinning, coppicing of trees, clear felling in forest / wood land,
- management of hedges and maintenance of trees and vegetated contour bunds or strips in cropland,
- pasture species management, removal of invasive species, thinning of bush in grazing land.

Use of products

- use of wood, wild fruits and nuts and medicinal plants from forest/ woodland,
- use of wood, non wood forest products, straw for thatching, etc., from grazing land,
- use of wood, organic materials for fertilizer and mulch, and other wild products from cropland.

Through use of the above indicators, a good understanding of the status and trends in vegetation resources and biodiversity and their effects on productivity can be obtained and supplemented by information from the household and other interviews on livelihood implications and effects on ecosystem services.

6.3 Assessing soil health and soil erosion status and trends

Soil degradation directly affects land productivity (i.e. provisioning services). A good understanding of the condition of the soil (state), the change dynamics (trends) and the degradation / soil restoration processes involved is required.

Sheet, rill and gully erosion by water, the scouring and deposition of soil by wind, the movement of sand dunes and the transport of sediment load in waterways, are all visible symptoms of degradation and tend to be the focus of degradation studies. A rapid assessment of soil erosion - the extent and severity of removal of soil particles by water and by wind – should be conducted to arrive at a soil erosion score and, as required, further measurements can be undertaken to obtain more quantitative data for monitoring (see Part 2, Section 4).

However, a number of other degradation processes (e.g. nutrient mining) may well be occurring, which are not directly visible but are very widespread and have direct implications on productivity and livelihoods. Adverse changes in the soil biological, chemical, physical and / or hydrological properties can also increase the vulnerability of the soil to further degradation, including:

- ⊗ Soil biological degradation – decline in soil organic matter content and the diversity of soil organisms⁵ negatively affects the beneficial functions of soil (e.g. mineralization, nitrification, nitrogen fixation) and are likely to increase the risk of soil pest damage;
- ⊗ Soil chemical degradation – increase in soil nutrient imbalances and toxicities, soil acidification, alkalisation, salinization and pollution;
- ⊗ Soil physical degradation - surface crusting and soil compaction through raindrop impact, trampling and mechanisation, loss of topsoil structure and organic matter through excess or inappropriate tillage;

⁵ Assessment of biodiversity of soil organisms is difficult as they are mostly microscopic so this cannot be part of a rapid field assessment methodology. Simple soil visual indicators of macro-fauna are used in this assessment as indicators of soil health (earthworm numbers and evidence of worm or termite castes).

- ⊗ Degradation of soil hydrological properties - waterlogging and aridification due to the decline in rainfall infiltration and soil moisture retention;
- ⊗ Soil pollution- due to contamination by, for example, agro-industries or heavy metals from mining or use of contaminated groundwater.

The VS Fast Soil Visual Assessment (McGarry 2006) used in this manual (see Part 2, Section 4) uses a number of key indicators of biological, chemical and physical properties that are either observed (qualitative) or measured (quantitative) and then scored and summed to arrive at an overall soil health score:

Soil Observations

- soil cover (protection)
- soil colour and soil life (SOM content)
- soil texture (erodibility)
- soil structure (permeability, root penetrability and stability)
- soil depth (plant rooting depth and nutrient and water availability)

Soil Measurements

- pH (acidity and alkalinity)
- slaking and dispersion (stability)
- soil labile carbon content (often backed up by lab. analysis of total organic C)
- salinity and sodicity
- nutrient content (N, P, K and micro-nutrients) (optional lab tests)

The combination of soil observations and measurements provides a good overall picture of soil health (condition) and the scoring facilitates comparisons between degraded and well managed sites, as well as providing a baseline for subsequent monitoring.

In assessing soil degradation / management in croplands, including agroforestry systems, it is

recommended that teams compare sites in the cultivated field with the soil at the field border or a nearby uncultivated area, then compare results with fields under different practices (e.g. no till and conventional tillage, with or without organic matter management). However, the effects on soil nutrient availability and soil fertility will require secondary information from livelihoods survey with land users and from the agricultural services on productivity (yields), crop rotations and organic matter management practices. This may need to be backed up by soil nutrient analyses in the soil laboratory to assess specific nutrient deficiencies.

In forest / woodland, sites in planted and in natural forests can be compared to determine the effects of tree species and management practices on soil health (litter, depth, pH, erosion etc.).

In grassland and rangelands, sites with different stocking densities/management practices can be compared with protected areas to ascertain effects, for example, of overgrazing on soil health.

6.4 Assessing water resources status and trends

Land - water linkages are significant in relation to land degradation in drylands. It is important to identify land degradation processes and land management practices that cause changes in the hydrological regime (rainfall infiltration, retention, runoff and flow) and thereby in water availability and quality (see Part 2, Section 6). For example, a reduction in vegetation cover will result in increased runoff, reduced ground water recharge and sedimentation of surface water resources which in turn affects water quality.

In semi-arid and arid areas, land degradation / management impacts on water resources are

strongly affected by the variability in rainfall, runoff and water flow, as rainfall is concentrated in a short rainy season and is often characterized by extreme events – long drought periods and intense rains that may cause flooding. Climate change has serious implications in potentially increasing the frequency of extreme events in drylands, resulting in increased soil erosion, runoff and flooding in lowland areas, estuaries and deltas and flash floods in highland areas.

As with vegetation, there are some challenges with assessing water resources due to the large inter-annual and seasonal variations in water availability which can make assessments carried-out at a single point in time less reliable. The timing of the water resources assessment is important as the observations / findings will vary significantly between rainy and dry seasons and secondary information will be needed to understand seasonal variations and effects. This is therefore one of many parts of this assessment where it is important to triangulate direct observations and measurements (Tools 6.2 to 6.6) with secondary data (e.g. from rainfall records and water boards) and with more qualitative information derived from land-user accounts (Tool 6.1). This triangulation will help the team to build up a reliable picture of water resource status and trends, which can be further supplemented by drawing on additional secondary information from agriculture and health authorities.

Scale is also a key parameter in detecting impacts of land use on water resources, as there are direct on-site effects and wider off-site / landscape effects of management practices that affect the hydrological regime.

When considering the impacts of land use and management on water resources, it is also important to understand the relative importance of anthropogenic and natural causes in order to

propose / develop appropriate responses. For example, if the amount of erosion generated by farming practices in a dam catchment is insignificant compared to natural erosion events (e.g. rainstorms), changing those practices will not change the sedimentation of the dam. The design and site of the dam may simply be inappropriate in that landscape, unless accompanied by appropriate sediment traps upstream and periodic sediment removal / dredging.

The water resources assessment focuses on obtaining information from multiple different sources:

- ⊗ **Information obtained from secondary data and key informants (Tool 6.1)**, backed up by information from land users / households (Tool 1.1), on:
 - Climatic conditions seasonality and trends - rainfall, evaporation, drought, flood, water management practices such as rainwater harvesting techniques and water conservation practices;
 - Water allocations, access rules and arrangements, incidence and management of water conflicts, water policy, legislation and other institutional issues;
 - Changes in the seasonality and quantity of rainfalls (spatially and temporally); diminution of the flux of streams and rivers; changes in the spatial location of streams and rivers and their evolution (constant, light deviation, abrupt deviation); changes in flooding regimes (importance and magnitude of the disaster, and frequency); change in the morphology of the stream and river (constant / light, widening, abrupt change).
- ⊗ **Observations and measurements of water bodies (lakes, rivers etc.) and water points (boreholes and wells) in the field**, backed up by information

from key informants and land users/ households, on:

- Water quality of the different water bodies (e.g. salinity increasing, stable or decreasing);
 - Water quantity / availability from different water bodies, for different users and uses; Lowering / increasing of the water table, stagnation; transport of solid matter, water flux regime, depth of soil behind dams; soil and water conservation practices; diminution of water retention in dams and small lakes;
 - Pressure on and demand of water: water use / consumption, water withdrawal / abstraction, proportion of illegal water withdrawals, water infrastructure; augmentation of private wells; modes of water harvesting; costs; distance between water points in grazing lands;
 - Water use efficiency (e.g. excess losses through runoff and evaporation), type and efficiency of the water infrastructure in irrigated areas.
- ✘ **Information on both on-site and off-site causes of water resources degradation or improvement** obtained during the assessment, where:
- **On-site causes of degradation of water resources** include: pressures on the water body, removal of protective vegetation, overgrazing or cultivation around the water body; changes to the water body through drainage, irrigation or other infrastructure; or changes due to natural events such as erosion or floods. Improvements may include watershed management, management of water sources for different uses (piped or pumped water for human consumption, rainwater

harvesting for crops, protection of water supplies from direct access by troughs for livestock etc..

- **Off-site causes of change in water resources** (quality, quantity and flow) may include changes in land use that affect the upstream / catchment area such as: fertilizer or agro-chemical use on farmland and associated runoff or other pollutants that affect water quality; change in water regime through draining of wetlands / swamps (e.g. increased floods; reduced flows or change from perennial to seasonal flow); damming for water storage, irrigation or recreation.

The South Africa Department of Water Affairs and Forestry used its Manual for the Assessment of a Habitat Integrity for Floodplain and Channelled Valley Bottom Wetland Types to conduct a rapid assessment (3 hour field visit of the wetland backed up by remote sensing data) to report on present ecological state of the wetlands in the study area. Photo 16 shows typical wetland vegetation used for cattle grazing.

The Wetland assessment method is designed for non-wetland experts but requires some training in the Excel based model which develops a Wetland Index by assessing vegetation alteration (structure; density) as driven by land use change /intensity (e.g., the removal of riparian vegetation along a river, or agricultural disturbance across the floodplain of a wetland) and catchment as well as “on-site” (within the wetland system) effects on hydrology and geomorphology, and on water quality in terms of nutrient loads and sewage return flows and oxygen loads.



PHOTO 15 Floodplain with typical wetland vegetation and slow moving water, Emmaus, Kwa Zulu Natal, South Africa

6.5 Assessing SLM technologies and approaches

A number of sustainable land management (SLM) best practices should be identified in the study areas and their effects observed in the field (i.e. on soil, water, vegetation and biodiversity) and their impacts on livelihoods and ecosystem services determined through observations, discussions and interviews. These may be local / indigenous practices or farmer innovations to adapt to change or introduced technologies from other areas or through projects and research and extension services. The different categories of land users identified on the ground and through the wealth ranking should be questioned on what they consider to be the best practices, their use, effectiveness and whether

there are any constraints to adoption. Tables 9 and 10 below can be used to make an inventory of SLM best practices in the local assessment area. (Section 4.2 above and Annexes 2 and 4 provide an overview of the most common types of technologies and approaches).

The expert teams are advised to use the questionnaires that have been developed and perfected by WOCAT (www.wocat.net) over many years and in all regions to evaluate a wide range of sustainable land management technologies (QT) and associated SLM approaches (QA) in croplands, grazing and forest lands and to also assess effects on the productive, ecological and socio-cultural services provided by ecosystems.

WOCAT Framework for Documentation and Evaluation of **SLM Technologies**: http://www.wocat.net/fileadmin/user_upload/documents/QT_and_QA/TechQuestE.pdf

This helps technical experts who are very familiar with a specific technology on the ground (technicians or extension staff) to collect relevant information with land users / farmers on the specifications of the given Technology, where is it used (natural and human environment), and what impacts it has.

WOCAT Framework for Documentation and Evaluation of **SLM Approaches**: http://www.wocat.net/fileadmin/user_upload/documents/QT_and_QA/AppQuestE.pdf

This helps those same persons, for the selected SLM technology / practice, to address the questions of how implementation was achieved and who achieved it. It provides complementary data to QT.

Annexes 3 and 5 provide case studies of the illustrated **Technologies and Approaches** that are obtained from completing the QT and QA questionnaires, and then entering the data into the on line ACCESS databases on the WOCAT website. These are currently being updated to an interactive online version, and already allows direct entry into the WOCAT Approaches and Mapping databases (the SLM Technologies database is still under development). <http://www.wocat.net/en/knowledge-base.html>

Specific templates are available for entering the data and graphics, also generating very clearly presented 4 page case studies.

<http://www.wocat.net/en/methods/case-study-assessment-qtqa/output-format.html>

The newest version of QT (and QA) includes a question on tolerance and sensitivity of SLM technologies (and approaches) to climate change (question 2.7.5) and further methods are being developed by FAO and WOCAT for more systematic assessment in the future. See also the TerrAfrica program resource guide on using sustainable land management practices to adapt to and mitigate climate change in sub-Saharan Africa (Woodfine, 2009).

Once the transects and site assessments have been conducted and the SLM best practices have been assessed, it is useful to bring the information together, see Table 7. For example to develop conclusions:

- ⊗ on land user types and the diversity of their land uses (LUS / LUT);
- ⊗ on which land degradation processes are occurring where (which land users and which LUS / LUT); and
- ⊗ on which SLM practices are adopted on which LUS / LUT and by whom.

TABLE 7 Bringing the assessment findings together for analysis

Land user type	LUS/LUT 1	LUS/LUT 2	LUS/LUT 3
A	e.g. LD processes x, y, z and SLM practices a,b,c	and so forth	
B			
C			

TABLE 8 Field form – WOCAT inventory on SLM technologies
WOCAT Inventory on SLM Technologies (page A)

Date:		Country/region:					Contributor: (Name, institutions, address, email)			
ID*	Name of Technology	Land use type	Position	Area	Main types of land degradation addressed	Conservation measures	Climate	Tolerance / sensitivity of technology to climatic extremes		Slope
								tolerant	sensitive	not known
...1										
...2										
...3										

See Notes below for details of information to provide in each column *Give consecutive numbers for ID.

ID		Short definition/description of SLM Technology (containing key characteristics of the technology)
...1		
...2		
...3		

For more detailed explanations and definitions refer to the basic version of the questionnaire on SLM technologies <http://www.wocat.net/en/methods/case-study-assessment-gtqa/questionnaires.html>

Notes for completing the inventory on SLM Technologies

Name of Technology: *(be specific to ensure that the Technology can be distinguished from similar ones)*

Land use type: *Only one of the following*
c: cropland
g: grazing land
f: forest / woodland
m: mixed land
o: other land (e.g. settlements, roads)

Position: *Name of location / region, coordinates*

Area: *Land area covered by Technology in km²*

Main types of land degradation addressed:

Choose from:
W: soil erosion by water
E: soil erosion by wind
C: chemical soil deterioration
P: physical soil deterioration
B: biological degradation
H: water degradation

Conservation measures: *Only one or a clearly defined combination of the following:*

A: agronomic
V: vegetative
S: structural
M: management.
(If you combine types, list according to importance)

Climate: *One or a combination of two adjacent zones:*

-humid
-subhumid
-semi-arid
-arid

And/or from:

-tropical
-subtropical
-temperate
-boreal
-polar/ arctic

Tolerance/sensitivity of Technology to climatic extremes: *Under climatic extremes the Technology is tolerant or sensitive to: (choose from:*

Ti: temperature increase
Ri: seasonal rainfall increase
Rd: seasonal rainfall decrease
Hr: heavy rainfall events
W: windstorm/dust storms
F: floods
D: droughts/dry spells
Gi: increasing length of growing period
Gd: decreasing length of growing period
O: others (specify)

Slope: *Choose from:*

-flat (0-2 %)
-gentle (2-5%)
-moderate (5-8%)
-rolling (8-16%)
-hilly (16-30%)
-steep (30-60%)
-very steep (>60%)

TABLE 9 Field form – WOCAT inventory on SLM approaches
WOCAT Inventory on SLM Approaches (page A)

Date:		Country/region:				Contributor: (Name, institutions, address, email)			
ID*	Name of Approach	For which land use type	Position	Area	Type of Approach	Implementing bodies	Objectives	Land user involvement	
								Initiation phase	Implementation phase
...1									
...2									
...3									

See Notes below for details of required information to provide in each column *Give consecutive numbers for ID

ID	Short definition/description of SLM Approach (containing key characteristics of the approach)
...1	
...2	
...3	

For more detailed explanations and definitions refer to the basic version of the questionnaire on SLM approaches <http://www.wocat.net/en/methods/case-study-assessment-qtqa/questionnaires.html>

TABLE 9 Field form – WOCAT inventory on SLM approaches (continued)

Date:		Country/region:			Contributor: (Name, institutions, address, email)		
ID*	Technical support	External material support	Motivation of land user to implement SLM	Impact	Photo	World Map	Ranking Potential
...1							
...2							
...3							

See Notes below for details of required information to provide in each column *Give consecutive numbers for ID

ID	Strengths of SLM Approach	Weaknesses of SLM Approach
...1		
...2		
...3		

For more detailed explanations and definitions refer to the basic version of the questionnaire on SLM approaches <http://www.wocat.net/en/methods/case-study-assessment-qtqa/questionnaires.html>

Notes for completing the Inventory on SLM Approaches

Name of Approach: Give name of the Approach (be specific to ensure that the Approach can be distinguished from similar ones)

For which land use type: Only one of the following land use types:
c: cropland, g: grazing land, f: forest/ woodland, m: mixed land, o: other land (e.g. settlements, roads)

Position: Name of location / region, coordinates

Area: Area covered by Approach in km²

Type of Approach: Only one of the following types:
t: traditional / indigenous, r: recent local initiative/innovative, p: project / programme based, o: other (specify)

Implementing bodies: One or a combination of two bodies:
i: international, g: government, in: international NGO, nn: national NGO, p: private sector, l: local government, l: local community / land user, o: other (specify)

Objectives: What were the main aims/objectives of the Approach

Land user involvement: Only one of the following options:
- none, - passive, - active: payment/ external support, - active: interactive, - active: self-mobilization

Technical support: Only one of the following options:
*-no
 - yes, specify (training, advisory service, research)*

External material support: Only one of the following options:

*- no;
 - yes, specify (subsidies, compensations, labour, inputs, credit, support to local institutions)*

Motivation of land user to implement SLM

Choose from and list in order of importance:
- production, - increased profit / increased cost-benefit-ratio, - rules and regulations / enforcement, - prestige / social pressure, - payments / subsidies, - reduced workload, - affiliation to movement/ projects/ groups / networks, - environmental consciousness, moral, health, - well-being and livelihood improvement - aesthetics, - other (specify)

Impact: Estimate from following options :

*- no, - yes, - little, - moderately, - greatly and Choose from categories below:
 - improved sustainable land management, - improved adoption of the approach through other projects / land users-improved livelihoods / human well-being, - improved situation of socially and economically disadvantaged groups, - reduced problem of land use / water rights, - improved effectiveness of training / advisory services, - other (specify)*

Photo: File- name of photos

Ranking World Map Rank according to area covered, High: +++, Medium: ++, Little: +
 Technologies with high area coverage will be integrated in the WOCAT world map.

Potential Rank according to potential for spread, High: +++, Medium: ++, Little: +

6.6 Assessing effects of land degradation / management on ecosystem services

6.6.1 Assessing effects of LD / management on productive services

The impacts of LD / SLM on the productivity of croplands, rangelands and forest / woodlands are of particular concern to land users as illustrated in Table 10. Ultimately all these production systems are dependent on the growth and use of plants (planted or naturally growing) which in turn depends on the capacity of the soils to fulfil a number of key functions and on the adequacy of rainfall (or irrigation) to satisfy plant water and nutrient requirements.

The assessment will generate information on the condition and change dynamics in the land resources (soil, water, vegetation). Some direct measurements of productivity may be possible

but the knowledge of local land users and experts will be very important in linking the biophysical information to effects on productivity, (e.g. identifying species or other variables that indicate high and low quality pasture and good or poor soil conditions). Such information can be obtained during community focus group discussion (see Part 2, Tool 1.1) and from key informants during transect walks (Tool 2.1). Older people in the community tend to have a particularly rich knowledge of these linkages.

The indicators and methods that can be used for assessing the effects of land degradation on productivity are specific for croplands, grasslands and forest lands. The knowledge of local technical experts is also required, for example to know the productivity value of various species for grazing, forage and specific nutrients, changes in water resources, the effects of climate change and information on yields / productivity of crops and livestock in the area.

TABLE 10 Effects of LD / SLM on productive services

Effects of LD / SLM on Ecosystem services	Off site / landscape effects of LD	Wider community effects of LD
Production and productivity	Indicative examples	
<ul style="list-style-type: none"> Change in production of food, fibre, energy, timber, fuel wood, other goods (yield, quality, diversity) 	<ul style="list-style-type: none"> Change in vegetation cover (hence in runoff, erosion and sedimentation) Change in energy supply 	<ul style="list-style-type: none"> Change in food (in) security and nutrition Change in reliance on bought fuel and other goods
<ul style="list-style-type: none"> Change in water productivity Change in land availability 	<ul style="list-style-type: none"> Risks from expansion (e.g. irrigation in wetlands; conversion to cropping in fragile lands, salinity, etc.). Change in water use efficiency and water availability for other uses 	<ul style="list-style-type: none"> Change in income Investment and opportunities in marketable commodities
<ul style="list-style-type: none"> Production risks (crop failure, livestock/ tree mortality, etc.) 	<ul style="list-style-type: none"> Risk of flooding in river plains, Spread/control of disease (specialised /diverse systems) 	<ul style="list-style-type: none"> Vulnerability, food insecurity, poverty

An understanding is also needed of the changes that are observed or provided by informants. For example, bush encroachment may increase the plant biomass or cover but it reflects a severe degradation process in drylands, whereby the grass-dominated vegetation is transformed into a woody species-dominated one. This results in an increase and spread of less palatable species for livestock (e.g. *Prosopis* spp. is a competitive, woody bush that is resistant to drought but spreads at the expense of other species and may hinder livestock access to grazing and water).

For more informed results, assessment of vegetation cover and grazing impact on the ground can be complemented by vegetation

cover index values derived from available time series remotely-sensed data. The aim is to triangulate the various pieces of information for validation purposes.

Cropland degradation / management and productivity

Reduction in the capacity of land used for crop production (rainfed or irrigated) to sustain the yield of annual and / or perennial crops is due largely to soil degradation and partly due to degradation of water resources. The main indicators of degradation / improvement in croplands are summarised in Table 11.

TABLE 11 Assessing LD /SLM processes in croplands

Effects of LD/SLM in croplands	Indicators
Change in soil properties: - biological, - chemical - physical - hydrological	<ul style="list-style-type: none"> - Change in soil OM content; plant nutrient availability, leading to change in fertility (i.e. yield / ha) and / or change in required inputs (fertiliser / OM / ha - Change in soil salinity and chemical toxicity (e.g. excess fertilisers, agro-chemicals, inadequate drainage in irrigated lands) leading to change in yields or crop suitability (tolerant species) - Change in soil physical structure (e.g. compaction, pulverisation of soil due to excess tillage, crusting due to burning) resulting in change in germination rate, root development, infiltration / drainage (e.g. leading to runoff or waterlogging; change in soil moisture retention (aridification).
Soil erosion or reclamation	<ul style="list-style-type: none"> - Change in extent and severity of splash, sheet, rill and gully erosion (by water) and of topsoil removal by wind blow leading to change in productivity (yield/ha) and productive land area (gullies and their reclamation) - Change in extent and depth of wind blown soil deposits and sand dune movement (wind erosion) leading to change in productivity and productive land area, and damage to property / infrastructure.
Change in water resources	<ul style="list-style-type: none"> - Change in the quantity and quality and flow regime of ground and surface water resources and change in water availability (human consumption, livestock, irrigation etc.
Change in vegetation	<ul style="list-style-type: none"> - Change in conservation and use of wild tree and plant species in farming systems (borders, strips, multiple storey etc) for fertiliser, mulch, shade, forage for livestock, habitat for pollinators and beneficial predators

These factors that affect cropland quality and extent will all affect productivity and can be assessed through looking at productive land area, yields, growth characteristics and nutrient deficiency symptoms in crops (Tool 3.4). However, often little is known about the relationship between land degradation and productivity as other factors play a more important role (i.e. soil type, rainfall etc.) and as productivity can be compensated for by inputs and management practices.

Rangeland degradation / management and productivity / livestock carrying capacity

Reduction in the capacity of natural and planted grassland areas to be used on a sustainable basis for livestock production is mainly due to vegetation degradation, although other

forms of degradation also contribute. Causes of rangeland / grassland degradation include overgrazing, inadequate livestock rotation, excessive burning and so forth.

Changes in the vegetation include change in the percentage and absolute number of desirable (palatable) species, change in plant vigour and biomass production and change in protective cover. In the case of rangelands, these will result in a change in condition or quality for grazing and a change in livestock carrying capacity. In turn, this affects livestock productivity and the livelihoods of livestock keepers.

The main indicators are summarised in Table 12:

Figure 11 shows a typical sequence of spiralling vegetation degradation, soil erosion and drought

TABLE 12 Assessing LD / SLM in grassland / rangelands

Effects of LD / SLM in grasslands	Indicators
Change in vegetation health and biodiversity	<ul style="list-style-type: none"> - Change in vigour of plants and consequently biomass; - Change in species diversity, i.e. share of high to low value (less palatable, toxic) species - Change in vegetation / litter cover (share of bare ground) - Change in and fragmentation of habitats and wildlife (wetlands, birds, etc.)
Change in soil properties: <ul style="list-style-type: none"> - biological, - chemical - physical - hydrological 	<ul style="list-style-type: none"> - Change in soil organic matter (e.g. through change in vegetative biomass, ground cover and leaf litter) - Change in pasture / rangeland fertility, for example effects on soil nutrient recycling process (e.g. through kraaling at night for fertilising croplands or use of dung for energy) - Change in extent and severity of salinization (e.g. following overgrazing and removal of deep rooted vegetation) - Change in surface compaction and topsoil structure (e.g. through the impact of animal hooves)
Soil erosion	<ul style="list-style-type: none"> - Change in erosion by water and wind following a change in protective vegetative cover especially around water points and along cattle tracks / corridors.
Water resources degradation	<ul style="list-style-type: none"> - Change in the quantity and quality of the ground and surface water resources available (less retention/recharge).

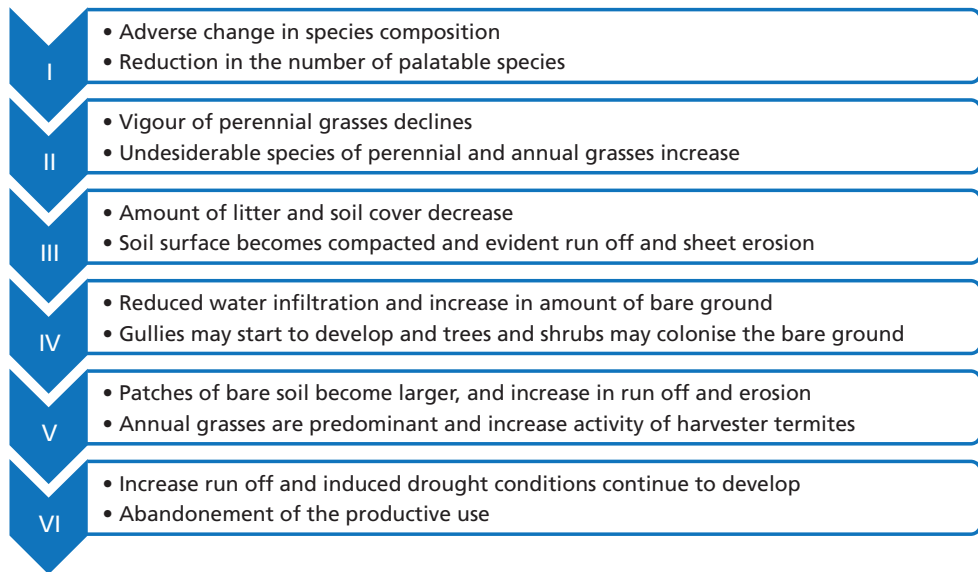


FIGURE 11 Sequence of stages in rangeland deterioration

TABLE 13 Assessing LD / SLM in forest / woodlands

Effects of LD / SLM in forests/woodlands	Indicators
Change in forest / woodland area (using aerial photos or satellite imagery)	<ul style="list-style-type: none"> - Change in forest / woodland area (e.g. cleared or converted to other uses (e.g. for crop and livestock production)) - Change in forest / woodland area for settlements and infrastructure (houses, factories, roads etc.)
Change in vegetative biomass of forest / woodland areas	<ul style="list-style-type: none"> - Change in density of trees and shrubs - Change in vigour (small-large branches and stems, more or less leaves, flowers, fruits, seeds, etc.) - Change in productivity of woody species - Change in number and productivity of non-woody species, resulting in change in diversity and yield of forest products (traditional and non traditional)
Change in the quality of the vegetative biomass	<ul style="list-style-type: none"> - Change in share of Plant species of high value (for fodder, timber, fuelwood, food, medicines etc.) and lower, or no value
Change in use / harvesting of individual plants	<ul style="list-style-type: none"> - Change in extent of damaged trees / shrubs through legal and illicit harvesting and use of above and below, ground parts (timber, fuelwood, fodder, fruits, food, medicine etc.)
Change in application of laws / regulations: and their effects	<ul style="list-style-type: none"> - Change in pressure on accessible areas (e.g. conversion of formerly productive forest areas under strict protection or preventing harvesting of forest products in other ways i.e. through logging bans)

Forest / woodland degradation / management and productivity

In some cases, the reduction in the capacity of land to be used for forests and woodland for the production of wood and other forest products will be of major concern. Forest degradation can be caused by over-harvesting, excessive burning, pest / disease damage or climate change.

The main indicators of degradation or improved management are summarised in Table 13.

In assessing degradation / improvement trends, it is important to understand where one is in a historical progression or evolution as illustrated by the Photo series below.

6.6.2 Assessing effects of land degradation / management on regulating and supportive services

While walking along the transect and at each of the detailed assessment sites, the team should consider and discuss with the land users whether there are off- site or wider landscape effects of the degradation processes that have been observed (deforestation, erosion, overgrazing etc) on regulating and supporting (life-support services).

Similarly, the team should consider with the land users the beneficial effects of identified best practices or SLM measures (integrated crop-livestock systems, soil and water conservation, pasture and rangeland management etc.).



1. People first collect dead wood in accessible riverine forests.
2. With increasing scarcity, wood may then be lopped off trees and bushes.
3. The coppice can be collected with less effort than big logs, so trees remain longer than brushwood.
4. With increased pressure on fuel supplies, firewood is sold and legally or illegally chopped.
5. Remaining stumps are gradually cut, until the area is cleared and used as pastureland [5,6] which is likely to become salinized.

Source and Photos: Droux, R. and Hoeck, T., University of Berne

PHOTO 16 **Evolution of forest depletion, Pamir mountains, Tajikistan**

Table 14 shows an indicative example of LD on regulating and supporting services, a similar analysis should be done of positive effects of SLM measures

The team can use the ecosystems services as a checklist for assessing wider positive and negative effects (e.g. off site and landscape effects and effects on the wider community).

6.6.3 Assessing effects of land degradation / management on socio-cultural services provided by the environment

The information from this part of the assessment should come from the land users and household livelihood interviews. Table 15 shows the types of effects of LD/SLM on sociocultural services

TABLE 14 Effects of LD / SLM on regulation and supporting services

Effects of LD / SLM on regulation and life-support services	Off-site / landscape effects of LD	Wider community effects of LD
<ul style="list-style-type: none"> Nutrient cycling + soil formation 		- reduced productivity
<ul style="list-style-type: none"> Carbon cycling - C sequestration and GHG emissions 	- reduced biomass and cover over large area affects water retention, climate and productivity	- lost opportunities - poverty
<ul style="list-style-type: none"> Maintenance of the hydrological cycle/regime 	- risk of flash floods, flooding and drying of water sources	- water shortage, effects on quality and in turn on human / animal life
<ul style="list-style-type: none"> Biodiversity conservation and associated functions 	- loss of habitat and pollination - reduced resilience (climate/pests/diseases)	- loss of opportunity and adaptation capacity
<ul style="list-style-type: none"> Climate regulation 	- increased risk of drought and flood	- damage and loss of life

TABLE 15 Effects of LD/SLM on socio-cultural services

Effects of LD/SLM on Socio-cultural services provided by the environment	Off site /Landscape effects of LD	Wider community effects of LD
<ul style="list-style-type: none"> livelihoods (farming, forestry, fisheries, ecotourism, etc.) 	land use change (shift of enterprises)	reduced opportunities/dependence on limited markets
<ul style="list-style-type: none"> spiritual and aesthetic value (landscape; recreation) 	reduced landscape value	reduced opportunities
<ul style="list-style-type: none"> vulnerability/risk aversion (conflict resolution, food security) 	risk of natural disasters	Vulnerability to natural disasters; competition over resources

However, if relevant information has not been forthcoming on the various ecosystem services, a back-up strategy is to pose relevant questions and to mobilise discussion during the meeting at which the assessment findings are presented back to the community for validation and finalisation.



7 CHAPTER

Analysis and reporting results

7.1 Introduction

This Chapter of the manual presents some methods and a structure for analysing the findings and for presenting the assessment in a well structured report for consideration by decision makers.

The report and database will be an important record of the assessment findings and should be used to mobilise better coordinated follow-up action among the range of actors that provide support for natural resources management and development. These products also provide the baseline for subsequent monitoring of changes, to assess progress in addressing land degradation and the effectiveness of different interventions by stakeholders.

The LADA local assessment methodology deserves to be widely used as a basis for supporting concerted efforts towards sustainable land management through, for example, targeted local and provincial action plans as well as future monitoring and investment planning to prevent or reverse land degradation and promote sustainable land management.

A better understanding of land uses and livelihood strategies used by land users to meet their needs and cope with change, seasonality and shocks can help with the design of policies and interventions to strengthen existing coping and adaptive strategies. Interventions could include: building capacities and improving access to knowledge and education on improved land management practices; strengthening security of tenure and access rights to natural resources for sustainable cropping, grazing and forestry including sustainable gathering / harvesting of fuelwood and other goods (e.g. energy, fodder, food, crafts); providing financial and enterprise development services (not just credit for farm equipment); and promotion of diversification (land use, on- and off-farm enterprises and livelihoods).

The local level assessment findings and analysis shall be documented in the form of a concise report supported by maps, tables and diagrams. The report should:

- ⊗ explain the location of study area(s), transects and detailed assessment sites in relation to national LUS;
- ⊗ present (e.g. using maps or Google earth images) the layout and distribution of land resources and land-use types;
- ⊗ describe land use / management practices and their effects on the status of land resources in term of LD processes and trends (type, extent, severity) and effectiveness of conservation / improvement measures / SLM;
- ⊗ present the analysis of apparent causes (drivers and pressures), impacts and policy implications on livelihoods and selected ecosystem services; and,
- ⊗ propose responses for addressing land degradation or to promote sustainable land management.

Finally, it is important to bring together and synthesise findings from the LADA local and national assessments where both have been conducted. This is expected to help highlight broader impacts of land use / management practices on ecosystem services and to draw out policy implications in relation to national action plans to combat land degradation (NAPs), natural resources management and agricultural and forestry strategies, and linkages with climate change and biodiversity.

7.2 Structure of the Assessment Report

The proposed structure of the local assessment report is as follows:

- ⊗ Introduction of the Assessment
- ⊗ Methodology
- ⊗ Characterization of the Study Area

- ⊗ State of the Land Resources (and trends)
- ⊗ Driving Forces & Pressures
- ⊗ Impacts on Ecosystem Services
- ⊗ Impacts on People and their Livelihoods
- ⊗ Responses
- ⊗ Conclusions and Policy Recommendations

Then, for each chapter, the scope and content is described.

7.2.1 Introduction of the assessment report

The introduction should describe briefly the composition of the assessment team (covering skills and background of team members) and key elements of the pre-assessment planning. This should be followed by an explanation of the reasons for the selection of the assessment area, notably:

- ⊗ To explain the selection of the assessment area (what are the LUS under assessment and why?)
- ⊗ To explain the rationale and the process by which the study areas were selected and how they represent the LUS found in the assessment area;
- ⊗ To refer to significant existing interventions and projects relevant to LD / SLM in the area;
- ⊗ To address specific concerns or questions concerning LD / SLM in the study area that came out of the national assessment or that the team members are interested in (e.g. an explanation of productivity decline in a once productive area).

7.2.2 Methodology

Summarise the approach, including the interactions with and participation of local stakeholders and highlighting where the LADA methodology was and was not followed (i.e.

reasons for omissions, additions, changes; problems encountered etc.). List the secondary information reviewed and used, also the tools / methods used in the field (by LUS).

7.2.3 Characterization of the study area

The study area can be characterized using available secondary information (from technical services, projects and relevant statistics) and the information collected through the community focus group discussion and mapping. This research process should include, in particular: an analysis of perceived and actual changes in climate (rainfall amount and distribution, frequency of extreme events and, as appropriate, temperature changes), population and land use trends, average farm size, livestock type and numbers, land management practices, types of crop, tree and livestock production and yields, access to resources also implications of land degradation and natural resource management interventions over the last 10 or so years.

The section will be largely descriptive and should use the following checklist of issues to be addressed:

- ⊗ Location, population and settlement history (period as appropriate e.g. up to 50 years) (including cultural and socio-economic stratification, demographic trends, etc.);
- ⊗ Development activities in recent past (last 10 years), stakeholders involved and nature of their interventions and projects;
- ⊗ Natural resources: brief description of the topography, soils, vegetation and biodiversity, water and hydrology, climate and wildlife;
- ⊗ Main forms of land-use: grazing, crop cultivation, forest etc, land management, and income generating activities (business, processing, crafts, etc.), agricultural intensification/ diversification;
- ⊗ Important formal and informal institutional features: identifying changes and trends in the last 10 years, access to research, extension, credit and financial issues;
- ⊗ Community organizations (e.g. commodity groups, forest or livestock committees), marketing opportunities and restrictions;
- ⊗ Land tenure regime: situation, changes and trends (state land, protected areas, ownership, tenancy (security of tenure), leasehold, common property, user rights, access rights), extent of fragmentation etc.;
- ⊗ Main sources of livelihood: degree of diversification, income generation within and outside agriculture and food security;
- ⊗ Main / common land related problems, constraints and implications in terms of livelihood strategies (past, present and trends) identifiable at the community level;
- ⊗ Identifiable gender / socio-economic differentiation in land resources management;
- ⊗ Indicators of wealth / poverty (to be used for wealth ranking);
- ⊗ Relevant socio-economic infrastructure (hydraulic, education, health, roads, markets, others) and their accessibility;
- ⊗ Linkages / interrelationships with neighbouring communities and territories.

This section should contain a copy of the participatory community territory map(s) (Tool 1.4) facilitated by support maps (topographic, soil, etc.) and / or remote sensing images (land cover, time-series NDVI etc.). These should display as much information as possible, including the locations of key resources, main areas and types of land degradation, main

conservation / SLM measures, location and route of the transect / reconnaissance visit and locations of the detailed sampling plots. The transect route can be illustrated using a Google Earth image on which the different landscape features (land use types, land units, severely degraded or restored areas) can be annotated.

The study area characterisation should also contain the transect diagram and indicators table, as well as tables / graphs and figures illustrating specific findings such as climatic and demographic trends based on secondary data.

Information to include in the synthesis (including tables and graphics)

Secondary information on the study area, for example:

- ⊗ Population, income generating activities, socio-economic data;

- ⊗ Climatic data (rainfalls, temperature, floods, droughts), farming calendar;
- ⊗ Maps (topography, soil, bioclimatic zones, land cover and use, etc.);
- ⊗ Projects / interventions of relevance to natural resources management.

Where possible, secondary data such as population, rainfall, market sales / prices and so forth, should be summarised and presented in the form of graphics. For example, the following graph of rainfall data from Tunisia (Figure 12) shows significant variability in monthly and seasonal rainfall, also in the length of summer dry period. The annual rainfall for the year(s) prior to the assessment can be plotted on such a graph to compare the current situation with the averages and to discuss with land users and compare reality (actual rainfall) with farmers’ / herders’ perceptions of wetter and drier years.

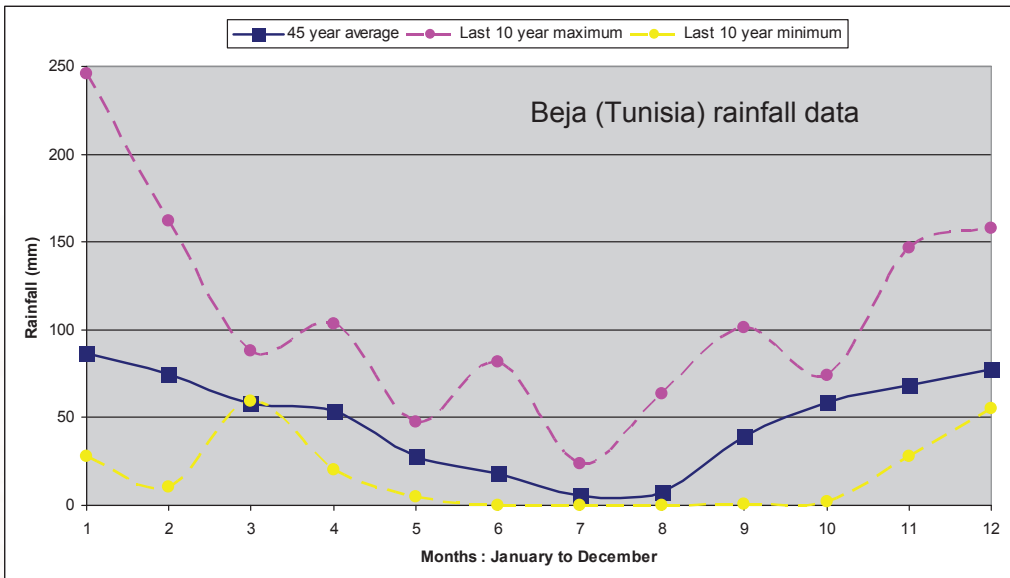


FIGURE 12 Graph of rainfall data for Béja, Tunisia, over last 10 years

[Note the Figure shows max. and min. rainfall in any 1 month for the last 10 years) compared to 45 year monthly average.]

Community focus group discussion findings are an important part of the assessment to understand land users perceptions and behaviour, see Photo 17

- ✘ Wealth ranking and land user typologies;
- ✘ Community mapping of the study area;
- ✘ Institutional mapping of relevant local/ external organisations and their influence (access to and use of resources, capacities, etc.);
- ✘ Identification of successful/best land resources management practices in the area.

Table 16 shows How to synthesize findings from a community focus group discussion (Tool 1.1)

Transect findings:

- ✘ Reasons for the selection of the transects, their locations (number and length) and what they show (e.g. to compare types of land users and degraded areas with well managed or protected areas);
- ✘ Transect diagram summarising information on each land use system / type;
- ✘ Maps (topography, aerial photographs, Google Earth images or sketches) to



PHOTO 17 **Group discussion in the field (Mendoza, Argentina) showing facilitator and land users**

TABLE 16 **Land use, livelihoods and socio-economic information in the study area**

Main LUS / LUT (1 to 3)	Land degradation types	Major Socio-economic and environmental changes (10 years)	Types of Land users	Income generating activities	Land uses and management practices	Vulnerabilities
1-			1.			
			2.			
			3. etc.			
2- etc.						



PHOTO 18 **Transect crossing the landscape and several LUS (Siliana, Tunisia)**

show transect locations, LUS and the main land use types, water sources, degraded / well managed areas, roads, markets, towns, etc.

In Photo 18, this long transect runs across a range of land use systems and types from A - a forested mountain escarpment (LUS1- with protected and managed forest), to degraded “garrigue” (LUS2), to olive orchards (LUS3), to cultivated land for cereals (LUS4), to Z - a dam for water storage.

The above tools provide a synopsis of land uses, management and land degradation issues in the selected study areas, also an understanding of how socio-economic and institutional factors influence land users’ perceptions and management of land resources at farm,

community and landscape level. The community focus group discussion, wealth ranking and participatory community territory mapping, guide the location and conduct of transects (1-4 per study area) and reconnaissance assessment with the land users of soil, vegetation and water resources degradation and its conservation (stability) or improvement (restoration or rehabilitation) in relation to land use. The findings provide a rational basis for the location of sampling sites and households for more detailed assessments.

7.2.4 State of the land resources (and trends)

This chapter should present the analysis of the state of the land resources, along with some

perspective on magnitude and direction of recent historical changes. The term “recent” throughout the methodology means in approximately the last ten years, as this is a reasonable recall period to discuss with land-users and also corresponds to the time-frame used in the national level LADA assessment. In some cases, specific events may have had significant implications on LD / SLM over a longer recall time-period and these should then also be considered.

There should be both qualitative and quantitative information available. The quantitative and semi-quantitative data from the biophysical assessments (soil, vegetation, water, ecosystem services) should be integrated and triangulated with the information from the community focus group discussion(s) and livelihoods interviews. In many cases, land-users will identify key LD / SLM features from their perspective i.e. in terms of livelihood implications that are then assessed and compared using the biophysical tools. The land-users will also provide an historical context for the LD / SLM observed.

In many cases, information on a particular land use type (e.g. fenced, managed pasture) or on land degradation process (e.g. overgrazing) will be generated by several tools. For example, the community focus group discussion, livelihoods and land user interviews, soil erosion and vegetation assessment tools will all give information on pasture condition, quality and change dynamics. Hopefully most of the results generated by these tools will point in a similar direction and suggest a similar trend in regard to pasture and overgrazing. This process of drawing from several findings (qualitative or quantitative) to improve understanding is called **triangulation**.

The **comparative sampling strategy** will also help interpretation of results. For example, a

good understanding of the state and recent dynamic of land resources supported by a comparison of a degraded area with a better managed area and / or an untouched protected area, will allow the team to identify the extent of degradation and the rate at which change is happening. It may also be possible to use this information to develop simple scenarios, looking at future changes in the “state” of the land resources and the changes in “impacts” that would follow. A “business as usual” scenario could be compared with scenarios where the land management improves and / or deteriorates. It might not be possible to do this in a sophisticated way (through modelling) using only the data provided by this methodology but some elementary scenario development will be possible.

For each land use system (LUS) along the transect and at all sampling sites, qualitative visual indicators and simple field measurements should be made comparing well managed and poorly managed land and assessing the following:

VEGETATION AND BIODIVERSITY: This section should present and summarise the findings of the vegetation assessments (see Part 2, Tools 3.1 to 3.4) that were conducted with the land users for forest land, grazing land and cropland. This will include observations from quadrats or line transects (a 1m² grid quadrat for herbaceous species; 5, 10 or 20m² quadrats or a line transect in shrub / tree vegetation depending on the vegetation density) (see Photo 19). These should have been repeated (up to 3 times per site) where the vegetation is less uniform, to ensure it is a representative sample. The state of vegetation and biodiversity is determined by the observations of:

- ⊗ Protective cover (% plant, litter, bare soil);
- ⊗ Vegetation structure (% trees, shrubs, annual herbaceous species);

- ⊗ Plant vigour (height, diameter), biomass, regrowth;
- ⊗ Habitat and species diversity (richness; abundance; useful / undesirable / invasive species and products);
- ⊗ Productivity (crop, livestock, forestry, energy);
- ⊗ Effectiveness of vegetative conservation measures - wind breaks, reforestation, fire control, grassed strips, etc.

Trends can be determined from the interviews with local resource persons and land users and, where available, from the use of satellite images and aerial photos to compare the current situation with the situation over the last 10 years.



PHOTO 19 **Line transect to assess vegetation cover and species diversity (Tunisia)**

In croplands, as well as assessing where possible the crop(s) (where they are in the ground), the state of the natural vegetation should be assessed, such as the maintenance of field borders, vegetated strips or bunds, shrubs / trees in fields and around homesteads. The natural vegetation provides host plants / habitats for wildlife including beneficial predators of pests (birds, reptiles and insects) and pollinators. A monocrop on a single farm (repeated year after year) or a tendency for all farmers in an area to grow the same crop will both result in a greater risk of pests and disease outbreaks (information from the land users). Crop rotations or sequences and crop mixes should be recorded, as these contribute to reducing community vulnerability to crop losses from drought, disease and pests.

SOIL: This section should present and summarise the findings of the soil assessment that was conducted with the land users for forest land, grazing land and cropland (see Part 2, Section 4). The soil is strongly influenced by vegetation and vice versa, so these findings could be usefully brought together for each land use type. The soil status and trends are determined from observations and measurements of a number of soil properties and of soil erosion:

SOIL PROPERTIES, including physical, biological, chemical properties, should have been assessed using the VS-Fast tools and indicators (see Part 2, Section 4) to provide a comparable score of soil health:

- ⊗ soil surface and structure (cover, crusting, compaction, depth, water infiltration rate);
- ⊗ soil organic matter and life - organic matter content, rooting, earthworms;
- ⊗ pH, salinity, plant nutrient deficiencies.

SOIL EROSION should have been assessed in terms of activity (is it active, or partially or fully

stabilised?) and type of erosion (raindrop splash, rill, gully, stream bank, or mass movement?) and severity (none, slight, moderate, severe?) (see Photo 20 which shows how loss of protective cover exposes the soils to rill erosion and Photo 21 which shows exposed roots due to soil erosion).

A number of optional measurements can be used to estimate the volume of soil loss (depending on erosion type), where it is a critical issue.

The summary of the status and trends of the soil should bring together the findings on soil health and soil erosion as both are related. While soil types vary in erodibility, in general a well managed soil that is rich in organic matter and with a friable structure is less vulnerable to erosion.

Trends in soil erosion and runoff need to be determined from the land users and where available, from the use of historical satellite images and aerial photos (e.g. 10 years before) to compare with the current situation.



PHOTO 20 Measuring percentage of bare soil and size & extent of rills / gullies (Tunisia)



PHOTO 21 Root exposure in stony shallow soil under woody garrigue (Tunisia)

WATER RESOURCES: The section on the status and trends of water resources is derived from both the key visual water indicators and from discussions with land users (availability, quality, use, access, etc.). As the assessment is conducted at one moment in time, information on seasonality and changes in water resources must be obtained from the community discussion and key informant / households interviews, also secondary data (meteorological, rainfall gauging stations if available etc).

Indicators include:

- ⊗ Rainfall (distribution, intensity, amount) and climate variability / change;
- ⊗ Water sources (types, number, size), availability (seasonality) and water quality;
- ⊗ Water uses for human consumption, livestock, agriculture, industry;
- ⊗ Water resources management (over a 10 year period) (e.g. water conservation and harvesting activities);
- ⊗ Water policy and institutional aspects (water allocation, rights and conflicts).

A focus should be placed on the effects of land uses and management on water for human and livestock consumption, also the effective (or otherwise) use of rainfall or irrigation water for agricultural production.

It is important to assess any off-site / landscape impacts of water resources degradation, such as flooding, sedimentation from runoff water or dust storms, salinity due to over-abstraction / irrigation, point contamination of water by housing or industry, upstream land use effects on resources downstream (e.g. water recharge, loss of productive land etc.). It is also useful for the team to think about these impacts not only in biophysical terms but also in terms of impacts on wider communities.

SLM TECHNOLOGIES AND APPROACHES:

The evaluation of the effects of successful SLM practices and associated approaches in croplands, grazing and forest lands in the study areas is facilitated by the use of the WOCAT questionnaires. The report should include the effects on the productive, ecological and socio-cultural services provided by ecosystems. [See Part 1 Annexes 2 to 5.] It is possible to document these SLM Technologies (QT) and Approaches (QA) by uploading the assessment results as case studies in the WOCAT database to share the experiences more widely.] The questionnaires help in making the team more rigorous in the evaluation and in carrying-out additional research to collect required additional information that may not be immediately available. For example, information on required inputs and costs, constraints to adoption and effects, not only for preventing, mitigating or reversing land degradation but also the effects in terms of biodiversity conservation, sustainable use and climate change adaptation and mitigation. Such issues are of increasing value for policy makers. The WOCAT questionnaires and database are available on the WOCAT website www.wocat.org, also see CDE / WOCAT *et al.* 2008 and 2011 .

To sum up, the chapter assessing the status (and trends) of land resources should present the findings / data collected on the state of the land (and trends) by LUS for all the local assessment area (this may include several different study areas):

- ⊗ Vegetation and biodiversity;
- ⊗ Soil properties;
- ⊗ Soil erosion;
- ⊗ Water resources;
- ⊗ Changes in the farming / production system (intensification, specialization, diversification, organic agriculture, no tillage, fragmentation, deforestation, reforestation) or protected areas (nature reserve, wetland, etc.);

Direct causes (pressures)	QM Code	Description	Cultivated commercial and irrigated			Grassland		
			Local		National	Local		National
			CA	Conv.		CA	Conv.	
Soil management (s)	s1	Cultivation of highly unsuitable/ vulnerable soils			x			
	s2	Missing or insufficient soil conservation / runoff & erosion control		x	x			
	s3	Heavy machinery Tillage practice	x	x	x			
Crop + rangeland management (c)	c1	Reduction of plant cover and residues	x	x	x	x		
	c2	Inappropriate application of manure, fertiliser, herbicides, pesticides and other agrochemicals			x			
		Inappropriate irrigation			x			
		Inappropriate use of water in rainfed agriculture (e.g. excess soil evaporation + runoff)		x				
		Occurrence and spread of weeds & invader plants						x
Overgrazing (g)	g1	Excessive numbers of livestock				x	x	
	g2	Trampling along animal paths						x
	g3	Overgrazing				x	x	
	g4	Too long or extensive grazing periods in a specific area or camp leading to over-use of palatable species				x	x	
	g5	Change in livestock composition						x

FIGURE 13 Comparing direct causes of land degradation in local and national assessment (Kwa-Zulu Natal, South Africa)

Direct causes (pressures)	QM Code	Description	Cultivated commercial and irrigated		Grassland		
			National		Local		National
			CA	Conv.	CA	Conv.	
	g6	Others					x
Disturbance of the water cycle	w1	Lower infiltration rates/increased surface runoff		x			
	w2	Others- Siltation of rivers and stream-lack of CA upstream			x	x	
	w3	Others- Drying up of boreholes and E coli contamination	x				
Over abstraction/ excess withdrawal of water (o)	o1	Irrigation	x	x	x		
Discharges (p)	P1	Sanitary sewage disposal				x	x
	P2	Waste water discharge				x	x

FIGURE 13 Comparing direct causes of land degradation in local and national assessment (Kwa-Zulu Natal, South Africa) (continued)

- ⊗ Land degradation problems/types identified in the assessment areas (also locate them spatially in the LUS):
 - Prioritise LD problems by order of importance in terms of:
 - Severity
 - Extent
 - Impacts on ecosystem services and livelihoods.
 - For each selected successful / best land management practice (QA-QT) indicate;
 - Impacts on productivity, on major ecosystem services and livelihoods (use of assets, tradeoffs, vulnerability).

Throughout the report, diagrams, graphics and pictures will be useful to present the data collected (see examples in Figures 13 to 15). Figure 13 shows the comparison that was made through the local assessment of causes of degradation in conventional tillage versus conservation agriculture in cultivated land and of conservation practices versus conventional practices in grassland.

It is important to also provide / make available the field data from the local assessment, in the form of supplementary Excel database or in the LADA local database (forthcoming, in Access) for data analysis, as well as for future monitoring.

7.2.5 Driving forces & pressures

This section tracks back from observations made on the state and dynamics of the key land resources to the causal factors (i.e. the pressures (direct) and the driving forces (indirect)) and includes the analysis of direct and indirect causes of LD / or SLM adoption by LUS.

The focus group discussion (Tool 1.1 (FAO *et al.*, 2011b)) and the key informants and households interviews (Tool 7.1) will provide information on the drivers and pressures of land degradation. In many cases, specific management practices or specific demands people are making on the resources (e.g. deforestation for fuelwood) are identified as the significant “pressures” on the land resources. Some of the driving forces may be environmental (e.g. drought, rainfall variability, climate change, pest attack) but many will be economic, social and institutional

in nature (such as population growth leading to land fragmentation and over exploitation). For this reason, it is important to analyse the role and implications of the different local institutions (government agencies, NGOs, producers groups, community organizations, support groups, etc.) and how they influence land use and management practices of the various types of land users (large- and small-scale farmers including subsistence and commercial enterprises, also livestock keepers (traditional and commercial)).

Figures 14 to 16 shows the use of data and graphs from secondary information sources, notably of increase in farmland area over 50 years and share of the population dependent on different livelihoods from agricultural /employment statistics for one study area in China, and of biomass dynamics over a 3 years period from remote sensing data for another study area.

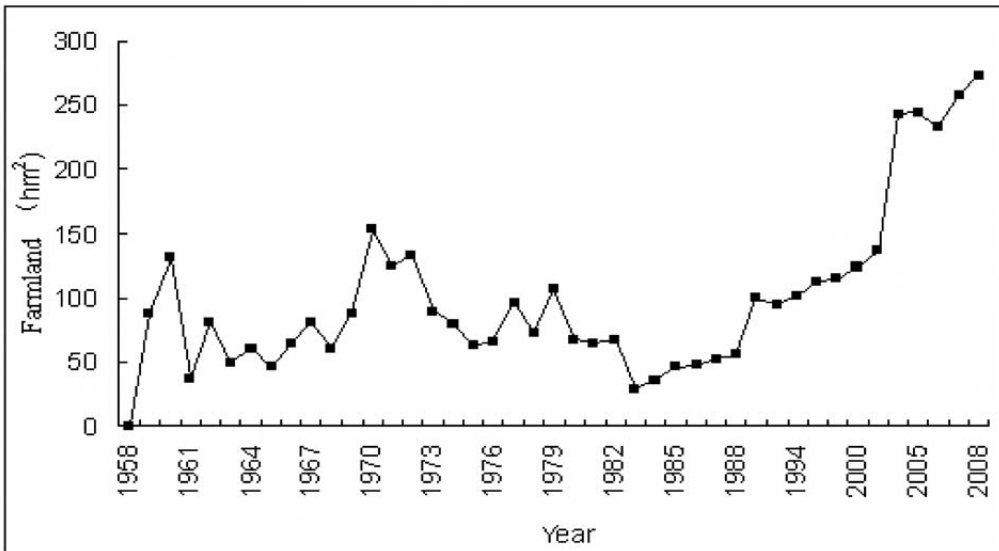


FIGURE 14 Farmland change 1958 -2008 (China, Wengniute banner, Ulan'aodou) (in square hectometers – 1hm2 = 1 hectare)

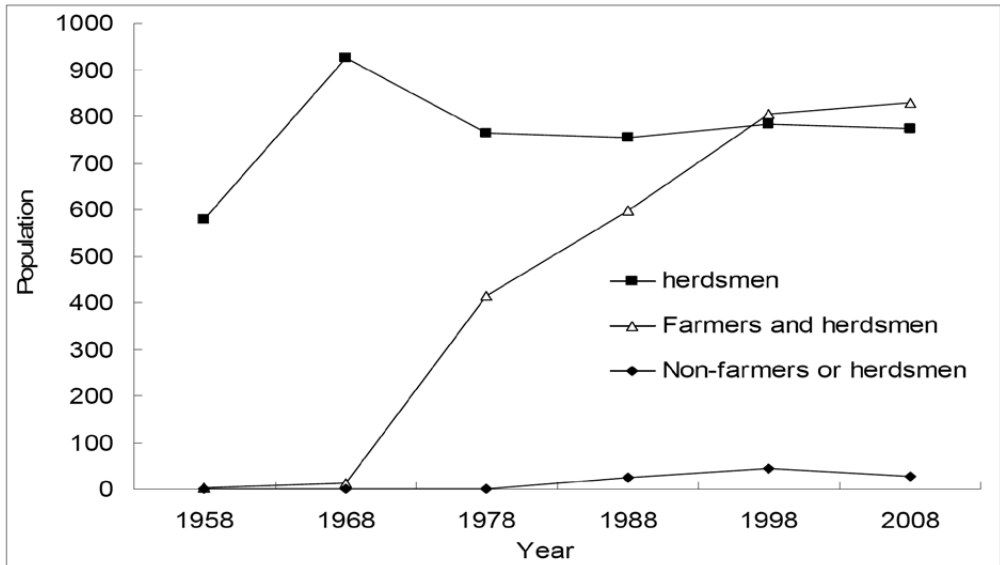


FIGURE 15 Share of the population in different livelihoods 1958-2008 (Wengniute banner, Ulan'aodou, China)

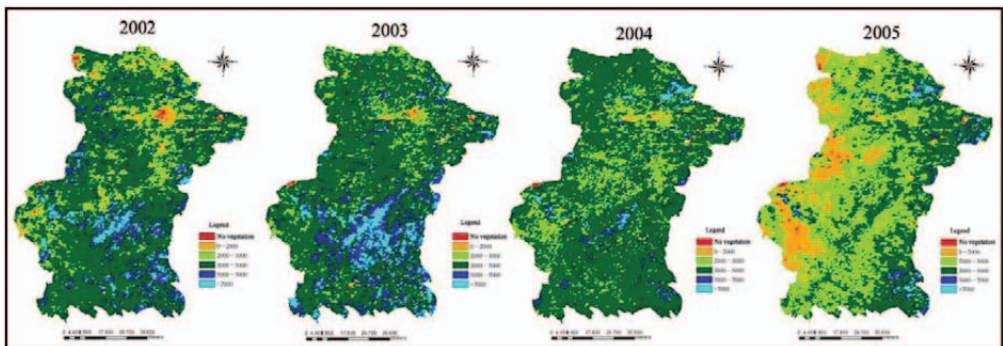


FIGURE 16 Biomass dynamics 2002-2005 (Yanchi, China)

Identification of direct and indirect causes of land degradation in the study area

Step 1: For each land use type in the study area, identify the main direct causes of degradation (“pressures” in DPSIR) using the list in Table 17 (below). First place a cross against all those causes that are relevant in the site.

Step 2: Then identify and if possible rank in importance up to 5 causes which are most important / critical in the given site (where 1 = most critical in terms of both severity and extent). Discuss these further in the report, in as much detail as possible, using specific examples from the assessment results.

TABLE 17 Record of the main direct causes of land degradation in the study area

LUS/LUT:.....

Land user group:.....

Direct causes of degradation	Relevant	Major	Remarks
Inappropriate soil management (s)			
(s1) cultivation of highly unsuitable / vulnerable soils			
(s2) lack or insufficient soil conservation/runoff and erosion control			
(s3) heavy machinery (including timing of its use i.e. too wet / dry)			
(s4) tillage practice (ploughing, harrowing, etc.)			
(s5) others (specify under Remarks)			
Inappropriate crop and rangeland management (c) (annual, perennial, shrub and tree crops)			
(c1) reduction of plant cover and residues (e.g. burning, use for fodder)			
(c2) inappropriate use of manure, fertilizer, herbicides, pesticides, other agro-chemicals or waste (leading to contamination or non-point pollution)			
(c3) nutrient mining (excess removal and inadequate replacement)			
(c4) shortening of the fallow period in shifting cultivation			
(c5) inappropriate irrigation: inefficient method (full / supplementary, over-irrigation, insufficient drainage, use of salty water)			
(c6) inappropriate use of water in rainfed agriculture (e.g. excessive soil evaporation and runoff)			
(c7) bush encroachment and bush thickening			
(c8) occurrence and spread of weeds and invader plants			
(c9) others (specify under Remarks)			
Deforestation/removal of natural vegetation (f) due to:			
(f1) large-scale commercial forestry,			
(f2) expansion of urban / settlement areas and industry			
(f3) conversion to agriculture			
(f4) forest / grassland fires			
(f5) road and rail construction			
(f6) others (specify under Remarks)			

TABLE 17 Record of the main direct causes of land degradation in the study area (continued)

Direct causes of degradation	Relevant	Major	Remarks
<p>Over-exploitation of vegetation for domestic use (e) and hence poor protection through:</p> <p>(e1) excessive gathering of fuelwood, (local) timber, fencing materials</p> <p>(e2) removal of fodder</p> <p>(e3) others (specify under Remarks)</p>			
<p>Overgrazing (g) (i.e. leading to a decrease in plant cover, fodder quality, soil compaction and in turn soil productivity decline and erosion</p> <p>(g1) excessive numbers of livestock</p> <p>(g2) trampling along animal paths</p> <p>(g3) overgrazing and trampling around or near feeding, watering and shelter points</p> <p>(g4) too long or extensive grazing periods in a specific area leading to over-utilization of palatable species</p> <p>(g5) change in livestock composition: from large to small stock; from grazers to browsers; from livestock to game and <i>vice versa</i></p> <p>(g6) others - specify</p>			
<p>Land used for Industrial activities and mining (i) (i.e. leading to loss of land resources and their functions for agriculture, water recharge, and causing damage offsite through pollution, etc.</p> <p>(i1) industry</p> <p>(i2) mining</p> <p>(i3) waste deposition</p> <p>(i4) others - specify</p>			
<p>Land use for urbanisation and infrastructure development (u) (i.e. leading to loss of land resources and their functions for agriculture, water recharge, and causing damage off-site through runoff, erosion, pollution, etc.</p> <p>(u1) settlements and roads</p> <p>(u2) (urban) recreation</p> <p>(u3) others (specify under Remarks)</p>			

Step 3: Carry out the same exercise to identify the indirect causes (drivers) of degradation in each site using the list in Table 18 (below). Place a cross against all those causes that are relevant in the site.

Step 4: Then identify and if possible rank in importance up to 3 indirect causes which are most important / critical in the given site (where 1 = most critical). Discuss these further, in as much detail as possible, using specific examples from the assessment.

TABLE 17 Record of the main direct causes of land degradation in the study area (continued)

Direct causes of degradation	Relevant	Major	Remarks
Discharges (p) leading to point contamination of surface and ground water resources, or excessive runoff off-site (neighbouring areas)			
(p1) sanitary sewage disposal			
(p2) waste water discharge			
(p3) excessive runoff			
(p4) poor and insufficient infrastructure to deal with urban waste (organic and inorganic waste)			
(p5) others - specify			
Release of airborne pollutants from industrial activities, mining and urbanisation (q) leading to:			
(q1) contamination of vegetation/ crops and soil			
(q2) contamination of surface and ground water resources			
(q3) others - specify			
Disturbance of the water cycle (w) leading to accelerated changes in the water level of ground water aquifers, lakes and rivers (improper recharge of surface and ground water) due to:			
(w1) lower infiltration rates / increased surface runoff			
(w2) others (specify under Remarks)			
Over-abstraction/excessive withdrawal of water (o):			
(o1) irrigation			
(o2) industrial use			
(o3) domestic use			
(o4) mining activities			
(o5) decreasing water use efficiency			
(o6) others (specify under Remarks)			
Natural causes of degradation (n):			
(n1) change in temperature			
(n2) change of seasonal rainfall			
(n3) heavy/extreme rainfall (intensity and amounts)			
(n4) windstorms / dust storms			
(n5) floods			
(n6) droughts			
(n7) topography			
(n8) other (earthquake, volcanic eruptions, landslides, highly fragile natural resources, etc.) – please specify			

TABLE 18 Record of the indirect causes (Drivers) of LD in the study area

LUS/LUT:.....

Indirect causes/drivers of degradation	Relevant	Major
<p>Population pressure (p): High: may trigger or enhance degradation, e.g. by increasing pressure on resources or ecosystem services. Low: may lead to degradation through lack of labour to manage resources.</p>		
<p>Change in consumption pattern and individual demand (c): of the population or in the individual demand for natural resources (e.g. for agricultural goods, water, land resources, etc.)</p>		
<p>Land Tenure (t): Poorly defined tenure security / access rights may lead to land degradation, as land-users are reluctant to invest in management when returns are not guaranteed.</p>		
<p>Poverty (h): limits land-user investment and choice. Poor people often have no alternative but to use marginal land that may be particularly prone to land degradation (e.g. steeply sloping areas)</p>		
<p>Labour Availability (l): Shortage of rural labour (e.g. through migration, diseases, out migration) can lead to abandonment of traditional resource conservation practices such as terrace maintenance. May also alleviate pressure on land resources.</p>		
<p>Inputs and infrastructure (r): Roads, markets, distribution of water points, etc.: inaccessibility to, or high prices for key agricultural inputs such as fertilizers. Quality of infrastructure will affect access to input and product markets.</p>		
<p>Education, access to knowledge and support services (e): Educated land users are less likely to be poor (often have higher returns from their land) and more likely to adopt technologies. Education can also provide off-farm labour opportunities.</p>		
<p>War and conflict (w): leading to reduced options for using the land and reluctance to invest.</p>		
<p>Formal institutions (gf): formal laws, policies controlling access and use of land resources. Government induced interventions.</p>		
<p>Informal institutions (gi): local rules and regulations, social and cultural arrangements & obligations affecting access to resources.</p>		
<p>Climate variability and change (e.g. drought, rainfall variability, climate change which may induce change in pests, diseases)</p>		
<p>Other environmental changes /stresses e.g. change in land use such as shift towards monocultures leading to stresses such as pests, loss of cover, chemical pollution, etc.)</p>		
<p>Others (o): (specify)</p>		

TABLE 19 Record of the drivers of SLM

Drivers of SLM (i.e. best practices)	Relevant	Major
Knowledge and skills (i.e. through training, extension)		
Institutions (i.e. strong producers' organisations, extension services etc.)		
Policy support (i.e. land rights, incentives)		
Legislative support (e.g. byelaws, recognition of common property resources etc.)		
Infrastructure and services (roads, markets, credit etc)		

Step 5: Rather than just a simple case of a driving force exerting a pressure on a resource, it is important to identify where there may be a more complex chain of explanation or a hierarchy of driving forces and pressures (i.e. driving force A causes driving force B, causes pressure A, causes LD). Document these cases as described in Box 5. These interrelations are particularly important if they affect a large number of land-users or if they are found in several LUS or study areas.

Where possible, a flow chart should be prepared with the land users to show the cause effect relations.

7.2.6 Impacts on ecosystem services

Adopting an integrated ecosystem approach improves understanding of the biophysical and socio-economic / human interactions that determine land degradation or improvement.

Drawing on the findings of the reconnaissance visit / transect walk and during the detailed site assessments of vegetation, soil and water resources, the LD / SLM impacts on ecosystem services are assessed including impacts on:

Production and productivity:

- ⊗ production of food, fibre, energy (through crops, livestock, forestry), other goods;

- ⊗ water productivity, availability of land;
- ⊗ risks of crop failure, livestock / tree mortality, etc.

Ecological regulation and life-support:

- ⊗ nutrient cycling – break down of organic matter, soil fertility replenishment, pollution (nitrates, phosphates, etc.);
- ⊗ carbon cycling - C sequestration through biomass production, organic matter management (including reduced tillage), and regulation of GHG emissions (biomass burning, methane emissions from livestock and irrigated systems, fuel emissions from mechanised farming, etc.);
- ⊗ maintenance of the hydrological cycle / regime (rainwater retention, flow, protection of wetlands, purification, flood and drought severity and incidence and salinization (e.g. where evapo-transpiration exceeds precipitation);
- ⊗ conservation of biodiversity and associated functions (pollination, biocontrol of pests and diseases;
- ⊗ climate regulation – through shade, windbreaks, water conservation etc., which also contribute to climate change adaptation.

Socio-cultural services (i.e. those provided by the environment), including;

- ⊗ livelihoods (e.g. farming, forestry, fisheries, ecotourism);

BOX 5 Example of direct and indirect drivers of land degradation: a chain of explanation

In this example two neighbouring banana farmers in SE Uganda were encountered on apparently very similar land. Farmer A was conserving his land with trash lines, grass strips and ditches, farmer B was not. The first impression of the extension officer was that farmer B was not interested in protecting his land as he had been shown the same techniques and given the same help as farmer A. A brief but careful discussion with the farmer lasting perhaps 20 minutes revealed the following - presented here as a “chain of explanation”:

- Farmer B had in fact tried the recommended SWC techniques several times but the force of water coming from upslope was too great and the ditches and trash lines were washed away – why? ▶
- Because upslope fields in supposedly protected forest areas had been recently opened up leading to a greater volume and force of water on his land during heavy rains –why? ▶
- Because some farmers were able to open fields without problems in these areas, even though there are local bye-laws prohibiting this – how? ▶
- Because the families involved were influential within the village and few could oppose them and anyway government forest protection policies / local byelaws were poorly enforced and ineffective.

Thus, in a relatively short time it becomes clear that the driving force of this problem is not the farmers’ attitude, nor even the techniques themselves (though more effective options might be available) but weaknesses in the formal and informal institutions protecting forested watersheds and problems with their enforcement. A “chain of explanation” is apparent with a sequence of linked factors or influences contributing to create the situation observed in the field. Understanding this chain is useful as not only are interventions frequently possible at several points in the chain but the most appropriate point of intervention is often not one that addresses the most immediate cause of the problem. In this example it might be more appropriate to look closely at local forest protection by-laws and community capacity to enforce them rather than just giving the land-user the best available advice on SWC. Improvements in by-law enforcement might benefit large numbers of land-user without requiring them to invest more of their resources in soil protection.



- ⊗ spiritual and aesthetic value (e.g. landscape or recreation value);
- ⊗ vulnerability / risk aversion (conflict resolution, food security).

Table 20 provides an example of how to score the impacts on each service and describe the relevant change. It uses the example of irrigation in and around a wetland

This shows, for example, that the effect of the given land management practice on food security may be positive or negative depending on the type of land user.

The DPSIR framework (see Chapter 2) encourages teams to look at the impacts of land degradation on both ecosystem services and livelihoods. The LADA methodology does not intend to deliver a full ecosystem services assessment but focuses

on the main ecosystems services affected by LD / SLM, in particular the provisioning services (food production from crops and livestock) as these capture the main productive uses people derive from their land resources and can be more readily assessed. However, it is important to think more broadly about ES impacts. The analysis should generate some information on important ecological (regulating and supporting) and socio-cultural services from which it will be possible to infer the impacts of LD / SLM on these services using the assessment findings. This may be backed-up by available scientific knowledge from relevant studies and research (e.g. changes in water table, river flow and water supply; sedimentation of reservoirs, soil analysis of nutrients and carbon etc.).

The information on ES impacts will be derived largely from qualitative information from the

TABLE 20 Impacts on ES of a given land management practice

Example of irrigation in and around a wetland

Ecosystem Services	Impacts (-3 to +3)	Description
Productive services		
P1 animal / plant quantity and quality	+2	increased yield due to irrigation
P2 water for human, animal and plant use	- 3	river water extraction reduces flow and quality
P3 land availability (productive area/caput)	+1	wetland developed for irrigation
Ecological regulating & life support services		
E1 Hydrological regime	- 2	downstream water shortage; risk of flash floods
E2 Carbon cycle	- 2	C emissions from drained wetland
E3 Species diversity	- 2	reduction in number of cultivated species /loss of wetland species.
Socio-cultural services		
S1 Food security.	+/-	More food but poorer farmers not benefiting
etc.		

community focus group discussion and key informant and household interviews, as well as on the findings of the biophysical assessment including impacts of land degradation on soil, water resources, vegetation (biomass quantity and pasture quality) and crop, livestock and tree / forest productivity.

A procedure is provided below to help the team members to carry out a simple analysis of LD / SLM effects on some key ecosystem services. A simple scoring system is provided to assess and prioritize, through in-depth discussion, those impacts believed to be most significant.

Identification of land degradation impacts on ecosystem services in the study area

The aim of this part of the analysis is to identify the wider effects of LD / SLM on different ecosystem services. The range of key ecosystem services are listed in Table 21 (below) and for each suggested indicator a possible proxies are given.

Step 1: For each land use system, assess the type of ES impacts caused by LD / SLM according

to the list of potential impacts in Table 22 and Table 25. Impacts should be assessed in areas with land degradation through comparisons with areas without land degradation (i.e. areas that are already well managed or protected).

Step 2: For each type of impact identified determine the degree of impact from -3 to +3 (see Table 21). The same land degradation process can cause negative and positive impact(s) at the same time (e.g. erosion in one place can lead to accumulation of fertile sediments further downslope or down stream). Moreover, it can affect positively or negatively the food security of different land users.

Step 3: Identify and rank in importance (1 to 5) a few of the most significant ecosystem service impacts identified by land use systems (see Table 22). Discuss these further, in as much detail as possible, using specific examples from the assessment results.

Step 4: Take care to consider whether the effects of degradation have been partially hidden or compensated by various response measures by the land users. For example, fertilizers may be used to

TABLE 21 Degree of impact on ecosystem services

-3	High negative impact: - land degradation contributes negatively (>50%) to changes in ES
-2	Moderate negative impact: - land degradation contributes negatively (10-50%) to changes in ES
-1	Low negative impact: - land degradation contributes negatively (0-10%) to changes in ES.
0	No observable change/impact
+1	Low positive impact: - land degradation contributes positively (0-10%) to the changes in ES
+2	Moderate positive impact: - land degradation contributes positively (10-50%) to the changes in ES
+3	High positive impact: - land degradation contributes positively (> 50%) to changes in ES.

TABLE 22 Record and rank the types and level of impacts of LD on ecosystem services
Record all relevant ES and then rank the 5 most significant ones (1 to 5)

LUS/LUT:..... Land user group:.....

Type of impact on Ecosystem services	Impact (-3 to +3)	Rank (1- 5)	Description of the Impact on ES
P Provisioning services			
(P1) production (animal / plant quantity and quality including biomass for energy) and risk			
(P2) water (quantity and quality) for human, animal and plant consumption			
(P3) land availability (area of land for production per person)			
(P4) others (specify under description column)			
E Regulating and supporting services			
a) Hydrological services:			
(E1) regulation of excess water such as excessive rains, storms, floods e.g. affecting infiltration, drainage, runoff, evaporation, etc.			
(E2) regulation of scarce water and its availability e.g. during dry seasons, droughts affecting water and evaporation loss, etc.			
b) Soil services:			
(E3) organic matter status			
(E4) soil cover (vegetation, mulch, etc.)			
(E5) soil structure: surface (e.g. sealing and crusting) and subsoil affecting infiltration, water and nutrient holding capacity, salinity etc.			
(E6a) nutrient cycle (N, P, K)			
(E6b) carbon cycle			
(E7) soil formation (including wind-deposited soils)			
c) Biodiversity:			
(E8a) biodiversity at habitat level			
(E8b) biodiversity at inter- and intra- species level (plant varieties, animal races etc)			
(E8c) associated species and functions (Pest and disease control- above and below ground; pollinators; soil organisms)			

TABLE 22 Record and rank the types and level of impacts of LD on ecosystem services (continued)

Type of impact on Ecosystem services	Impact (-3 to +3)	Rank (1- 5)	Description of the Impact on ES
d) Climate services:			
(E9) greenhouse gas emissions (CO ₂ , methane, etc.)			
(E10) (micro)-climate (wind, shade, temperature, humidity)			
(E11) others			
S Socio-cultural services / human well-being			
(S1) spiritual, aesthetic, cultural landscape and heritage values, recreation and tourism			
(S2) education and knowledge (including indigenous knowledge)			
(S3) conflict transformation			
(S4) food & livelihood security and poverty			
(S5) health			
(S6) net income			
(S7) protection / damage of private and public infrastructure (buildings, roads, dams, etc.)			
(S8) marketing opportunities (access to markets, etc.)			
(S9) others			

Source: This list has been adapted from the Millennium Ecosystem Assessment (WRI, 2005)

partly compensate for the productivity loss caused by soil erosion and nutrient loss, however the inherent soil fertility may be being impoverished; or the treatment of polluted water may be used to compensate for the decline in water quality. Factors that are not related directly to land degradation but a consequence of reduced ecosystem health or resilience may contribute to yield declines (e.g. pests and diseases, weather influences).

Step 5: Provide any additional information on the LD and SLM impacts on ecosystem services for the main types of LD / SLM respectively see Table 24 and 25.

7.2.7 Impacts on people and their livelihoods

One of the objectives of a livelihoods analysis is to deliver an improved understanding of how socio-economic, cultural and institutional factors influence land-users’ views and their management of their land resources. It helps analyse both the drivers and pressures leading to LD / SLM and the impacts of LD / SLM on people. Understanding these LD drivers helps to identify policy responses for the diverse land user groups.

TABLE 23 List of SLM impacts on ES

Production/ economic benefits of SLM	Socio-cultural benefits of SLM	Ecological benefits of SLM
<ul style="list-style-type: none"> Increased crop yield (CY) <ul style="list-style-type: none"> increased animal production (AP) increase fodder production increased fodder quality Increase wood production (WP) Reduced risk of production failure (RF) Increased water availability / quality (W) <ul style="list-style-type: none"> household livestock irrigation Reduced demand for irrigation water (DI) Reduced expenses on agricultural inputs (AI) Increased farm income (FI) Diversification (D) of <ul style="list-style-type: none"> products income sources Increased production area (new land use) (PA) Other (PO): 	<ul style="list-style-type: none"> Community institution strengthening (C) Improved conservation/ erosion knowledge (K) Improved situation of socially and economically disadvantage groups (S) Improved food security/ self-sufficiently (F) Conflict mitigation (CM) Improved health (H) Other (SO): 	<ul style="list-style-type: none"> Increase water quantity and / or quality (W) Improved harvesting/ collection of runoff (R) Increased soil moisture / reduced evaporation) (SM) Improved land cover (reduced runoff) (LC) Recharge of groundwater table / aquifer (G) Reduced hazards (flood, drought, storms) (H) Reduced wind velocity (WI) Increased biomass (B) Increased soil organic matter (nutrient recharge) (OM) Reduced greenhouse gases and C emissions (C) Reduced soil loss (SL) Reduced soil compaction/ crusting (SC) Reduced salinity (S) Increased animal and/or plant diversity (D) Reduced invasive species (IS) Increased pest control (PC) Other (EO):

TABLE 24 Land degradation types and impacts on ES at site and landscape levels

Land degradation type	Main ES affected	
	Site level	Catchment / landscape
Overgrazing	<ul style="list-style-type: none"> reduction in protective vegetation cover reduction in species diversity and pasture quality shortage of water in water points 	<ul style="list-style-type: none"> increased runoff and erosion reduced carrying capacity for livestock and wildlife lack of recharge of groundwater and sedimentation of water points
etc.		

There are many examples from dryland areas showing that providing land-users with technical options for more sustainable land management can be useful, but it is rarely enough on its own to change behaviour significantly in the long-term.

Attention is paid in the land use / livelihood analysis to consider what people are already doing or trying to do to manage their resources and meet their needs. Why are certain households, innovators or succeeding entrepreneurs? What

TABLE 25 Impacts of sustainable management practices on ecosystem services

SLM measures & interventions	Impacts on Ecosystem Services		
	Production/socio-economic benefits	Socio-cultural benefits	Ecological benefits
Reduced tillage	Increased crop yields	Reduced manual land tillage	Improved rainwater infiltration and reduced evaporation Reduced sheet erosion
etc.			

are the constraints or opportunities for others to follow? In a specific study area it may be possible to identify several different strategies: those intensifying crop or livestock farming; others who depend on mobility and diversified income from off-farm work and so forth.

The review of assets (pentagon diagram – Figures 17 and 18) helps readers to understand the strategies and trade-offs operating (e.g. natural assets such as forests and land quality may be drawn down in order to build up human capital in the form of education or health care). In the short term, households find ways to cope with change but in time their longer strategies also need to be adapted to the new context. In this regard, the expert teams should pay attention to the ways that households and wider communities are coping with and adapting, notably to population pressures and climate change (for example pressures on land and fragmentation may influence their coping strategies to address rainfall variability or increased incidence of extreme events - storms, drought, floods etc.).

The LADA local livelihoods (socioeconomic and institutional) analysis should be completed using information from:

- ⊗ **Community Focus Group Discussion** (Tool 1.1 (FAO et al., 2011b)): This generates initial information about the range of land-users, their individual and communal land management regimes and the area history. It also informs on how the socio-economic and institutional factors influence land users’ perceptions and management of land resources at landscape level. It helps in interpreting secondary information.
- ⊗ **Wealth ranking** (Tool 1.2) is used to categorize the household / livelihoods in the community in terms of relative wealth status or wellbeing since this determines views and behaviour in relation to the land resources that are used directly (e.g. farmland) and those in the wider study area (fuelwood, water, recreation). Both the extent to which people are responsible for LD / SLM and how they are affected by the impacts of LD / SLM are strongly linked to their wealth status.
- ⊗ **Institutional mapping** (Tool 1.3) shows the different stakeholders and their roles and influence in term of sustainable land management.
- ⊗ **Household livelihoods interviews** (Tool 7.1): These help identify most of the

relevant issues that determine sustainable resource use and land degradation and “trends” or changes over the last 10 years or so. Based on the 20-30 households interviewed (depending on community heterogeneity), it is possible to identify

the socio-economic and institutional factors influencing how land users view and manage their land resources. Moreover, the various categories of land users identified during the wealth ranking will serve as a basis for the livelihoods

BOX 6 Questions that the livelihoods assessment should try to answer

Who is being affected by land degradation? Who is practising / benefiting from sustainable land management (SLM) and who is not (wealthy / poor, men / women)? and Why?

Why is there a diverse and patchy engagement in SLM by communities?

How does land degradation / engagement in SLM (prevention and restoration) relate to specific livelihood features and strategies

“Good” and “bad” land management often fits within a quite deliberate livelihood strategy in terms of risk aversion, market orientation, diversification, etc. Understanding the key elements of this strategy can explain behaviour and help guide support interventions.

What are the important socio-economic, institutional and policy drivers for land degradation, SLM and dryland development (e.g. population pressure, tenure security, effectiveness and fairness of local governance, markets / market access, infrastructure, national / regional policies).

It is important throughout the socio-economic component of the assessment to identify what are the main drivers of behaviour leading to LD, and also what are the main incentives for practicing SLM.

How does policy affect land degradation and facilitate or hinder engagement in land degradation control / SLM?

Policy influences fall within the “institutional” question above but there should be a direct consideration of the impact of national and regional policies on land management. There will almost always be a particular policy or policy process (or a policy vacuum, implementation gap, perverse outcome etc.) affecting the behaviour of land-users with respect to their land.

In addition to the natural resources assets, what roles do social, financial, human and physical forms of capital (assets) play at the local level in influencing perspectives on land and its management?

The livelihoods approach helps to adequately address all the assets: natural (land resources,) social (i.e. community organisation), financial (income, access to credit/savings etc), human (i.e. capacity, know-how) and physical (i.e. infrastructure) and gives great emphasis to the role of asset access and ownership in influencing land management behaviour.

What are the important trade-offs land-users make between the different assets to which they have access and how do these affect land management?

It is vital to develop an understanding of the strategy of the land-user and the tradeoffs that that household has been obliged to make.

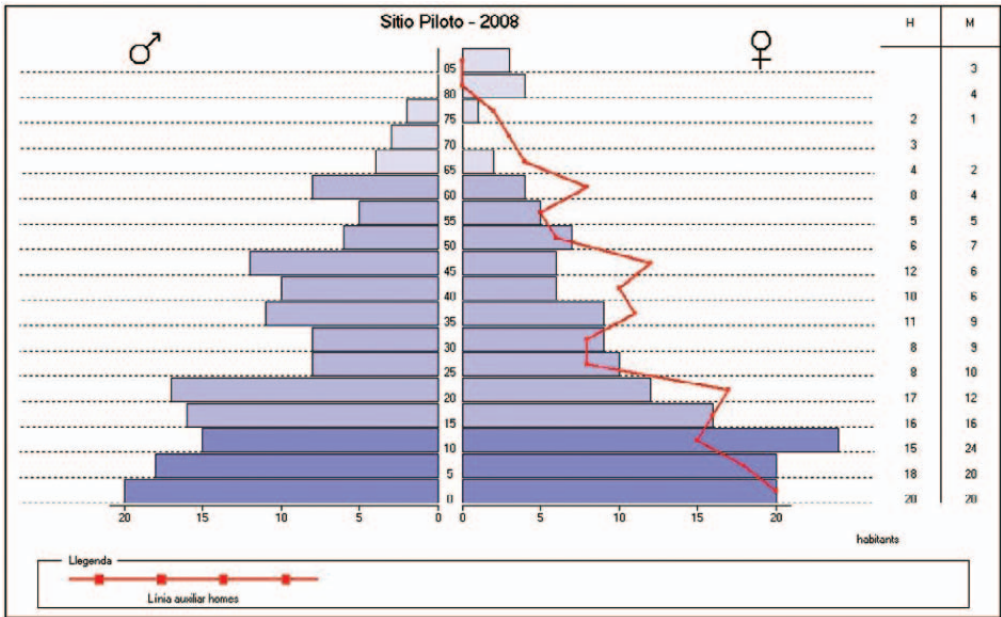


FIGURE 17 Population pyramid (Mendoza, Argentina)

analysis as it will help categorise the household interviewed. The capital assets of that household which represents a given wealth group can be shown on a pentagon diagram.

⊗ **Key informants and land users**

interviews (Tools 5.1, 5.2 and 5.3) help cross-check and further discuss specific aspects of LD problems and SLM responses, and issues less visible in the field such as water resources, use of farm inputs, livestock management, experiences of by laws and policies, and risks of current practices and or their conservation effectiveness and benefits and constraints to adoption of SLM practices.

Secondary information should be used to complement and validate the information

gathered through discussions and interviews (e.g. on household size distribution to ensure the sample of households interviewed is representative or on population growth or age distribution see Figure 16).

The interpretation of assessment results should be complemented by results of the discussions with key informants and community members. It is essential to obtain community feedback on assessment findings, to complete the understanding and develop recommendations for action from community to policy levels.

The results should provide information on the pressures on land resources caused by land-users, their effects on land resources (status and trends), the consequences of LD / SLM on ecosystem services and the impacts on

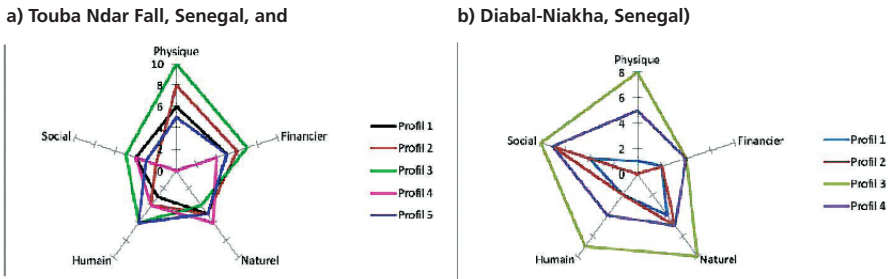


FIGURE 18 Analysis of household profiles of the working population in Senegal

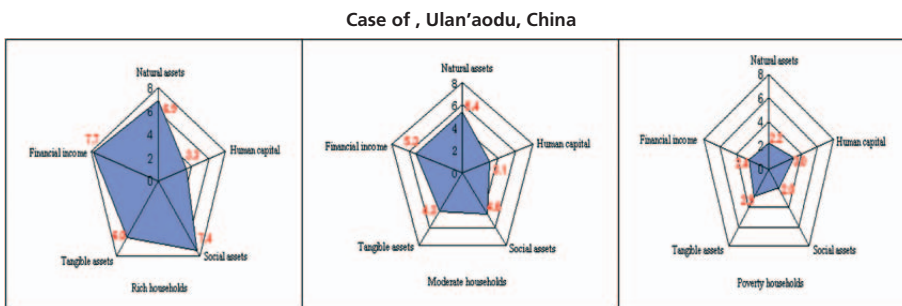


FIGURE 19 Analysis of profiles of the household working population in China

household livelihoods (e.g. in terms of food insecurity, poverty, out-migration⁶). Asset pentagons (see Figures 17 and 18) can be drawn for each of the household profiles identified showing different livelihoods strategies, trade-offs and management practices.

Any trade-offs that the various households are making over time (e.g. 5 -10 years) in terms of their various assets should be analysed to understand and guide how to intervene to prevent the continuous drawing down of natural resources and promote more sustainable

and productive practices. Strategies of small and large farmers can be assessed in terms of technologies (prevention, mitigation, restoration) and investments in SLM (labour, funds etc) and the effects of markets, policies and laws.

Analysis of these findings helps to understand the constraints and extent to which land users are addressing LD. It also reveals the various factors that influence the land users' perspectives on their land resources and that enhances or constrains their ability to practice SLM or LD control / rehabilitation. Besides land users' knowledge of improved management options and socio-economic situation (relative poverty), factors relating to resource and market access,

6 The approach draws on the work on sustainable livelihoods analysis by Ellis (2000) and Carloni (2005).

access rights, tenure and other institutional / policy issues, including associated perverse outcomes (indirect negative effects), should be addressed.

Procedure for identifying the asset indicators for different household profiles

The impacts of land degradation on households such as food insecurity, poverty, out-migration, etc., can be analysed using information from the group community discussion and household interviews. The information on wealth / poverty indicators obtained from the community discussion can help to identify relevant associations between:

- ⊗ wealth / poverty and land-user activity that causes LD / SLM;
- ⊗ wealth / poverty and the type / severity of impacts;

In most situations, “wealth” will be the most useful way to stratify the sample of households and land-users interviewed (Tools 5.1, 5.2 and 5.3 (FAO *et al.*, 2011b)) in the study area (see Table 26). However, other social groupings such as by main livelihoods activity, gender, ethnic group, age etc. may also be relevant in many areas.

The sustainable livelihoods approach is based on an appreciation of the assets diversity, activities and strategies, and of the forces affecting and constraining the way those are conducted. These forces are the:

- ⊗ Public and private sectors and civil society structures;
- ⊗ Vulnerability context, trends, shocks and seasonality; and
- ⊗ Processes including policies, laws, institutions, socio-cultural relationships.

These forces affect the value of the assets, access rights, household capacity to be involved in particular livelihoods activities and strategies, and affect also the results of those activities. It is important to elaborate on the impacts on the livelihoods assets and strategies (socio-economic conditions) for the different typologies of land users present in the study areas on the basis of the community focus group discussion and households, key informant and land users interviews (Tools 1.1, 7.1, 5.1,5.2 and 5.3, Part 2).

The asset profiles of the different households can be represented graphically to highlight trade-offs in their livelihoods strategies. This analysis should be conducted with at least 20 (20 to 30) households responsible for managing the land assessed under the detailed bio-physical assessments.

Step 1: Identify the most relevant indicators for each asset based on the initial community wealth ranking. Some common indicators for the different types of assets are given in Table 27 (below). These should illustrate the differences between different categories of land users (better off, average and poor). Any association

TABLE 26 Households classification by typology and wealth

Land user Typology	Households wealth class		
	Poor	Average	Better off
Farmer			
Herder			
...etc.			

TABLE 27 Typical important indicators in determining relative wealth at household level

Capital Assets	Indicators*
Physical	House, car, farm equipment, tractor, bicycle, animal traction, TV
Financial	Land ownership, saving, credit, insurance, income from farming, off- farm income, subsidies
Natural	Size of crop land, size of grazing land/pasture and quality, size of forest land, timber, fuelwood, forest products (honey, medicine), water (rainfed or irrigation), livestock number
Human	Health, labour, education, knowledge, skills
Social	Kinship networks, associations, membership organisation, peer group networks, access rights (land / water), access to technical assistance, access to markets, access to financial services, access to health services, access to education, access to safe drinking water and sanitation

* This list is not ordered and not exhaustive. Context specific indicators should be identified by the team with the community.

between LD / SLM or impacts felt and wealth groups should be identified and discussed.

Step 2: Give each household a score (1-10) for each capital asset and fill in Excel as in Table 28 (below).

Step 3: Identify the different household profiles that reflect groups of similar households interviewed in the study area, this may not exactly coincide with the wealth ranking.

Step 4: Create the asset pentagon for each of the household profiles identified showing different livelihoods strategies, trade-offs and land management practices.

Step 5: A written section should describe the different household profiles present in the study area, as reflected in the asset pentagon, explaining drivers and pressures causing land degradation and the impacts of land degradation on land users.

7.2.8 Responses

Once the impacts, driving forces and pressures have been identified and analysed, the current responses of land users and communities and decision makers (e.g. incentives for certain crops or land uses, regulations, land registration etc.) can be better understood and contextualized.

TABLE 28 Summary scoring (1-10) of most relevant indicator(s) for each asset

Household	Capital Assets				
	Physical	Financial	Natural	Human	Social
1					
2					
3					
N					

This section of the analysis and report should present:

The actual responses (already undertaken in the study area);

- ⊗ Type and efficacy of existing land management measures and practices;
- ⊗ Support measures available;
- ⊗ Constraints in their larger adoption.

Propositions of appropriate responses/options (proposed):

- ⊗ Proposed solutions by categories of land users and wealth:
- ⊗ Recommendations for:
 - Land users;
 - Stakeholders and decision makers at national, provincial/local levels.

Feedback loops exist between the driving forces, pressures, impacts on people livelihoods and responses (e.g. a negative impact on an important ES will lead to a negative impact on people perhaps causing them to adopt behaviour that creates increased or new pressures on the state). It is often possible to identify positive (or virtuous) and negative (or vicious) spirals and feedbacks and these should be analysed and well understood.

There are a number of cost-benefit tools that can be used to quantify the costs of land degradation and the benefits of control (see Stocking and Murnaghan, 2001) and these can be used in the analysis if useful. Undeniably, soil erosion involves a cost to land users in terms of declined crop yield or increased input demand in order to maintain yield. Comparing the costs and benefits of land degradation and conservation can help land users to make decision on when and where conservation measures should to be taken, as most conservation measures involve extra costs, labour, material or the land forgone.

Procedure to develop response options

The response options should be based on the assessment results and discussions with land users and local authorities. It could be useful to synthesis these by enumerating the types of land degradation and sustainable land management present in the assessment area and locate them spatially in relation to the LUS (see Table 29). Land degradation types can be ordered by severity, extent, and level of impact on productivity. Second, indirect (drivers) and direct (pressures) causes should be summarized, also by order of importance. Then the team should identify the responses required to preventing and mitigating land degradation and enhancing sustainable land management, including: How to increase the adoption of positive responses to land degradation, and their efficacy? What are the needs in terms of training and capacity building? It is important to develop sequences or chains of explanation linking major land degradation types to their causes to the responses required. The proposed responses can be detailed in terms of where (spatially), who (which land users), costs and how to implement them.

Step 1: Analyse the effectiveness, uptake, and constraints to adoption of the key sustainable land management practices identified in the study area to maintain land productivity and ecosystem services.

Step 2: Identify the sequences of responses to prevent or mitigate land degradation (see Table 30). What are appropriate responses? At what level? By which stakeholders? What are approximate costs and means of implementation?

At this stage, extreme care needs to be taken to ensure that proposals remain as possible options

TABLE 31 Simple MDCA for responses analysis

Response Options	Environmental Criteria			Economic Criteria	Socio-cultural Criteria
	We	Wo	Wa		
Response A	Score				
Response B					
Response C					

e.g. Response A= We x score + Wo x score + Wa x score +...

TABLE 32 DPSIR analysis by LUS

LUS	State	Drivers and Pressures	Impacts on ecosystem services and livelihoods	Responses

the response options against a set of criteria identified important based on the assessment (see Table 31).

The criteria should be selected based on the assessment results in terms of the main / priority land degradation types and environmental / livelihoods problems in the area and the scores were given by experts based on the performance of the response option to address each criteria (scale 0-1).

Step 3: Complete a synthesis table summarizing the DPSIR by LUS to link the analysis of the state/trends, with the causes, impacts and responses (see Table 32).

One of the outcomes of the assessment process will be the quantification of the vulnerability of specific physical and human components of the system and the system as a whole in regard to land degradation (i.e. vulnerability of the natural resources, the various livelihood situations and the interactions between human activity, the resources and ecosystem functions).

The identification of future responses should obviously be carried-out in close collaboration with communities, decision-makers and other stakeholders involved (i.e. projects, NGO’s etc.) in the area. In order to share and discuss the results of the local assessment, it can be useful to organize a workshop with all stakeholders involved in land degradation control and sustainable land management at regional level. The comments, concerns and recommendations of potential follow-up actions resulting from this stakeholder consultation should be part of the report.

The two pairs of photos below (Photo 22) show the substantive effects of SLM interventions in dryland areas

7.2.9 Conclusions and policy recommendations

This section should be addressed to decision makers and is useful to identify the priorities, aspects that need more in-depth assessment



PHOTO 22 **Degraded land to SLM - before and after project (Xiabazi, China)**

in order to help future decision making on investments and to:

- ⊗ Show and analyse any relevant maps from the national LD / SLM assessment of
- ⊗ LD type, extent, severity, causes and impacts
- ⊗ Type, extent and effectiveness of SLM measures
- ⊗ Describe and illustrate with photos and graphs what are the impacts of recent interventions see Photos 22 above.
- ⊗ Propose solutions to reinforce positive responses to mitigate land degradation and decrease short term negative responses;
- ⊗ Develop scenarios or chains of explanations (e.g. link sustainable land management measures, agricultural productivity and livelihoods);
- ⊗ Target responses / recommendations by decision makers and types of intervention (training, awareness, subventions, value chain development, land tenure, etc.);
- ⊗ Specify spatial responses / recommendations (upstream/ downstream, LUS and LUT);
- ⊗ Link agricultural policies and the assessment results with the other global issues (such climate change and food security).

Stakeholders' consultation during the development of recommendations is critical to ensure that the results are of interest and use to the various clients and convincing for policy / decision makers to mobilise adapted policies and interventions and priority setting. This includes consulting:

- ⊗ local land users, producers associations, water users associations, etc.;
- ⊗ local and provincial authorities for priority setting and planning;
- ⊗ government departments (environment, land resources, agriculture, forestry, water, local development, etc.) and NGOs and projects in the area;
- ⊗ funding agencies, scientists and research students.

The recommended responses can be discussed in this section of the report, including: support, interventions, policy change, adapted local regulations etc. These responses might target the impacts directly or the drivers of these impacts. In the case of environmental driving forces (e.g. climate change) an appropriate response might be to support adaptation, ability to cope etc. rather than trying to “manage” the driver directly. The suggestions and advice given here will be important for sustainable land management implementation at community level and policy recommendations at regional and national level.

Annexes suggested for reports include:

- I. Names and functions of team members
- II. Work planning (agenda)
- III. Budget
- IV. Database (Excel or Access tables)
- V. Names of participants (land users, technical staff, and decision makers) at workshop to present and discuss the assessment results

7.3 Establishing and maintaining a LADA-Local database

A database should be established for the storage of quantitative and qualitative data generated by the assessments. The initial assessment will provide the baseline for monitoring future changes and trends in the selected district / province or SLM project and, where national assessments are conducted, to feed more in-depth knowledge and understanding into the findings of the national assessment for the area in question.

To facilitate the collection of quantitative as well as qualitative data a prototype database has been developed that will be tested and validated through the follow up LADA-WOCAT project (being prepared for GEF-5 funding as from 2012+). It will be used as a support tool for supporting data collection, maintenance and analysis in the conduct of local assessments. This database builds on the experiences of the FAO Forest Resources Assessment and the development of an Integrated Natural Resources Assessment in Kenya and Zambia.

CHAPTER 8

Use of land degradation / SLM assessment and monitoring for wise decision making

This chapter presents the very important aspects of how to ensure that the assessment results are presented to and considered by the various concerned decision makers. The findings may need to be targeted to different specific groups of decision makers, for example; local authorities and planners; national institutions (technical institutions and ministries); interested project partners and NGOs / CSOs; the private sector (agricultural suppliers, etc.).

8.1 Drawing conclusions from the assessment findings

Each transect studied was located and each detailed site was selected due to specific biophysical and human characteristics (terrain, soil, land use, management practices). However the aim is not only to gather precise data on all specific transects and sites, but to analyse the findings to enable the assessment team to:

- ⊗ draw conclusions on land degradation (type, extent, severity) under various land use systems and management practices;
- ⊗ assess the effectiveness of current land use / management practices that are being promoted (government, NGOs, projects) and / or used (small and large farmers, herders, foresters) and to identify a few main SLM best practices; and,
- ⊗ assess the impacts of LD and SLM practices on livelihoods and on ecosystem services.

As described in more details in Chapter 2, the analysis of the findings are done by the assessment team using the DPSIR framework. The first step is to describe the state of the land resources using the appropriate tools in each main land use system / type. This is followed by the explanation of the identified direct pressures and indirect drivers of land degradation or sustainable land management. Often the indirect drivers are the same for the range of LUS, however the pressures will vary (e.g. population pressure leading to overgrazing on pasture land and nutrient mining on crop land). The information on these direct and indirect causes will come mainly from the rural participatory tools (e.g. the focus group discussion, household interviews, and land user and key informant interviews – Tools 1.1, 7.1, 5.1 (FAO *et al.*, 2011b)). At this stage in the analysis, it is important to consider the historical context in which different land uses have evolved and how land users have been affected by these major historical changes. The third step is to look at the impacts of land uses and management practices on land resources status and trends (i.e. recent / current responses of the local land users and of policy / programme interventions) in terms of degradation, conservation, or restoration and their effects on ecosystem services and livelihoods using the ecosystem assessment and sustainable livelihoods approaches. It is important to highlight any synergies and trade-offs between the causes and the impacts, particularly in relation to their different temporal, spatial and human dimensions.

Once the draft findings have been analysed and summarised, (preferably in a clear PowerPoint presentation) a response analysis workshop should be organized with all stakeholders to discuss the most appropriate responses (i.e. potential responses to address the identified LD and promote the SLM best practices) within the local assessment area and the different land use systems assessed.

Where a national LD / SLM assessment is also taking place, the local assessment findings should be fed into the national process to provide more in depth understanding of the causes and impacts of land use practices and behaviour of various land user types. In turn, the national findings should be compared with the local findings to ensure that there are no major discrepancies and if there are to conduct further investigations to find out why.

8.2 Adaptive management and land use / territorial planning

Although this step has not yet been tested by the LADA countries, as it was beyond the scope of the LADA project, the LADA methodology and results can be integrated into an environmental monitoring and evaluation programme for a number of purposes:

- ⊗ to improve decision making on natural resources management and rural development;
- ⊗ to identify community and natural resources management needs in the development phase of a rural project or programme and as part of the development of a SLM plan for the community or local assessment area;
- ⊗ to provide an inventory of the baseline conditions (further allowing for an assessment of the performance and impacts of SLM measures and / or other changes brought about by the project, programme or SLM plan).

The results of the LD / SLM assessment would be the basis for the SLM Plan for a given community or a local assessment area. This would comprise improvement and retrofitting directed towards increasing the effectiveness of SLM measures in combating land degradation and in generating multiple benefits in terms of

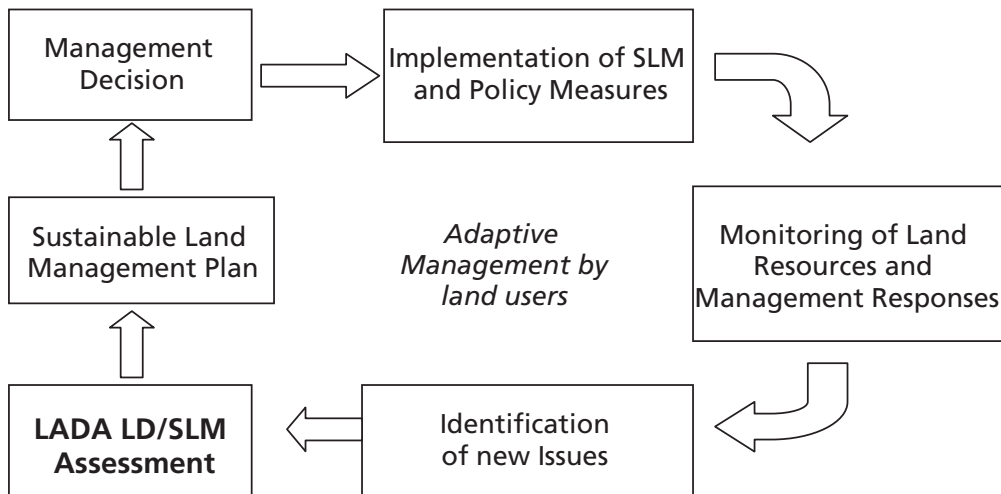


FIGURE 20 Adaptive management for territorial planning

productivity as well as ecological and socio-cultural benefits. In turn, this could be expected to increase the stability and resilience of the ecosystem and reduce vulnerability to shocks such as droughts, floods and increasing weather / climate variability.

The SLM Plan should prioritize the activities to be carried-out and should specify who is responsible for executing the plan, a timeframe for completion and estimated costs. The plan should also consider barriers in the overall environment hindering the implementation of the SLM Plan and should strive to implement measures to create an enabling environment for SLM. This could for example include policy changes, availability of resources and the initiation of an awareness and incentive program. This SLM Plan may require negotiation and conflict resolution to address the needs and expectations of different stakeholders and should be agreed upon with local policy makers and service providers (research, extension, NGOs etc) and as required with government

authorities at provincial or national levels for required financial and technical support.

There are four important steps involved in the development of an SLM Plan, namely:

- i. Establish the context and goals for the SLM Plan and any remediation strategies;
- ii. Identify, evaluate and select remediation strategies;
- iii. Apply and implement remediation strategies and monitoring progress;
- iv. Reflect on progress and the impacts of remediation strategies and adjust SLM Plan and strategies where and when necessary.

This process can also be described as an 'adaptive management' approach, which entails setting clear goals and targets when planning projects. It is then important to meticulously monitor and evaluate the project / interventions at every stage, to ensure goals and targets are reached. If not, changes and corrections should be made to the plan.

8.3 Informed decision making by stakeholders

As land degradation becomes of increasing concern, governments tend to increase their investment in programmes which aim to promote more sustainable land uses. Many of these programmes seek to change the management behaviour of land users. From both a policy-making and scientific perspective, it is important to understand how people perceive and respond to the need for sustainable land use. In order to stop and reverse the degradation of land, water and biological resources, an understanding is first needed of what motivates those whose everyday decisions and actions influence land management. A better understanding is also needed of the characteristics of sustainable management practices that most land users will be willing to adopt and the intricacies of the adoption process.

Through the DESIRE project (<http://www.desire-project.eu/index.php>) and based on WOCAT tools for best practices assessment, a participatory stakeholder process has been developed for appraising and selecting conservation measures to mitigate desertification and land degradation (Schwilch *et al.*, 2009).

This recognizes that decisions are taken at different levels and by different people. The land user needs to make everyday decisions about the utilization of natural resources; the practitioners (extension workers, soil conservation technicians etc.) need to advise land users on SLM practices and the implementation thereof; policy makers need to create an enabling environment for all these to happen; and researchers have to proactively undertake methodology development and troubleshooting.

An informed decision making process uses the assessment results of the LADA local assessment and other secondary information, as a basis to determine the vulnerability of different groups, of communities, and of their resources base and landscapes / territories. The assessment results then form the basis for the development, in close collaboration with stakeholders, of an SLM Plan to address land degradation in the area by proposing specific remediation strategies. This implies different decisions at land user, practitioner and policy making levels.

The TerrAfrica partnership programme (<http://www.terrafrica.org/>) has developed some tools to help countries scale up SLM notably:

- ⊗ Country support tool : How a country should engage more programmatically in SLM, how to identify, prioritize and formulate a SLM investment framework, and bring together other relevant products / tools (TerrAfrica, 2009a)
- ⊗ Policies for scaling up sustainable land management: resource guide for policy makers (TerrAfrica, 2009b)
- ⊗ Assessment of the barriers and bottlenecks for scaling up SLM investments throughout sub-Saharan Africa Strategic Investment Programme Activity 1.4 (TerrAfrica, 2007)

Please find below 5 Annexes that provide further information as cited in the document:

Annex 1: Fieldwork materials

Annex 2: Sustainable land management technologies

Annex 3: Case study of a SLM Technology assessment

Annex 4: Sustainable land management approaches

Annex 5: Case study of a SLM Approaches assessment

1 ANNEX

Fieldwork materials

Each member of the team should be well equipped with walking boots, waterproofs, a drinking water bottle and notebooks. The team should have a mobile phone or radio equipment and emergency numbers / frequencies. A tentative list of equipment for the field team is provided below. The equipment should be ordered well ahead of the start of the field assessment as international ordering can take more than one month.

Tools / equipment for each field team

Tools / Equipment	Number	Additional Comments
Compass (360°)	1	<ul style="list-style-type: none"> • High precision, in degrees • Waterproof and resistant
GPS receiver (Geographic Positioning System) and extra batteries	1	<ul style="list-style-type: none"> • Possibility to calculate average point • Optional antenna
Digital camera+ Spare memory card + Extra batteries + charger	1	For recording land degradation type and severity and SWC measures
Topographic maps and field maps, including national LADA LUS map	As available	If possible 1:50,000 scale of each LAA
Aerial photographs and/or satellite imagery	if possible	Enabling historic analysis of land use change);
Abney level or Altimeter- for measuring land slope and tree height	1	Haga altimeter, Suunto graduated in degrees and %
Measuring Tape or rope or chain -30-50m	1	Metric, marked at every 1-5 meters (if possible self-rolling)
Quadrats - for vegetation sampling <ul style="list-style-type: none"> • 1m x 1m • 1m x 1m with 10 divisions 	2	made locally using metal /bamboo rods and wire
Flora and fauna species list / identification key	As necessary	On forestry, pasture, range, weeds, pests and others are relevant topics
Soil auger	1	
Spade /Hoe	1	
1 Plastic Basin + 1 hard board insert + 4 Plastic sheets	1	For soil measurements on structure, texture, porosity, type, colour
Soil pH Test Kit and plastic plates (10cm diam;2cm deep)		can also be used for water
Plastic bags		For collection of samples (soil/plants/ leaves)
Water infiltration cylinders (100mm long x 100mm diameter)	2	locally fabricated from metal /plastic tubes
Machete	1	and file for sharpening
Penknife	1	
Rucksacks and heavy duty plastic bags	2	To protect measurement instruments and forms
Ranging poles	1-2	- straight; about 2m long, 3-4 cm thick can be made locally e.g. bamboo
Flipchart and paper and tape	1	For community/group discussions, PRA maps/ diagrams (several flipchart sheets can be taped to make a large sheet)

Tools / equipment for each field team (continued)

Tools / Equipment	Number	Additional Comments
Clipboards for reporting forms	3	To take notes (with plastic bag to protect from rain)
Field recording forms		
LADA-L Field manual	As necessary	
Notebooks, pens, pencils, marker pens		
First aid kit	1	

Optional tools / equipment (to be decided in country)

<u>For measuring soil labile C:</u>	1	• single (550 nm wavelength)
• Hand held Colorimeter	20	• graduated
• conical centrifuge tubes (50 ml)	1	•
• holding rack	1	•
• plastic syringe (50 ml)	several	• disposable
• graduated bulb pipettes 5ml	1	
• 5 cm ³ soil scoop	as	to make 33 mM KMnO ₄ solution
• KMnO ₄ (crystalline)	necessary	to make CaCl solution
• CaCl ₂ (crystalline)		
<u>For measuring soil and water salinity</u>		
• Electrical conductivity meter		
<u>For measuring vegetation size/quality</u>	1	
• Diameter tapes for tree diameter		• Metric, Auto rewind
• Callipers - shrub stem diameter		• Metric,
<u>For measuring water quality</u>	1	
• Portable water analyzer (EA513-162)		To measure pH, dissolved oxygen, conductivity and temperature
Plant press and newspaper	Optional	For safeguard of plant parts

ANNEX 2

Sustainable Land Management Technologies

Common types of SLM technologies / management practices are described below.

SLM Technology	Description
<p>Integrated Soil Fertility Management (mainly agronomic measures)</p>	<p>Benefits from positive interaction and complementarities of the combined use of organic and inorganic plant nutrients in crop production.</p> <ul style="list-style-type: none"> • Organic matter management such as manuring, composting, mulching and nutrient management using local plants such as Tithonia - these practices enhance soil structure, rainwater infiltration and moisture retention, also replenishing nutrients; • Fertilizer use to overcome nutrient deficiencies. Precision farming should be used to optimize fertilizer use (as well as other inputs seed, water etc).
<p>Conservation agriculture (CA) (mainly agronomic measures)</p>	<p>CA is a system characterised by 3 basic principles:</p> <ul style="list-style-type: none"> • minimum soil disturbance (i.e. zero or minimum tillage and direct planting - to prevent damage to soil structure by repetitive tillage); • permanent soil cover (to the extent possible) to improve soil structure, infiltration, and reduce erosion by water and wind); • crop rotation.to optimise use of the soil. <p>This is suitable for large- as well as small-scale farming.</p>
<p>Organic agriculture</p>	<p>A holistic production system which promotes and enhances agro-ecosystem health (biodiversity, biological cycles, soil biological activity). It emphasises the use of management practices in preference to the use of off-farm inputs. Agronomic, biological and mechanical methods, are used where possible, as opposed to using synthetic materials, to maintain functions within the system. Many of the techniques used (e.g. inter-cropping, crop rotation, double-digging, mulching, crop- livestock integration) are practised under other agricultural systems. What makes organic agriculture unique, as regulated under various laws and certification programmes, is that: (1) almost all synthetic inputs are prohibited (i.e. those harmful to human and environmental health) and (2) 'soil building' crop rotations are mandated (i.e. designed to steadily improve soil tilth and fertility while reducing nitrate leaching, weed, pest and disease problems).</p>

SLM Technology	Description
<p>Cross-slope barriers on sloping lands (vegetative or structural, often combined with vegetative and agronomic measures)</p>	<p>These include a range of measures on sloping lands for reducing run-off velocity and soil erosion They may be in the form of:</p> <ul style="list-style-type: none"> • earth or soil bunds, stone lines; • vegetative strips often grasses or trees that may lead to the formation of bunds and terraces due to the downslope movement of soil during cultivation; • terraces vary in form (from forward-sloping terraces to level or backward-sloping bench terraces) with or without drainage systems. Irrigated terraces (e.g. for paddy rice) are a special case in terms of water management and terrace design.
<p>Rotational cropping systems</p>	<p>Sustainable rotational systems are characterized by the rotation of different land use and management intensity such as a few years of intensive crop production followed by a period of low intensity use allowing natural regrowth (fallow) or replanting of grasses, legumes, trees etc. followed by intensive use and clearing of the vegetation.</p> <ul style="list-style-type: none"> • Shifting cultivation is an agricultural system in which plots of land are cultivated temporarily then abandoned. This system often involves clearing of a piece of land followed by several years of wood harvesting or farming until the soil loses fertility. Once the land becomes inadequate for crop production, it is left to be reclaimed by natural vegetation, or sometimes converted to a different long term cyclical farming practice. • Slash and burn refers to the cutting and burning of forests or woodlands to create fields for agriculture or pasture for livestock, or for a variety of other purposes <p>Natural regeneration of soil fertility is an important aspect of the system.</p>
<p>Integrated Crop-Livestock Management</p>	<p>These systems optimise the uses of crop and livestock resources through interaction and the promotion of synergies. For example, wastes from livestock replenish soil nutrients, secondary products of crops (i.e. straw and residues) are used for livestock feed and grass leys and fodder crops may be included in the system Specific practices include:</p> <ul style="list-style-type: none"> • night corralling; • rotations and manuring and composting; • grazing and fodder production.

SLM Technology	Description
Sustainable grazing land management (management practices with associated vegetative and agronomic measures)	Improved management of grazing land involves changing the control and regulation of grazing pressure. It is associated with an initial reduction of the grazing intensity. Examples include; <ul style="list-style-type: none"> • fencing, followed either by rotational grazing; • cut-and-carry of fodder, vegetation improvement and management change.
Pastoralism and rangeland management	Sustainable grazing on natural or semi-natural grassland, grassland with trees and / or open woodlands. Animal owners may have a permanent residence while livestock is moved to distant grazing areas, according to the availability of resources. Practices include for example; <ul style="list-style-type: none"> • rotational grazing; • dry season fodder reserves; • improved well / borehole distribution.
Agroforestry (mainly vegetative, combined with agronomic)	These are land use systems where woody perennials are grown in association with agricultural crops or pastures for livestock. These catalyse a variety of benefits and improved services, including better use of soil and water resources, multiple fuel, fodder and food products, habitats for associated species. There are a wide range of systems, including: <ul style="list-style-type: none"> • shelterbelts; • trees to provide shade for tea, coffee etc.; • multi-storey cropping (e.g. home gardens).
Sustainable Planted Forest Management	Planted forests can be either commercial or for environmental / protective use or for rehabilitation of degraded areas. Sustainability of new planted forests depends on what they replace (i.e.. this should avoid loss of natural forest). This includes: <ul style="list-style-type: none"> • afforestation (e.g. for watershed protection; tree belts for halting desertification); • replanting of forests; • improved forest (e.g. species composition, health); • protection against fires; • improved management of forest use and felling of trees.
Sustainable Forest Management <ul style="list-style-type: none"> • in drylands • in rainforests 	This encompasses administrative, legal, technical, economic, social and environmental aspects of the conservation and use of forests. Examples include: <ul style="list-style-type: none"> • assisted natural regeneration of degraded land; • indigenous management of specific woodlands / species; • forest bee keeping; • community forest management.

SLM Technology	Description
Water harvesting	<p>Water harvesting is the collection and concentration of rainfall runoff for crop production or for improving the performance of grass and trees in dry areas where moisture deficit is the primary limiting factor. It may also be used for livestock and domestic uses. Examples include;</p> <ul style="list-style-type: none"> • Tassa /Zai planting pits; • small earth dams; • floodwater farming.
Surface and ground water management	<p>All measures that lead to an improved regulation of the water cycle, reducing flood flows, improving water infiltration in the soil and the recharge of the groundwater table or in case of salinity to lower the ground water table and improve water availability and quantity. This includes:</p> <ul style="list-style-type: none"> • improved irrigation techniques for water use efficiency (e.g. drip irrigation); • salinity regulation; • control of storm water and runoff from sealed surfaces (i.e measures designed to deal with extreme events).
Smallholder Irrigation Management	<p>Aims to achieve higher water use efficiency through more efficient water collection and abstraction, water storage, distribution and water application. This may include:</p> <ul style="list-style-type: none"> • Small- or large-scale schemes; • low pressure or high pressure (gravity fed, sprinkler, or drip) systems; • market gardens; • spate irrigation; • irrigated oases.
Water quality improvements	<p>Measures that primarily aim to improve water quality, for example:</p> <ul style="list-style-type: none"> • sedimentation traps; • filter / purification system; • infiltration ponds.
Gully control and other land rehabilitation measures	<p>There are a whole range of different and complementary measures, though structural barriers dominate, often stabilised with permanent vegetation, including:</p> <ul style="list-style-type: none"> • gully control using structural barriers; • reshaping to reduce landslip and vegetation stabilisation; • mining rehabilitation; • topsoil storage; • sloping and revegetation.

SLM Technology	Description
Sand dune stabilization	Fixing surfaces from being blown and transported by wind, such as sand dunes, light structured soils (e.g. as loess soils). The aim can be to reduce the material from being blown and / or to stop the shifting of dunes. Also includes stabilization of mine dumps.
Riverine and coastal bank protection	Vegetative and structural measures that protect land and infrastructure from erosion of river banks and coasts by flowing water, tides and impact of waves.
Protection against natural hazards	Measures to mitigate effects of floods, storms, earthquakes, stone falls, avalanches, landslides and mudflows.
Waste management	Organic and inorganic waste management, including: <ul style="list-style-type: none"> • solid waste (sewerage); • rubble littering; • effluent tailings; • bio-waste and chemical waste.
Biodiversity conservation and sustainable use	<ul style="list-style-type: none"> • Agricultural biodiversity conservation and sustainable management including maintenance of a wide range of plant varieties and livestock breeds and indigenous agricultural heritage systems for their current and potential future value • Conservation and sustainable use of natural habitats and rare and endangered or highly valued species (plant animal and microbial).
Protected areas	Certain areas may be protected for conservation, including: <ul style="list-style-type: none"> • forests; • wetlands; • biodiversity (i.e. specific species and habitats); • watersheds (for water supply, reduction of flood risk to downstream urban areas etc.) These may be supported through ecotourism.

Source: Questionnaire for Mapping Land Degradation and Sustainable Land Management, v2 (FAO-WOCAT, 2011) and SLM in Practice (FAO/TerrAfrica, 2011)

ANNEX 3

Case Study of a SLM Technology Assessment



Farmland shelterbelt on dryland

Aohan Banner of Inner Mongolia, China

The shelterbelt in the shape of grid can be established on dryland (rain-fed cropland) without irrigation. The technological demonstration plot is located in Aohan Banner, the eastern part of Inner Mongolia and the south of Horqin Desert. Hills and sandlot dominate this area. The demonstration plot is a semi-arid area with poor natural conditions. This area faces shortage of both surface and ground water resources, so most farmlands are rain fed. The crops often suffer from wind gusts and cold spells. Sometimes there is no harvest at all. Establishment of shelterbelts is an essential measure to ensure stable and high yield of farming products.

The key points of the technique are as follows:

1. Site selection – hillside land or sand-covered cropland with slope less than 15°.
2. Shelterbelt configuration – narrow belt, small grid with ventilation configuration. The main belt should be arranged perpendicular to prevailing wind direction and has three rows of trees at 2x2m spacing. The ancillary (side) belt should

left: Bird's-eye view of farmland shelterbelt on dryland – *Photo by Ding Rong*

right: Close shot of farmland shelterbelt on dryland – *Photo by Li Xianyu*

Location: Aohan Banner, Inner Mongolia

Technology area: 2000 km²

SWC measure: vegetation

Land use: cropland

Climate: sub-humid

WOCAT database reference:

Related approach:

Compiled by: Li Chunying, Inner Mongolia Forestry Department; Tian Lü, Inner Mongolia Forestry Survey and Design Institute.

Date: August 2007

Editors' comments: This technology is suitable for hill land and sand-covered rain-fed cropland. It needs less investment but produces good protection effect. At the same time, the forest belt at mature stage can be felled for timber use to realize ecological and economic benefits. Now, this technology has been widely extended in areas with serious sand harm of Inner Mongolia autonomous region. This technology has good potential to be adopted for similar areas.

be perpendicular to the main belts and has two rows of trees at 2x2m spacing. The spacing of main belts is 300m and that of ancillary belts 400-500m.

3. Species selection - P. X *Simopyramidalis* chon-Lin CV, *Populus simonii* × *P. nigra* and *Populus X beijingensis* W. Y. Hsu or other tolerant and fast-growing poplars species or varieties.
4. Site preparation – conduct site preparation in rainy season one year before planting in a) semi-underground form, size: 4-6m long, 1m wide, 0.5m deep and dig the planting pit inside at 0.6x0.6x0.6m; topsoil is backfilled to 30cm. b) in level trough from size: 0.8m wide in upper opening, 0.6m basal width, 3-5m long and 0.5m deep; planting pits are arranged inside the trough in a delta form and topsoil is backfilled to 30cm.
5. Seedling preparation – “2-yr old root and 2-yr old stem” or “3-yr old root and 2-yr old stem”, 1cm in collar diameter, 1.5m in height for the seedlings. Dig out the seedlings several days before planting date and water well before lifting. Wet soil should be used to maintain moisture of the roots of the lifted seedling and wrap the roots with wheat straw or plastic cloth when the seedlings are to be transported. Soak them completely in water for 48h before planting.
6. Planting – April and May are best planting seasons. Place the seedling upright in the hole and backfill soil in layers and tread it firmly in each layer. Water the seedling sufficiently after planting and make 20-30cm high drought-resistant soil pile surrounding the seedling. Adopt watered planting method to the hole or use film mulching plantation if possible.
7. Maintenance measures – build wall at 1m distance to trees of edge row (1m wide in the opening, 0.8m wide at the base, 1m deep), to prevent damage by humans




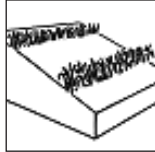
or livestock. Tending should be done once in spring and once in autumn over three consecutive years for soil loosening, weeding and watering. Guards shall be built to protect the trees.

The farmland shelterbelt in Aohan Banner has produced good economic and ecological benefits. Observations show that farmlands guarded by shelterbelts have less wind erosion and increased resistance to natural disasters and 10% increase in crop output. On September 3, 1996, early frost struck Chifeng region of Inner Mongolia and the farmland in Aohan had minor damage, while the lands without shelterbelts were affected by reduced crop output. Estimates show that each hectare of forest can give an increase of five cubic meters of growing stock. Such remarkable predictable economic benefits promote great enthusiasm of farmers to participate. At present, almost all dry lands in Aohan Banner have farmland shelterbelts.

Classification

Land use problems

- ⊗ serious wind erosion
- ⊗ crops are easily affected by extreme weather conditions
- ⊗ land economic benefits is low in general

Land use	Climate	Degradation	SWC measure
			
Cropland, potato	Sub-humid	Wind erosion	Biological measurer
Technical function/impact			
main: <ul style="list-style-type: none"> • reduce wind erosion • prevent sand burials • prevent the crops from mechanical or freezing harms 		secondary: <ul style="list-style-type: none"> • reduce evaporation • improve micro climate of the farmland 	

Environment

Natural Environment

Average annual rainfall (mm)	Altitude (m a.s.l.)	Landform	Slope (%)	Soil depth (cm)
>4000	>4000		very steep (>60)	0–20
3000–4000	3500–4000		steep (30-60)	20–50
2000–3000	3000–3500		hilly (16-30)	50–80
1500–2000	2500–3000		rolling (8-16)	80–120
1000–1500	2000–2500		moderate (5-8)	>120
750–1000	1500–2000		gentle (2-5)	
500–750	1000–1500		flat (0-2)	
250–500	1000–500			
<250	<250			

Growing season: 150 days in succession, from April to September

Soil fertility: moderate

Soil texture: moderate (loamy)

Surface stoniness: no

Topsoil organic matter: moderate (1–3%)

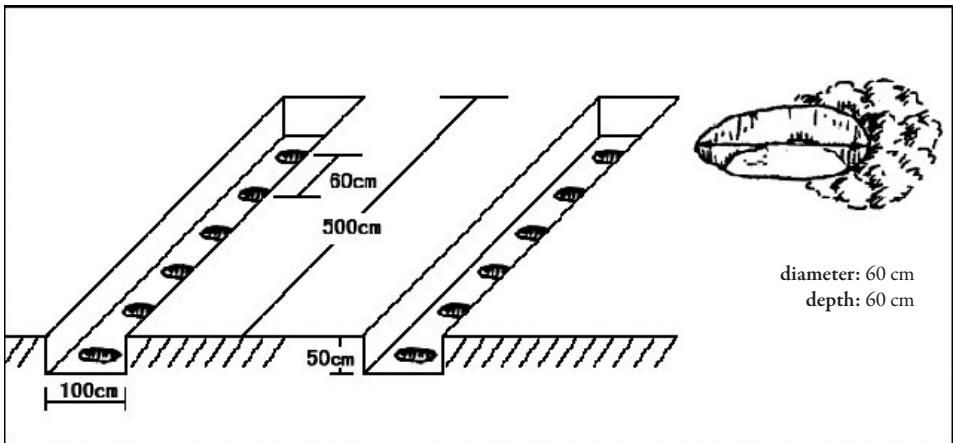
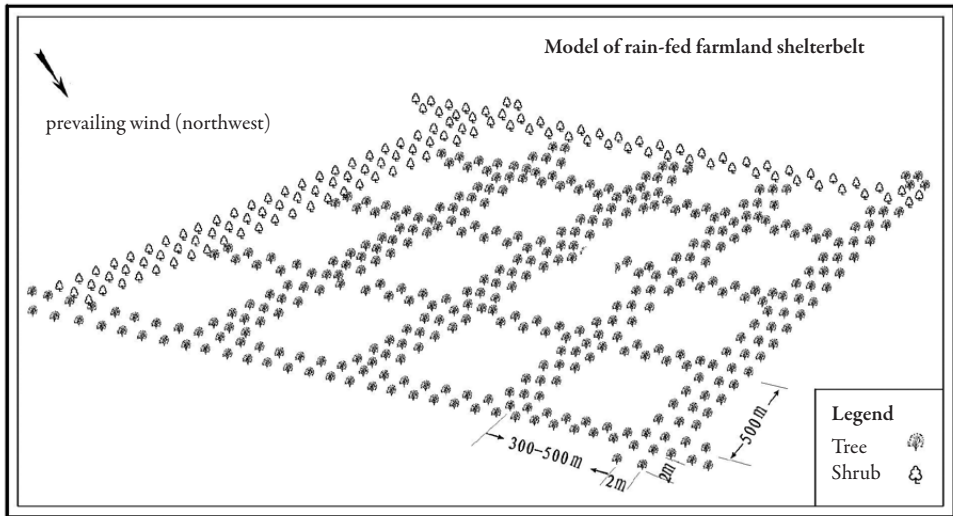
Soil drainage: moderate

Soil erodibility: high

Human environment

Mixed land per household (ha)

<1	Land use rights: individual
1–2	Land ownership: collective
2–5	Market orientation: self use
5–15	Level of technical knowledge required: moderate for technical extensionists and low to land user
15–50	Importance of off-farm income: less than 10% of the total income
50–100	
100–500	
500–1000	
1000–10000	
>10000	



Note:

Pattern design: spacing: 2×2m, two lines belt with grid size: 300×500m or 500×500m.

Semi-underground site preparation: 4–6m long, 1 m wide, 0.5m deep; Inside prepare the planting pits with size 0.6×0.6×0.6m.

Drawing by Guo Huimei, Inner Mongolia Forestry Monitoring and Planning Institute.

Implementation activities, inputs and costs

Establishment activities

1. Preparation investigation: determine location and technical methodology;
2. Farmer and government sign afforestation contract;
3. Planting design.
4. Selection of tree species.
5. Site preparation. Done at rainy season one year before planting.
6. Seedlings.
7. Planting. Put seedling upright the planting hole, fill in earth, tread and water earth.
8. Maintenance protection. One meter away from the trees of edge row, dig a gully with 1m wide at upper edge, 0.8m wide bottom edge and build walls aside the gully to avoid human or domestic animal damages. Three years of maintenance tending.

Establishment inputs and costs per ha

Inputs	Costs (US\$)	% met by land user
Labour (_15_person days)	54.9	100%
Equipment		
- tractor, water trasport vehicle	36.6	0%
Materials		
- seedling	609.8	0%
Agricultural		
TOTAL	701.3	7.8%

Establishment time: 1 year.

Maintenance/recurrent activities

1. Artificial weeding between forest belts, twice a year watering in spring and autumn;
2. Supplemental planting In spring of the year following the initial plating;
3. Arrange special guards for protecting shelterbelts.

Maintenance/recurrent inputs and costs per ha per year

Inputs	Costs (US\$)	% met by land user
Labour (_10_person days)	36.6	100%
Equipment		
- tractor, water trasport vehicle	18.3	0%
Materials		
- seedling, pesticide	60.0	0%
Agricultural		
TOTAL	114.9	85%

Remarks: labor price at USD3.7/peron day; seedlings used during maintenance are for replanting; Exchange rate (at establishment): USD1= RMB 8.2 yuan

Assessment

Acceptance/adoption

With existing incentive mechanism, most households accept this technology;

Without incentive mechanism most households do not accept this technology;

If the comparative benefit of farmland shelterbelt is high, farmer households can accept the technology.

Benefits/costs according to land user	Benefits compared with costs	short-term:	Long-term:
	establishment	Neutral	Very positive
	maintenance/recurrent	Neutral	Very positive

The farmland shelterbelt brings to farmer households direct benefit, and government provides considerable subsidy, so the enthusiasm of farmer household is very high.

Impacts of the technology

Production and socio-economic benefits		Production and socio-economic disadvantages	
+++	Improve the growth environment of the crops and ensure high and stable output of farmland	-	The trees have some effect on neighboring crops, and thus reducing crop output
++	Increase timber standing volume and generate economic income		
Socio-cultural benefits		Socio-cultural disadvantages	
+	Enrich farmers' knowledge of ecological improvement and protection	x	None
Ecological benefits		Ecological disadvantages	
++	Reduce wind erosion		None
+	Prevent sand burials		
+	Reduce evaporation		
Off-site benefits		Off-site disadvantages	
+	Reduce sand dust weather days, absorbing carbon dioxide and releasing oxygen		None

Concluding statements

Strengths and → how to sustain/improve	Weaknesses and → how to overcome
Protection performance is good → further extension	Forest belt has effect on neighboring crops → introduce proper species and conduct root cutting to mitigate the effect
Have certain economic benefits → explore possibility of planting cash trees for higher output	Single tree species adopted → introduce more forest species suitable for shelterbelt

Key reference(s):

- [1] Technique of farmland shelterbelt establishment on rain-fed farmland: Appropriate forestry technology. Inner Mongolia Forestry Department. 2001. 116-118.
- [2] Desertification combating and Management Center of State Forestry Administration, Applied technology and pattern of desertification control in China, Beijing. China environmental science press. 2001

Contact person:

Tian Lü, Inner Mongolia Forestry Survey and Design Institute, Tel: 0471-5953487, email: tianlv001@sina.com

4

ANNEX

Sustainable Land Management approaches

A list of widely known SLM approaches in most regions is provided, derived from the WOCAT database.

SLM Approaches	Description
Participatory Research and Development (PRD) which includes Participatory Learning and Action (PLA)	<p>A pool of concepts and approaches that enable people to enhance their knowledge of SLM and strengthen land users' innovative capacity. It is bottom-up, demand-driven and has partly evolved from technology development and dissemination efforts. It includes adaptive management of technologies to suit local contexts also the wider sharing and use of technology options and local innovations that build on local knowledge and resources.</p> <p>PLA refers to systematic learning processes to facilitate empowerment and capacity development of local people, including;</p> <ul style="list-style-type: none"> • Participatory Rural Appraisal (PRA): approaches for analysis by rural people of their own realities and incorporation of the knowledge and opinions in planning and management of projects. (e.g. transect walks, maps, calendars, matrices, diagrams using locally available materials); • Participatory Monitoring and Evaluation (PME) primarily used in impact assessment and project management. Local people, community organisations, NGOs and other stakeholder agencies initiate and decide together how to assess results and who benefits, to analyse findings and identify follow-up actions.
Participatory Land Use Planning (PLUP)	<p>Approaches for planning of communal or common property land, /communal lands which are often the most seriously degraded and where conflicts over land use rights exist. As a complement or alternative to national policy, new arrangements can be regulated through negotiation among all stakeholders and communally binding rules for SLM, based on planning units, such as social units (e.g. village) or geographical units (e.g. watershed) can be developed, including:</p> <ul style="list-style-type: none"> • <i>Gestion des Terroirs</i> a participatory catchment approach used in francophone West Africa. It associates groups and communities with a traditionally recognised land area, aiding these communities in building skills and developing local institutions for implementation of sustainable management plans. It has focused on village / community level NRM through: i) technical projects (e.g. soil conservation); ii) organisational structures within which people arrange their livelihood strategies; and iii) the legal / administrative system by which use rights are enforced in practice; • Participatory and Negotiated Territorial Development (PNTD) contributes to SLM and rural development through negotiation, participation, dialogue, and creating partnership among stakeholders that leads to the consolidation of a territorial social pact to overcome the social and economic inequalities that affect rural populations (food insecurity, inequitable access rights, social marginalisation etc.).
Integrated watershed / landscape management (IWM)	<p>These approaches aim to improve both private and communal livelihood benefits from a range of technological and institutional interventions across a specific watershed (the main geographic unit of intervention). The concept of IWM goes beyond traditional integrated technical interventions for soil and water conservation, to include proper institutional arrangements for collective action and market-related innovations that support and diversify livelihoods. This concept ties together the biophysical notion of a watershed as a hydrological landscape unit with that of community and institutional factors that regulate local demand and determine the viability and sustainability of such interventions (i.e. SLM).</p>

SLM Approaches	Description
Community-Based Natural Resource Management (CBNRM)	<p>The concept embraces a variety of concepts around participatory, community-driven and collaborative natural resource management, often with a focus on resources subject to communal rights. It is effective where decentralisation assists in institutionalising and scaling-up popular participation and moving from project-based approaches toward legally institutionalised popular participation. It is critical that there is sufficient transfer of powers to local institutions.</p> <ul style="list-style-type: none"> • Landcare is a community-based approach focused on building social capital to voluntarily resolve local problems affecting the community while preserving land resources. It is based on an effective partnership with government and the broader society, including the business sector, in the form of financial and technical advice. In this way, technical knowledge from scientific sources can be integrated with indigenous knowledge and the skills of local people.
Community development / investment funds	<p>Funds made available to communities for their own development efforts through decentralization processes. Depending on the specific situation (i.e. donor, context, local needs) the funds may be open or earmarked for specific purposes. The basic concept is that the community has sovereignty over and decides on the use of these funds within a specific domain (e.g. for agricultural intensification). Funds may be paid-back by individuals after some years to form a local 'revolving fund. Some such schemes broaden their scope and become, effectively, savings and credit schemes benefiting the community as a whole.</p>
Extension, advisory service and training	<p>Investment in training and extension to support the capacity of land users and other local and national stakeholders is a priority to adapt better to changing environmental, social and economic conditions, and to stimulate innovation. For example</p> <ul style="list-style-type: none"> • Participatory Technology Development (PTD); • Promoting Farmer Innovation (PFI) / Participatory Innovation Development (PID); • Training and Visit (T&V); • Information and Communication Technologies (ICTs); • Commodity / market driven extension; • Entrepreneurship to support value chains, etc. <p>These may be multiple strategies, combining e.g. awareness-raising, extension worker to farmer visits, training workshops and seminars, exposure visits, hands-on training, and demonstration plots. Or they may focus on informal farmer-to-farmer extension and exchange of ideas: this was the only form of 'extension' for thousands of years and is being rejuvenated through progressive projects. Trained 'local promoters' that become facilitators / extension workers under a project / programme, or contracting extension services to NGOs / other third parties (e.g. strategic partnerships by NGOs with government agencies, private sector and grassroots organizations to strengthen technical capacities for scaling-up successful initiatives while piloting innovative approaches).</p>

SLM Approaches	Description
Innovative extension approaches that empower farmers' groups and innovators	<p>Farmer Field Schools (FFS) for SLM (and 'Farmer Study Circles', which are more informal): A group learning approach which builds knowledge and capacity among land users to enable them to diagnose their problems, identify solutions and develop plans and implement them with or without support from outside. The school brings together land users who live in the similar ecological settings and socio-economic and political situation in the field. FFS provide opportunities for learning-by-doing. Extension workers, SLM specialists or trained land users facilitate the learning process.</p> <p>Initiatives for supporting local innovators identify traditional practices with a SLM potential and support recent innovations (e.g. self-help groups, self teaching). The 'approach' is basically through transfer of knowledge within a community and through generations. Land users continuously adapt and experiment with new seeds and plants, as well as new practices and technologies, in order to cope with changing environments and new problems. Spontaneous spread may have occurred either recently or through the ages as a tradition. Adoption can be supported by local institutions / community organisations such as land user groups, marketing cooperatives, irrigation and range management associations, women's groups, land user to land user extension groups etc. More attention and support should be given to local innovation as well as to traditional systems, rather than focusing solely on project-based SLM implementation of standard technologies.</p>
Payments / Rewards for Ecosystem Services (PES)	<p>A recent approach that includes:</p> <ul style="list-style-type: none"> • Carbon markets (CDM and voluntary markets) in particular, offer incentives to mobilise investments to conserve or rebuild forests and vegetative cover, in favour of higher biomass, as well as other co-benefits (e.g. higher productivity, sustaining water and energy resources and resilience to climate change); • The Clean development Mechanism (CDM) allows emission-reduction (or removal) projects in developing countries to earn certified emission reduction (CER) credits, each equivalent to one tonne of CO₂. These CERs can be traded and sold, and used by industrialised countries to meet a part of their emission reduction targets under the Kyoto Protocol. The mechanism stimulates sustainable development and emission reductions, while giving industrialised countries some flexibility in how they meet their emission reduction / limitation targets. It was developed more for reduced emissions from the energy sector and works less well for productive forests and does not yet include agricultural lands; • Payments for Reduced Emissions from Deforestation and Degradation (REDD and REDD+) a well funded process supporting reduced GHG emissions from forest lands (not yet including agricultural lands); • Pro-Poor Rewards for Environmental Services in Africa (PRESA) a project providing technical and policy support to small-holder PES projects; • Payments for improved water supply downstream to land users for their contributions to upstream watershed management; • Payments for biodiversity conservation and sustainable use: e.g. management and controlled harvesting of wild species, maintenance of traditional varieties and animal breeds through; • Labelling for specific products from designated areas of origin (e.g. Champagne) or for sustainable practices used in their production e.g. fair trade tea and coffee.

Source: Questionnaire for Mapping Land Degradation and Sustainable Land Management, v2 (FAO-WOCAT, 2011) and SLM in Practice (FAO/TerrAfrica, 2011)

ANNEX 5

Case study of a SLM
approach assessment



Terrace approach

China

Highly organised strategic campaign to assist land users in creating terraces: support and planning from national down to local level.

Before 1964, the slopes on China's Loess Plateau were cultivated up and down by machinery. Consequently soil and water were lost at high rates, and fertility and yields declined. Accessibility to cultivated land became more and more difficult due to dissection by gullies. The first terraces were established by self-mobilisation of the local land users. However there was no standard design. Furthermore, as the individual plots were very small and scattered all over the village land, terracing needed better coordination. Between 1964 and 1978, the local government at the county level took the initiative of organising farmers and planning terrace implementation according to specific technical design on a larger scale. At that time the land was still communally managed by production brigades. Through mass mobilisation campaigns people from several villages were organised to collectively terrace the land - village by village - covering around 2,000 hectares each year. Labour was unpaid.

left: Mass mobilization showing people from several villages helping each other. Initially, farmers were not paid but from the 1980s onwards farmers received cash and other support for their work. – Photo from 'Terraces in China' Ministry of Agriculture
right: Construction of terrace risers following instructions given by a specialist – Photo from 'Terraces in China' Ministry of Agriculture

Location: Zhuanlang County, Gansu Province, Loess Plateau Region, Northern China, Peoples' Republic of China

Technology area: 1 555 km²

Land use: cropland

Type of Approach: programme

Focus: mainly on conservation

Climate: semi-arid

WOCAT database reference: QT CHN45

Related technology: Loess Plateau Terraces

Compiled by: Wang Yaolin, Gansu GEF/OP12 Project Office, Lanzhou, Gansu, China;

Wen Meili, Department of Resources and Environmental Sciences, Beijing Normal University, China; Bai Zhanguo, World Soil Information, Wageningen, Netherlands

Date: May 2002, updated March 2006

The Yellow River Conservancy Commission (YRCC) came into being in 1948 – and the Upper and Middle Yellow River Bureau in 1977. This gave greater impetus to the implementation of SWC in the Loess Plateau. After 1978, land use rights were allocated to individuals (though official ownership was still vested in the state). SWC specialists and county level SWC bureaus started to work with groups of farmers who had land use rights within a given area. Survey and design were carried out. The farmers organised themselves, consolidated the parcels of land, and after the conservation work was done they redistributed the terraced fields.

In the 1980s the government started to financially support land users involved in SWC projects. Subsidies ranged from (approx) US\$* 20 / ha in projects at county level, to US\$* 55 / ha for national projects (e.g. through the Yellow River Commission), and up to US\$* 935 / ha

when World Bank projects were involved – as in the recent past. Implements were provided by the farmers themselves. Then, in 1988 a nationwide project in SWC - which originally was proposed at county level – was approved by the national government. Furthermore, in 1991 a national law on SWC came into force. Protection of the Yellow River and associated dams became a priority at regional and national levels. In total, within Zhuanglang County, 60 SWC specialists /extensionists cover an area of 1,550 km² and most of the terraces were built with low levels of subsidies. Annual plans about implementation of new SWC measures were made during summer. Small areas were planned at village or township level, whereas bigger areas (> 7 hectares) were designed at county level. Implementation then took place during winter. Terracing was implemented first where access was easiest and closest to settlements, and only later, further away.

Problem, objectives and constraints

Problems

- ⊗ Lack of organisation, capital and technical knowledge in farmer communities to counter the underlying problems of water loss, soil loss, fertility decline and downstream effects on the Yellow River (floods and sediment) at catchment level.
- ⊗ Absence or poor maintenance of erosion control measures.

Aims / Objectives




- ⊗ Water conservation (this is a semi-arid area)
- ⊗ Soil conservation: reduce soil loss on the sloping and erosion-prone land of loess plateau
- ⊗ Enhancing soil fertility, and consequently production
- ⊗ Improve people's living conditions

These primary objectives were to be achieved by building level bench terraces on a large scale through a structured and organised campaign. Finally at the national level, a fourth aim was added: the protection of the Yellow river (avoiding floods and reducing the sediment load).

Constraints addressed

	Constraints	Treatments
Legal	Land users leased the land from the state and land users' rights were insecure in the long term. Investments in SWC were not encouraged.	National government persuaded land users to implement terraces by 'selling' the benefits (increased yield and easier workability of the land). After 1978, individual user rights motivated farmers to invest in SWC.
Technical	Poor knowledge of how to reduce water loss, soil loss and fertility loss. Technical solutions were needed at the catchment level, involving the whole population.	Enhanced guidance by SWC specialists.
Financial	Initially farmers were not paid and as they had no immediate benefit from, or security over, the use of the land. The investment in construction was a heavy burden on poor farmers.	After 1988, labour inputs by farmers started to be partly covered by subsidies provided by local and national government.

Participation and decision making

Target groups			Approach costs met by:
			Government 10% Community/local* 90% TOTAL 100%
Land users	Planners	Politicians/ decision-makers	Annual budget for SLM component: 2 000-10 000*

Decisions on choice of the Technology (ies): Mainly made by SWC specialists with consultation of land users

Decisions on method of implementing the Technology (ies): Decisions are made by politicians / SLM specialists; land users are consulted in the planning phase (experienced farmers may be involved initially).

Approach designed by: County level and national specialists.

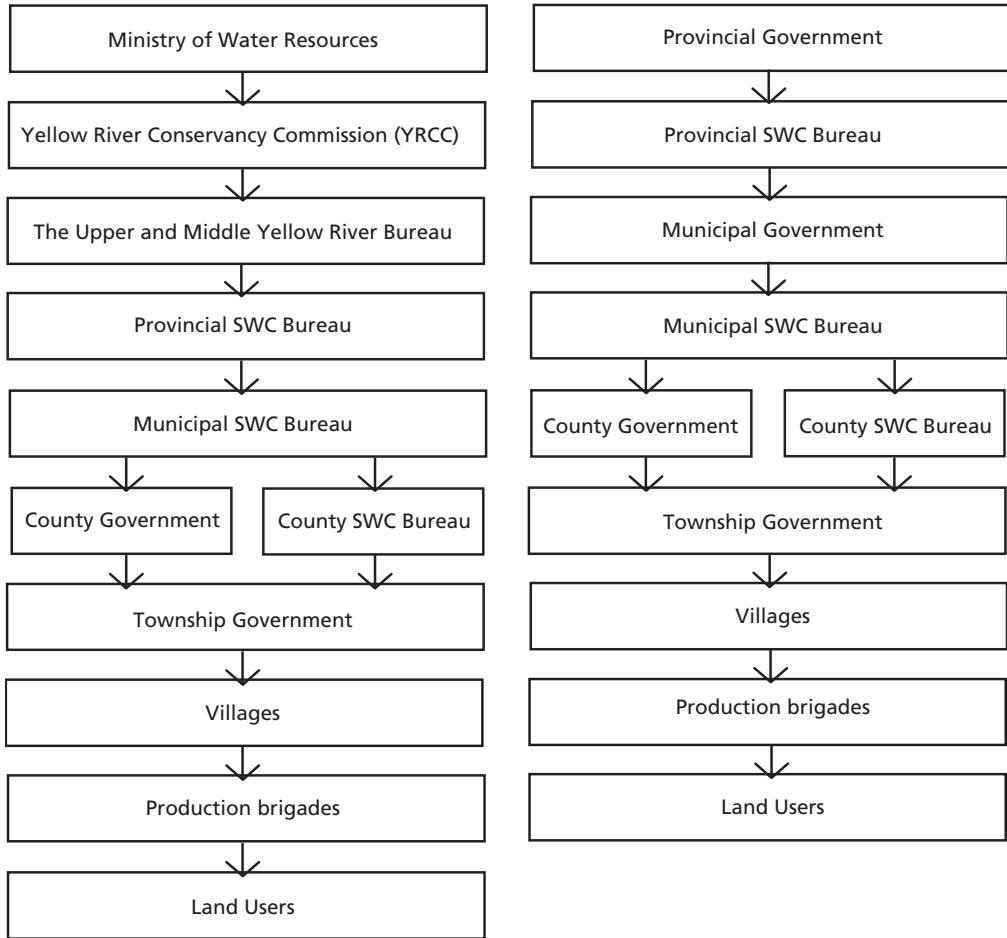
Implementing bodies: government.*

Land user involvement

Phase	Involvement	Activities
Initiation/motivation	Self-mobilisation/interactive	Land users started implementing terraces but SWC specialists at the country level assisted in designing standards for terrace construction and township governments and production brigades organised whole villages and watersheds.
Planning	Passive	Being consulted in the planning phase. Experienced peasants may be involved in introducing the local situation.
Implementation	Interactive	Major organisation done through the SWC bureau specialists with the village organisation including land users. Land users were actively involved in implementation.
Monitoring/evaluation	none	Reporting. No participation of land users.
Research	none	On-station research. No participation of land users.

Differences between participation of men and women: For manual labour, men can do more work and they have greater technical knowledge and skills related to terrace construction than women.*

Involvement of disadvantaged groups: Yes, moderate*



Organogram

Terrace construction supported by projects from MWR, YRCC and international organizations (left) and terrace construction supported by provincial funds (right)

Technical support

Training / awareness raising: Until 1978 the ‘pyramid system’ was used: the county level trained the township level, which trained the village level, which in turn trained the production brigades/farmers, who then trained other production brigades and farmers.

Training was on-the-job, focussing on design and construction of terraces on sloping land (provided by the county level specialists and by land users from villages where implementation was already carried out; at a later stage national trainers were involved as well). With respect to courses, demonstration areas, and farm visits – these were effective for all target groups.

Advisory service: The pyramid system is also used for extension. At each government level (at the county, district and provincial levels) there is a SWC division which is in charge of SWC activities including extension (demonstration, farm visits, etc). Effectiveness with respect to land users has been good. With rural economic development, more and more land users plan to invest in the SWC activities, including terrace making. The extension system is quite adequate to ensure continuation of activities.

Research: Mostly on-station research; carried out at the provincial and national levels, mostly by technical staff. Land users have not been involved. Topics covered include economics/marketing, ecology, technology. Terrace building is based on scientific design, according to local conditions.

External material support / subsidies

Contribution per area (state/private sector): no

Labour: In the 1960s and 1970s farmers were not paid for their labour inputs. From the 1980s onwards the government started to reward the community for establishment of terraces with cash: projects paid on the basis of area treated, and at different rates.

Input: Shovels and carts were provided by land users.

Credit: Credit was available at interest rates (0.5-1% per year) lower than the market rates.

Support to local institutions: Financial support to local institutions was made available through SWC Bureaus.

Monitoring and evaluation

Monitored aspects	Methods and indicators
Bio-physical	Regular measurements of runoff loss, sediment load, soil moisture
Technical	Regular measurements of structure of terraced areas, slope of risers, levelness of terrace surface
Socio-cultural	<i>Ad hoc</i> observations of land users' perceptions of terraces
Economic/production	Regular measurements of yield, income of land users.
Area treated	Regular measurements of terraced area
No. of land users involved	<i>Ad hoc</i> measurements of the numbers of farmers directly involved in terracing and farmers benefited directly
Management of Approach	<i>Ad hoc</i> observations of number of small watersheds terraced

Changes as result of monitoring and evaluation: The approach changed fundamentally from self-mobilisation to organised mass movements guided by the government

Impacts of the Approach

Improved sustainable land management: Soil and water management have improved a lot: easier workability, intensified land use, in-situ water retention, top soil and fertilizer/manure are not washed away, etc.

Adoption by other land users / projects: As the Zhuanglang area was one of the pioneering areas for the Loess Plateau other regions were able to profit from the approach. But likewise, experiences gained in other counties helped improve the approach, and a basically similar approach has been applied over the whole Loess Plateau – though the level of subsidies for construction is much higher under World Bank projects.

Improved livelihoods / human well-being: Yes, little*

Improved situation of disadvantaged groups: Yes, little*

Poverty alleviation: Yes little*

Training, advisory service and research: Many people from different levels are trained, training effective.*

Land/water use rights: The ownership of the land and its resources belongs to state and communities: land users can only lease the land for a period of time. Due to uncertainty over future user rights and possible reallocation of the land every few years (5, 10 or 20) by the village in response to changes in population and household needs, additional investments into land/SWC measures may be hindered. 1978 a first major change took place by allocating some individual land use rights.

Long-term impact of subsidies: As more and more payment is currently being made to land users on the basis of the area treated, land users rely more and more on being paid for investments into SWC. The willingness to invest in SWC measures without receiving financial support has decreased. Thus the use of incentives in the current approach is considered to have a negative long-term impact.

Concluding statements

Main motivation of land users to implement SLM: well-being and livelihood improvement*

Sustainability of activities: Given the recent escalation in payments made to land users for implementation under certain projects it seems that the costs will be too high to sustain. Currently the Ministry of Finance is demanding that in-depth cost-benefit analyses are carried out involving environmental, social as well as economic assessments.

Strengths and → how to sustain/improve ^{*1}	Weaknesses and → how to overcome
Efficient organisation, planning to cover a large area, which is very susceptible to land degradation.	High costs: farmers depend on external support from the government, they are not willing to invest their labour without payments (as it used to be in communist times) → new approach: give farmers loans for construction as now they use machines to do the work. In addition, search for cheaper SWC technologies and for improving the benefits.
Heavy investment made by the land users and local as well as national government to reduce land degradation	The steeper slopes which are also further away from the village, are now often not cultivated and maintained as they are too far and marginal in production. → solutions need to be found for these areas, eg afforestation.
Many people involved and trained at different levels (pyramid system; see training/extension); commitment by all stakeholders.	
The collective activities / organisation strengthens the community and enhances social stability and coherence within villages; collective activities are expanded to other sectors, such as road construction, supply of agrochemical inputs, etc.	
Farmers are getting direct benefits: marked increase in productivity, improved workability of the land, etc.	

^{*1} no recommendations provided on how to sustain/improve the strengths in this case study.

* New questions, no information available from this case study. Possible answers are invented.

Key reference(s):

Water and Soil Conservation Department of Yellow River Water Resources Committee of Ministry of Water Resources and Electric Power 1987: Corpus of economic benefits of water and soil measures, p77~102, 510~514 • Suide Water and Soil Conservation examination station of Yellow River Water Resources Committee, 1981. Corpus of Test Research of Water and Soil Conservation, p130~185 (the second volume) • Jiangdingsheng, ACTA CONSERVATIONIS SOLI ET AQUAE SINICA, 1987. Discussion on section design of the terrace on the Loess Plateau; Vol.1, No.2, p28~35

Contact person:

Wang Yaolin, Project Manager, Gansu GEF PMO, +86, 13919467141, Gansu@gefop12.cn yaolingw@gsdcrci.com • Bai Zhanguo, World Soil Information, Wageningen, The Netherlands • Liu Baoyuan, Department of Resource and Environmental Science, Beijing Normal University, Beijing, China. 100875, +086-10- 62206955+086-10- 62209959, baoyuan@bnu.edu.cn. • He Yu, Zhuanglang SWC Bureau, +86 933 6621681, 744600, gszlhuyu@163.com

References

- Anderson, H. & Cummings, S. 1999. *Landcare Notes: Measuring the salinity of water*. State of Victoria, Department of Sustainability and Environment.
- CDE/WOCAT, FAO/LADA, ISRIC. 2011. *A Questionnaire for Mapping Land Degradation and Sustainable Land Management*. Eds.: Liniger, H., van Lynden, G., Nachtergaele, F., Schwilch, G., Biancalani, R. and Woodfine, A.
- DG/ACTA. 2010. *Système de notation (Scoring) pour l'évaluation visuelle de l'érosion par l'équipe LADA-Tunisie* (Scoring system for visual assessment of soil erosion). Working document by LADA-Tunisia team. May 2010.
- Droux, R. & Hoeck, T. 2004. *Analysis of the energy situation in the Tajik Pamirs and its consequences for land use and natural resources management*. Joint diploma thesis, University of Berne.
- Ellis, F. 2000. *Rural Livelihoods and Diversity in Developing Countries*. Oxford University Press, Oxford, UK. Available from: <http://books.google.co.uk/books?hl=en&lr=&id=gCKQs-3NKhUC&oi=fnd&pg=PR9&dq=Ellis+2000+sustainable+livelihood+analysis&ots=vUOaarhmob&sig=BqydUG1F30yvfEkzLSW0lq92JDM#v=onepage&q&cf=false>
- FAO. 2003. *Local Institutions and Livelihoods: Guidelines for Analysis*. Food and Agriculture Organization of the United Nations. Rome, Italy. Available from: <http://www.fao.org/docrep/006/y5084e/y5084e00.htm#Contents>
- FAO. 2006. *The rapid characterization and mapping of agricultural land-use: A methodological framework approach for the LADA project*. LADA internal document by George, H. and Petri, M. Food and Agriculture Organization of the United Nations, Rome, Italy.
- FAO. 2009. *National Forest Monitoring and Assessment— Meeting Evolving Needs*. Expert Consultation 26-28 November 2008, Rome Italy. Food and Agriculture Organisation of the United Nations, Rome, Italy. Available from: <http://www.fao.org/forestry/19891-0866a2011092120a81e88f2712beb137e.pdf>
- FAO. 2008. *Visual Soil Assessment (VSA) Field Guides*, Food and Agriculture Organization of the United Nations, Rome, Italy. Available from http://www.fao.org/nr/land/pubs/en/?no_cache=1

- FAO. 2011a. Land Degradation Assessment in Drylands: *Manual for Local Level Assessment of Land Degradation and Sustainable Land Management. Part 1: Planning and Methodological Approach, Analysis and Reporting*. Food and Agriculture Organization of the United Nations, Rome, Italy.
- FAO. 2011b. Land Degradation Assessment in Drylands: *Manual for Local Level Assessment of Land Degradation and Sustainable Land Management. Part 2: Field Methodology and Tools*. Food and Agriculture Organization of the United Nations, Rome, Italy.
- FAO. 2011c. Land Degradation Assessment in Drylands: *Mapping Land Use Systems at Global and Regional Scales for Land Degradation Assessment Analysis v1.1*. Food and Agriculture Organization of the United Nations, Rome, Italy.
- McKenzie, D.C. 1998. *Rapid assessment of soil compaction damage. The SOILpak score, a semi-quantitative measure of soil structural*, Australian Journal of Soil Research 39(1) 117 – 125
- Fourie, J.J. & Roberts, B.R. 1977. Seasonal dry matter production and digestibility of *Themeda triandra* and *Eragrostis lehmanniana*. *Agroplanta* 9:129-133.
- Government of South Africa. 2007. *Manual for the assessment of a Wetland Index of Habitat Integrity for South African floodplain and channelled valley bottom wetland types*. Report of the Department of Water Affairs and Forestry, Pretoria, South Africa.
- Jordaan, F.P. & de Beer, A.S. 1991. *Habitat preferences of twenty-three grass species in the Bankenveld*. Journal of the Grassland Society of Southern Africa. Vol 8 (4) pp 186-189.
- McGarry D. 2004. *Final Consultancy Report for FAO on the Development of Methodology of a Visual Soil- Field Assessment Tool – to support and enhance the LADA program*. China. Available from ftp://ftp.fao.org/agl/agll/lada/vsfast_china.pdf
- McGarry, D. 2006. *A Methodology of a Visual Soil - Field Assessment Tool “VS-Fast” to support, enhance and contribute to the LADA program*
- McGarry, D. 2010. *LADA for Irrigated Lands - an additional module for LADA-Local* (version 1, working document).
- McGarry, D. 2011. *LADA for irrigated lands: an additional module for LADA local level assessment of land degradation and sustainable land management*.
- McKenzie, D.C., Hall, D.J.M., Daniells, I.G., Abbott, T.S., Kay, A.M. & Sykes, J.D. 1992. *Soil management for irrigated cotton*, NSW Agriculture Agfact P5.3.6, New South Wales, Australia
- Maas, E.V. & Hoffman, G.J. 1977. *Crop salt tolerance – current assessment*. Journal of Irrigation and Drainage iv, ASCE 103 (IR2): 115
- Meissner, H.H. 1982. *Theory and application of a method to calculate forage intake of wild southern African ungulates for purposes of estimating carrying capacity*. South African Journal of Wildlife Research 12, 41–47.
- Moody, P.W. & Cong, P.T. 2008. *Soil Constraints and Management Package (SCAMP): guidelines for sustainable management of tropical upland soils*. 85 pp. Australian Centre for International Agricultural Research (ACIAR), Canberra, Australia.

- Moody, P.C. (in press). *Soil Constraints and management package (SCAMP): A decision support system for sustainable soil management*. Queensland, Australia
- Morris, R. & Devitt, D. 1991. *Sampling and interpretation of landscape irrigation water*. Fact Sheet 01 – 91. University of Nevada, Reno, USA. pp. 5. Available at <http://www.unce.unr.edu/publications/files/ho/2002/fs0291.pdf>
- Mulder P. & McGarry D. 2010. *Soil Erosion Indicators*. Part of the Project: “Rural Development Project: Contract 3 - Sustainable Pasture, Arable and Forest Land Management - Tajikistan”. Asian Development Bank.
- Roose. E. 1994. *Introduction à la gestion conservatoire de l'eau, de la biomasse et de la fertilité des sols*. FAO Soils Bulletin No. 70. Food and Agriculture Organization of the United Nations, Rome, Italy. (Also available in Spanish)
- Shaw, R. & Gordon, I.G. 1997. *Salinity Management Handbook*. The State of Queensland, Department of Natural Resources, Queensland, Australia. pp 214. ISBN: 0 7242 7412 X
- Schoenenberger, P.J., Wysocki, D.A., Benham, E.C. & Broderson, W.D. 2002. *Field book for describing and sampling soils*. Version 2.0 Lincoln, USA, National Soil Survey Center, Natural Resources Conservation Service, USDA. in Guidelines for Soil Description, 4th Edition, Food and Agriculture Organization of the United Nations, Rome, Italy
- Schwilch, G.A, Liniger, H.P. and van Lynden, G.W.J. 2004. *Towards a global map of soil and water conservation achievements: a WOCAT Initiative*. Paper presented at “Conserving Soil and Water for Society: Sharing Solutions”, ISCO 2004 - 13th International Soil Conservation Organisation Conference – Brisbane, Australia, July 2004.
- Shepherd, T.G. 2000. *Visual soil assessment. Volume 1. Field guide for cropping and pastoral grazing on flat to rolling country*. Horizons.mw / Landcare Research, Palmerston North, New Zealand 210 pp.
- Shepherd, T.G. 2009. *Visual Soil Assessment. Volume 1. Field guide for pastoral grazing and cropping on flat to rolling country*. 2nd Edition. Horizons Regional Council, Palmerston North, New Zealand. 106p. ISBN 978–1–877468–75–9
- Stocking, M. & Murnaghan, N. 2001. *Field Guide for Soil Degradation Assessment*. Earthscan Publications, London, UK.
- Trollope, W.S.W., Trollope, L.A. & Bosch, O.J.H. 1990. *Veld and pasture management terminology in southern Africa*. Journal of the Grassland Society of South Africa 7: 52-61.
- UNEP/FAO. 2004. *Photo library of soil erosion processes* (CD-ROM). Food and Agriculture Organisation, Rome, Italy. Available from: http://www.fao.org/icatalog/search/dett.asp?aries_id=105032
- Victorian resources online. 2011. *Salinity Class Ranges*. Available from: http://www.dpi.vic.gov.au/dpi/vro/vrosite.nsf/pages/water_spotting_soil_salting_class_ranges#s0
- Weil, R.R., Islam, K.R., Stine, M.A., Gruver, J.B. & Samson-Liebig, S.E. 2003. *Estimating active carbon for soil quality assessment: A simplified method for laboratory and field use*. American Journal of Alternative Agriculture, 18: 3-17

