Field Manual for Local Level
Land Degradation Assessment in Drylands

LADA-L Part 1:

Methodological Approach, Planning and Analysis

Foreword

This first complete version of the **Local level land degradation assessment manual, LADA-Local (Version 1, March 2009)** incorporates inputs and feed-back both from many individuals involved in piloting the tools and methods as well as a series of LADA project workshops conducted during the period 2007-2009. The development process was guided by the LADA team in FAO Headquarters and University of East Anglia (UEA). Both remain keen to receive comments and suggestions for improvements resulting from application of the manual in drylands and also from any experiences in other areas.

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- *The water degradation assessment was developed by Janie Rioux (environment consultant), Hanspeter Liniger (WOCAT/CDE) and Sally Bunning (FAO),*
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1. Introduction

This manual has been produced as part of the Land Degradation Assessment in Drylands or LADA project about which details are provided in Annex 1. The main purpose of the manual is to provide a methodology and tool-kit for the assessment of land degradation (LD) at local level in the field and with the concerned local community(ies). Although the LADA project and this manual emphasize land degradation, the approach can and should be used to also assess an improvement in land resources through sustainable land management (SLM). A focus on just the negative trends is unlikely to deliver the detailed understanding of the drivers and impacts of changes in land resources and the actual and required management and policy responses that a combined and comparative approach will provide.

This LADA-Local manual has been developed and piloted in collaboration with the six pilot LADA countries (Argentina, China, Cuba, Senegal, South Africa and Tunisia) which provide a wide range of dryland situations and contexts. It is designed to be of much wider use to those conducting land degradation assessments in dryland areas worldwide. Moreover, it is expected to be also easily used and adapted for other ecological situations. For this reason the direct references to the LADA project are kept to a minimum and the wider application of the methods is considered where appropriate.

1.1 GUIDING PRINCIPLES

It is useful to highlight a number of guiding principles that have influenced the design of this methodology and help to explain the approach:

1. This manual describes a rapid but robust assessment methodology and this has guided the choice of methods and indicators. It should be possible for a team of approximately five people with multi-sectoral expertise to implement this assessment in a period of some two to three weeks, including time for analysis and report writing. Despite the rapid nature of the approach, the methodology is designed to be robust enough to provide base-line data on land degradation and improvement for planning, priority setting and subsequent monitoring activities.

2. The approach is ambitious. Previous land degradation assessments have not always moved much beyond the description and quantification of biophysical processes. This methodology aims to deliver an understanding, not only of the state and nature of change in the land resources (soil, water, vegetation) and ecosystem, but also of the drivers and impacts of LD/SLM.

3. Conceptually, three frameworks are used. The DPSIR[1] framework links all parts of the assessment and guides the synthesis and analysis of the data. The Ecosystem Services (ES) and Sustainable Livelihoods (SL) frameworks are used to help consider and categorise impacts of LD/SLM. Brief descriptions of the origins and key aspects of these three frameworks are provided in section 4 below.

4. The methods and indicators have been selected/adapted for use across the main land use/ecosystems in dryland areas. In the interests of consistency and

[1] **D**riving forces of environmental change; **P**ressures on the environment; **S**tate of the environment; **I**mpacts on population, economy, ecosystems; **R**esponse of the society. The DPSIR framework is described in Section 4.1

comparability a "core" methodology, a set of core indicators and some detailed methods for assessing these indicators are proposed. However, in some areas and under some circumstances, additional indicators will be relevant and/or it may be appropriate to assess the proposed indicators using different methods. For example, there may be the added aim locally to generate technical datasets on land resources to complement existing national studies; or a locally established method may be preferred or better suited to assessing a particular indicator than the one proposed here.

5. Wherever possible, methods and indicators have been selected that are easy to use and easy to interpret. This is in order to reduce the work involved but also to stimulate interest and engagement in the assessment from land-users themselves. In many places the approach relies on land users for information, notably, on the history of land-use, the dynamics of resource change and the local drivers and impacts of LD/SLM. If they are involved in and see the relevance of the assessment it is more likely that land users will provide such information.

6. The approach 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 through “triangulation”[2], rather than through large-scale sampling and repeated technical measurements, is an important principle. It is expected that the precision lost in some areas will be more than compensated for by the broader and deeper understanding of land degradation that this integrated assessment will deliver.

7. 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 productive services the land-users require from the land, i.e. the Provisioning Services. A second important consideration for the LADA project is the need to identify and evaluate significant impacts of LD/SLM on other key ecosystem services, particularly on global level systems and resources such as climate, biodiversity etc. Both require some attention to the supporting and regulating services that determine productivity and ecosystem resilience such as nutrient and organic matter cycling and maintenance of the hydrological cycle.

8. It is intended that this manual and associated training will build on country experiences and approaches and will build the capacity of participating countries for more integrated and participatory assessments of land degradation and for monitoring impacts of various land uses, management practices and technical and policy interventions.

1.3 MANUAL STRUCTURE

The manual consists of two main Parts.

Part 1 provides a guide for the coordinator and key team members responsible for planning the assessment, analyzing the results and producing the outputs. The conceptual framework is presented with some recommendations for site selection, sampling, analysis and reporting of the assessment findings.

[2] “Triangulation” is the approach where more than one method is used in a study in order to double (or triple) checking results. The belief behind this is that we can be more confident with our information and data if different methods lead to the same result

Part 2 provides the tools for the Field Assessment. Tools 1 to 6 are proposed for characterisation of the study area and Tools 7 to 14 for conducting the detailed site assessments including wider catchment or landscape effects (off-site).

The overall structure of the manual follows more or less the recommended sequence of steps to be taken when conducting the field assessment:

- Introduction (Part 1)
- Planning the assessment (Part 1)
- Identifying areas for the local land degradation assessment (Part 1)
- Introduction to the Conceptual Framework (Part 1)
- Introduction to the components of the Assessment and related Tools (Part I)
- Characterization of the Study Area (Part 2)
- Household livelihood survey and key informants interviews (Part 2)
- Identifying sites and households for the detailed assessments (Part 2)
- Assessing the type, extent and severity of soil erosion (Part 2)
- Assessing the status and degradation of soil properties (Part 2)
- Assessing the status and degradation of vegetation and water resources (Part 2)
- Assessing the impact of land degradation on productivity (Part 2)
- Analysis of findings and reporting on the land degradation assessment (Part 1)

A number of Annexes to Part 1 and Part 2 provide additional explanations and more specialized tools that will not be needed in all areas. A list of References and Further Reading is provided in Annex 6 of Part 1.

Whilst we recommend the above sequence, it is recognized that logistics and resource availability, particularly time, will mean that in practice some sections could be addressed simultaneously or in a different order. The aim is to provide a standardised but flexible assessment that can be complemented with additional tools as appropriate to the local context and stakeholder interests. It is important to involve the land-user in most stages of the assessment not only during interviews (see guiding principle no. 5 above).

2. Assessment Team and Planning

This section starts with a brief discussion of the make-up of the assessment team as this has proved to be a particularly important consideration during piloting of the methodology.

2.1 COMPOSITION OF THE TEAM

The assessment addresses a number of different elements (soil, vegetation, water resources, agriculture and socio-economic assessment) and requires synthesis, analysis and output production in addition to data collection. Ideally members skilled in all these main disciplines should be included. It is most important to include someone with knowledge and experience of socio-economic assessment and participatory survey methods (e.g. use of P/RRA tools such as focus group discussions, territory mapping, livelihood calendars, etc.). The team will also be guided and supported by local representatives, for example, technical staff from the district/ provincial office or a relevant project on the ground. This will help to ensure the assessment will have both scientific rigour and will deliver outputs with relevance and accessibility to all stakeholders.

The team needs to be coordinated by capable individuals; ideally those who are responsible for the analysis of the results and output production. Experience of field work, team management, natural resources assessment, data quality control and participatory and inter-sectoral approaches, are all desirable qualities for the coordinator.

Good team work is essential among the specialists to ensure an holistic ecosystem assessment. Regular and effective communication among members in the field and in analysing findings will strengthen the assessment in several ways:

– Regular, structured communication between team members (e.g. team meetings at the start or end of every day in the field to bring together findings) will improve understanding of interrelations and synergies in the ecosystem Traditional sector based (i.e. water, soils etc.) assessments tend to ignore interactions among resources and human management.
– Good communication should also reduce repetition, particularly of the topics covered in informant interviews and group meetings. There are ethical considerations linked to resource assessments that, besides common understanding of impacts of current land use practices, do not promise any short-term material benefit to the land-users (see section 2.3 and Annex 3); thus demands made on local people should be minimized.
– Team discussion during the assessment allows initial thoughts on findings to be aired, problems in assessment methods to be talked through and gaps in the assessment identified and to the extent possible addressed.

2.2 PLANNING

Before the assessment starts in each country and at each site some time should be set aside for planning. Include as many members of the assessment team as possible (see section 2.1) in the planning process and ensure they review and are familiar with the manual. This will facilitate preparatory discussions and focussing of the assessment.

Assessment outputs and stakeholder interests: In any assessment the collection of data only becomes meaningful if it helps to deliver desirable outputs. The intended core outputs of LADA-L range from reports and briefings on LD/SLM in the pilot sites and countries to baseline data against which subsequent change can be monitored (see Annex 2 for detail). Different stakeholders will be interested in different types of output and the range of stakeholders and their interests should be identified during the planning stage. Commonly stakeholders are:

- Government departments (environment, water, forest, soil, agriculture, etc.);
- local and provincial authorities;
- the national and international scientific community;
- NGOs and projects operating in the sites and/or land resources sector; and,
- local institutions (producers associations; water users associations, community leaders, etc.).

Brief consultation with the main stakeholders during the planning phase is an opportunity to identify additional output needs, available data and synergies with past or ongoing activities. In some cases it may be possible to add tools or increase emphasis in particular areas of the assessment to help deliver more targeted or detailed information.

The core assessment and possible additions: For the LADA project, as desired by country Parties to the UNCCD, it is important that local land degradation assessments are as consistent /standardised across countries as possible. This will enable stakeholders to use the results as a basis for comparisons, for example, to assess effects with or without interventions, or to establish a baseline for monitoring. There must also be flexibility to add to the methodology where appropriate and even to use different methods to assess some of the indicators. Experiences during the development phase suggest that there will often be a wish locally to add to the core methods; or to give greater emphasis to some elements of the assessment, for example salinity, rangeland degradation; or to meet the specific needs of existing country assessment or monitoring processes.

Important decisions on study area and focus: The following aspects of the assessment need careful review, discussion and agreement during assessment planning:

- **The assessment location:** What geographical assessment areas and study areas are most appropriate? (see section 3)
- **The livelihoods assessment:** What are the important questions relating to livelihoods that the assessment should answer? (see section 5.3 and part 2 section 2.2)
- **The ecosystem service assessment:** What are the key services likely to be affected by the LD/SLM revealed by the assessment (see section 6.2.5)

Duration and Scheduling: Piloting activities suggest that it takes approximately 2 to 3 weeks for a team of five or so persons to carry out the assessment in a typical study area with up to a week required to conduct the analysis and for 1 or 2 members to prepare the report. In the spirit of a “rapid assessment” it is expected that there will be a single period of field work during which most or all of the data will be collected. The timing of the field work should be chosen with this in mind. It may be necessary or preferable for some of the team to return to the area at a later date to collect data unavailable during this main period.. Again, this manual offers guidance but the precise schedule and format of the assessments are likely to differ quite widely between locations.

Tools and Equipment: Several months before the assessment the required tools and equipment need to be assembled, on loan from appropriate institutions or to be procured and some may require ordering from abroad.
Annex 2 provides a list of equipment and tools that the field teams might require and sources for ordering of equipment not available in country.

Secondary Information: The results from a rapid assessment need to be contextualized, for which a review of existing and ongoing land use and land resources interventions is required. Important sources of this information are local authorities and technical institutions/projects working on land resources. It is important to review relevant policy and socio-economic information for the study areas such as policy documents and development statistics e.g. on poverty, land tenure and access to resources and trends in crop, livestock and forest production. .
A list of secondary information likely to be useful is also provided in Section 3.3.

Mapping and Images: Maps and images are an important tool for use in the field during the local assessment of land degradation. They serve many purposes:

- a basis for drawing a sketch map with local participants;
- to help inform the general characterisation of the assessment area;
- to help acquire a semi-quantitative assessment of some features of the landscape, such as farm or field size, vegetation or land use type, population density, siting of 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 within a protected area) in order to help establish trends of degradation or improvement

Table 1 summarises the types of images that can be used and their use, indicating advantages and limitations. Besides aerial photos and satellite images, the use of a camera and photographs is very valuable as part of the assessment and for monitoring as it enables to readily present /visualise changes.

Table 1 Types of images and their uses

Use of Images	Type of Images	Advantages	Limitations
i) To draw a sketch map and ii) obtain a general overview of the local assessment/ study area	Aerial photographs	Consistent in quality handy format/size easy to read	Cost and availability
	Satellite images - true colour, high resolution – Ikonos, Quickbird	Consistent in quality easy to read	high cost
	Satellite images - false colour, medium resolution- Landsat, Spot	Consistent in quality highly informative relatively cheap	more difficult to read
	Google Earth	Freely available Easy to read	Poor and inconsistent quality
Semi-quantitative assessment of some features of the landscape	Aerial photographs Satellite images Google Earth	As above	As above
To compare situations in time or space	Aerial photographs Satellite images	as above Consistently available for past dates and for almost all places in the world	As above
	Ground photographs (digital)- a very useful tool for the local assessment	Well known, easy cheap to produce Can be used for monitoring change May be found for the distant past (long term changes)	Inconsistent in quality, locations and time of production

2.3 TALKING TO PEOPLE

There are four specific assessment tools used to collect information from local people: the community focus group discussion (Tool 1a and its field form Tool 1b); the livelihoods interviews (Tool 7); the guide to key informant interviews (tool 8) and the on site discussion with the land-user (Tool 9). It is important, however, to talk to and involve the community and land-users in other parts of the assessment whenever possible. This recommendation is noted in the relevant tool descriptions below, but any additional opportunities that arise for discussion should be taken up.

Key informant interviews
It is important to conduct a small number of key informant interviews in addition to the community discussions and the livelihoods interviews. These might be with local government officials (at community, district or regional level), NGO staff, representatives of technical departments (land, water, agriculture, forestry) or managers of protected areas. Such informants will provide useful contextual information but also help verify or explain some of the assessment findings. For example, links between national activities/ policies and LD/SLM might be made by community members that would need to be explored. There is also considerable scope for discussion of possible responses to land degradation with local government or project representatives. It is not possible to predict when and where these interviews will be required at each location hence their general importance is emphasised here. It is the responsibility of the teams to decide who best to talk to and when, as part of the assessment. Tool 8 is provided as a guide for these interviews.

There are significant ethical considerations with taking up a lot of people's time, particularly when the assessment will is not directly linked directly to support or other interventions in the community. Some guidance on ethics is given in the next section.

2.4 ETHICAL CONSIDERATIONS

The assessment team should try to make minimum demands on people's time, however it is recognised that this methodology relies greatly on inputs from local people. Some of the data and information collected during the assessment will be potentially sensitive. It is not unusual to find that formal rules on access to/use of land resources such as farm and grazing land, forest, water etc. are not well observed. In some cases there will be "informal" or illegal arrangements that land-users will be reluctant to talk about. There are two important considerations for the assessment team: first they should be aware that the responses to questions may not always be accurate; second they need to be sensitive to the land users and observe standard ethical procedures on confidentiality and consent. This applies to the use of information obtained through discussions, questionnaires, field visits as well as the use of photographs.

The accuracy concern can be addressed in a number of ways. In both the biophysical and socio-economic elements of the assessment, information obtained during the assessment should be critically evaluated and "triangulated" [3] across information sources wherever possible. Looking carefully at the responses given by different people to the same questions can identify anomalies and inaccurate information. Follow-up interviews with relevant key informants such as representatives from water, agriculture, forest and fisheries departments at different levels (e.g. national, district etc.) can help clarify the information given by land-users and explain local level responses and findings. It is important not to assume that "official" information is more accurate or reliable than that provided by the land-user as it can be in the interests of either group to manipulate the picture of trends in land resources that the assessment is trying to build up.

Further ethical guidance is provided in Annex 3.

3. Identifying areas for assessment (sampling).

3.1 SAMPLING STRATEGY

A clear and robust sampling strategy is required to allow extrapolation from the field level results to the provincial and national level. The need to say something meaningful about LD/SLM at these scales is not just a requirement of the LADA project but will be important for decision makers wherever the assessment is carried out. To facilitate this extrapolation to a larger area, the 3-tiered sampling strategy described in Table 2 and Fig. 1 is recommended. Several terms are used for sampling units throughout the manual and they are defined in Box 1.

Table 2. LADA-L Levels/units of analysis

Unit/level	Size/number
1. Geographic Assessment area (GAA)	2-6 per country. Each GAA could be anything from a single watershed to a region of several hundred km^2
2. Study Area†	Two to three locations ensuring that the GAA is well represented. Size variable.
4. Sites/field plots for detailed assessments	3 pairs†† of plots per LUT depending on number and complexity of LUT.

† see Boxes 1 and 2 for definitions

†† In most cases a comparative element to the sampling will be required – as elaborated in the Tools for the site assessments

Box 1. Working definitions of some key terms used in the assessment:

Geographic Assessment Area (GAA): the 2-6 areas identified within each country for the assessments. GAAs will usually be quite large – from several hundred to several thousand km^2. They will be areas of significant LD/SLM activity and impact and each should be representative of one or more important land use system (LUS).

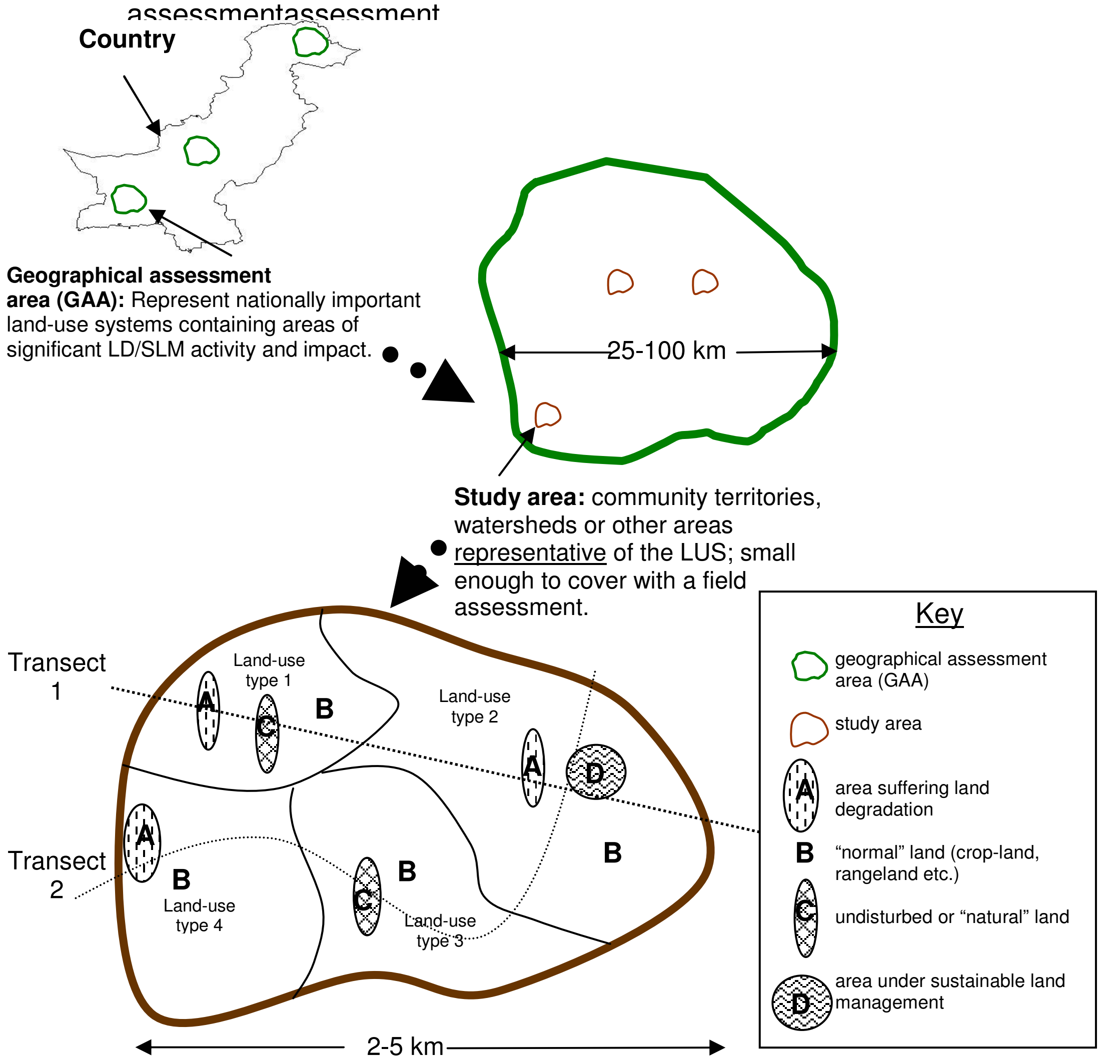
Land Use System (LUS): the sequence and combination of operations designed to obtain goods and services from the land (Nachtergaele, F. and Petri, M., 2007). The study area, which contains the sites where transects and field sampling is conducted, should be representative of the given LUS. *Low resolution*

Study Area (SA): the areas (two or more) selected within each GAA for the field assessments. They must be representative of the GAA, containing as many of the main LUTs and forms of LD/SLM present in the GAA as possible. A study area may be a community and the territory it occupies or it may have some othr form 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, see Table 2). *High resolution*.

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.

Figure 1. The three tiers of sampling in the local assessment assessmentassessment



N.B.

- The transects do not need to be a straight line. They are used to verify features discussed in the community discussion and to identify sites for detailed assessments, not as detailed quantitative sampling tools.
- Comparison is at the heart of the sampling strategy. Detailed assessments are conducted in areas of LD, SLM and undisturbed or "natural" land and the results from these are compared. e.g. A, B and C are compared in land-use 1; A, B and D are compared in land-use 2 etc.

3.2 IDENTIFICATION OF THE ASSESSMENT AREAS

Geographic assessment area

The first sampling tier below the national level is the "**Geographic assessment area (GAA)**". There should be 2-6 of these per country, depending on its size and complexity. Logistics, existing activity and other factors may influence the choice of GAAs but it is essential that they are areas of national priority concern and interest with respect to land degradation and/or SLM. With the LADA project it is important to select the GAA partly on the basis of the land-use systems (LUS)[3] it contains: the GAA is effectively a sample of one or more nationally important LUS. Typically GAAs are quite large, several hundred to several thousand km^2 across, and will not be uniform. They will contain a small number of land use systems (LUS); several types of land degradation and SLM and a range of impacts on people and ecosystem services. Within those GAAs, a few **study areas** for the field level assessments should be chosen.

Study area

The most important consideration in choosing Study areas is that they should be representative of the GAA and, where a national LADA assessment has been conducted, also representative of the selected Land Use Systems (LUS) present within the GAA. The ability to extrapolate the assessment findings from the local level to the provincial level and above depends on this representativity. In some situations the study area will consist of a village or other discrete settlement and the area occupied and accessed by the community living there (the community territory). As the GAAs are often quite large it will usually be necessary to select two or more study areas in order to capture the diversity of LUS and LD/SLM situations within each GAA.

There are two particular advantages of using a community based sampling unit:

- if sample communities are representative of the LUS, extrapolation of assessment findings to other similar community teritories can be justified.
- rules and systems regulating access and management of land resources are often organized at community level. Some community level analysis is usually required to fully understand this.

However, in the LADA project pilot countries, and generally in drylands, a community-based settlement pattern is not always found. Individuals and families of land-users may be mobile or scattered in single domestic units or family clusters. It is important for assessment team to think about sampling during the assessment planning and discuss methods for achieving a representative sample of the LUS.
When piloting the methodology, it was revealed that a transect-based sampling approach, along a gradient of available moisture and land use types, may be an effective way to sample a LUS. In other cases an appropriate study area could be: a small catchment or watershed; an area delimited by the extent of the agro-pastoral movements of a community, or a randomly selected area within the local assessment area.

[3] Within the LADA project the selected GAAs should be representative of a certain Land Use System (LUS) as identified and mapped during the national LADA assessment on the basis of biophysical and socioeconomic data.

Sites/plots for detailed assessment

The objective with the detailed site assessments is to generate an in-depth understanding of each of the main types of LD/SLM in the study area, on which land use type they occur and an analysis of their drivers and impacts. It is likely that there will be several or perhaps many distinct land-use types (LUTs) present within a study area. The assessment team should ensure the main ones are identified as these will determine the basic characteristics of the land resources (see section 1 in Part 2 for list of LUTs). Similarly the team should identify and classify the different types of conservation/SLM measures in the study area (see Annex 1, Part 2).

The procedure for selecting plots/sites is linked to the characterization of the study area and described in section 1 of Part 2. Wherever possible there should be a comparative element to the sampling, i.e. degraded land can be compared with land that is not degraded or land under SLM practices. This is illustrated in the example in Figure 1. The detailed measurements of soil and vegetation, in particular, should be replicated 2-3 times in each site/plot. Replication is discussed more under each specific tool in Part 2. 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 complexity of the area and on whether two or three replications per site are made (three is better but more guidance is given in Part 2). This calculation is shown in Box 2.

Box 2. Example calculation of total number of sites for biophysical measurement in a study area.

This example related to the hypothetical study area in Figure 1 in which there are 4 land use types:

- In LUT 1 a three way comparison is possible: LD/SLM degraded land (A) with “normal” land (B), with 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 total 30 sets of biophysical measurements would be required in this sample area (9+9+6+6). Depending on whether the same land user managed sites A, B, C etc. interviews with up to three land users per LUT would be required. Thus a total of 4-10 livelihoods interviews would be conducted in this example.

If there are available datasets, aerial photographs, etc. that give a time-series picture of land degradation and control/improvement (over a 10-50 year period) these can help identify those sites/plots of most “interest” for the detailed assessment. 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 land restoration/ rehabilitation has occurred and resulted in significant improvement in the quality of land resources.

Take care to distinguish land use from land cover where

- Land use = human activities which are directly related to land, making use of its resources or having an impact upon it.
- Land cover = Vegetation (natural or planted) or man-made structures (buildings, etc.) that cover the earth's surface.

The use of these LUT classes and categories of conservation/SLM measures will allow linkages to be made between local and national level assessments. For more detailed explanations refer to www.wocat.net

3.3 Collection of Secondary Information

Once the study areas within the GAA have been selected the detail of the assessment can be planned (section 2.2). At this point the teams must gather any relevant technical and socio-economic information available on these areas from local authorities and technical institutions/ projects (See Table 3 below) for a checklist of useful secondary information). It may be possible to find some local technical staff or research students to assist in collecting and analysing such information guided by the local assessment team.

Table 3. List of secondary information for collection and review prior to and during the LADA-L assessment.

Categories	Contents
Maps, satellite images and photos	Maps: administrative, soil, terrain, land-use, vegetation, watersheds and water points, planning; Time series satellite images (SPOT, NDVI, etc.) Aerial photographs
Climatic and meteorological records. Natural disasters	Rainfall amounts and variability; temperature; humidity; trends in rainfall and temperature over recent decades, incidence and impacts of drought and flooding; etc. Information on impacts of climate change. Studies looking at impacts, including likely future impacts, of climate change on water resources (source: projects, IPCC 2008 reports).
Human Population	Total population and recent trend(s); age and gender distribution; household and family composition information; employment by sector; labour force; migration and immigration information; information on settlement patterns, poverty and food security, etc.
Land and land use types	Total land area in the local assessment area and community territory (sample levels 1 & 2); farm land area, areas and proportions under different LUTs (including forest and protected areas), land resources surveys, etc.
Farming system information	Existing plans, projects & programmes; crop and livestock systems information; information (presence & extent) on local and introduced practices for land management & land degradation control/sustainable land management e.g. agroforestry, fallow etc.; information on livestock numbers, distribution, ownership, actual and recommended stocking densities, management.
Water resources	Water resources records over the last decade to show: a) Water flow regimes in rivers and b) water storage capacity and water levels of lakes, dams and reservoirs and c) sedimentation load/rates (source: water boards/authorities); Incidence of water borne diseases (source: health sector) etc.
Economy and livelihood	Household income information; composition of income (i.e. contribution from farming and other activities); poverty profile (proportion of population below poverty line etc); household consumption information; credit/loan availability, etc.

Categories	Contents
Land Tenure	Information on land-holding ownership size & distribution; type and prevalence of renting arrangements; legal status of holding (civil, cooperative, government); etc.
Institutions, policies, regulations, bylaws	Relating to land, agriculture, livestock, water resource, environment, rural development, technical extension, etc, their function, capacity, mandate, etc.; formal (i.e. official) and informal, private and public sector. Presence and roles & activity of NGOs, community based organisations, etc.
Basic infrastructure and investments	Road access; markets/shops; schools; health centres; irrigation systems; reservoirs; water points; rivers/streams etc.
Planning reports and other relevant documents	e.g. land use planning; water resources management & planning; forest management; livestock management; environmental management; etc.

The next step is the characterisation of the study area described in Part 2 of the manual.

4. Conceptual Framework

The main emphasis of this local land degradation assessment approach is on understanding the direct and indirect causes (or drivers) of LD/SLM and the impacts of LD/SLM on the environment and on local peoples'/stakeholders' lives and livelihoods. The DPSIR framework provides a structure for integrating the different parts of the assessment. The Ecosystem Services and the Sustainable Livelihoods frameworks help us to think about LD/SLM impacts in a structured and systematic way. This section briefly introduces the three frameworks. Details on how they are used to integrate and guide the assessment are more fully described in section 6.

4.1 DPSIR Framework

DPSIR allows the identification of the linkages between the **driving forces (D)** that are behind the **direct pressures (P)** on land resources that cause degradation, the current **state of land resources (S) and their dynamics (i.e. the direction and magnitude of any change)**, the **impacts (I)** of such degradation on the environment and on human livelihoods, and possible **responses (R)** of land users to land degradation and its impacts. DPSIR, as applied in the LADA project is illustrated in Figure 2. The figure also indicates the need to link and extrapolate from local assessment findings to the national level and to global environmental effects of LD/SLM. Many driving forces, pressures, impacts and responses are relevant at each of these scales and, by forcing the assessment team to think systematically about these across different study areas and GAAs, DPSIR can help to identify and understand these important local-national-global linkages.

Although the assessment addresses land resources and these are biophysical components of the environment, the drivers, pressures, impact and responses will often not be biophysical or technical in nature. Economic, policy and cultural factors drive LD/SLM as frequently as technical constraints. Similarly impacts and appropriate responses can be in any one, or a combination, of the technical, economic or policy domains. In this way DPSIR can help deliver an integrated or interdisciplinary assessment.

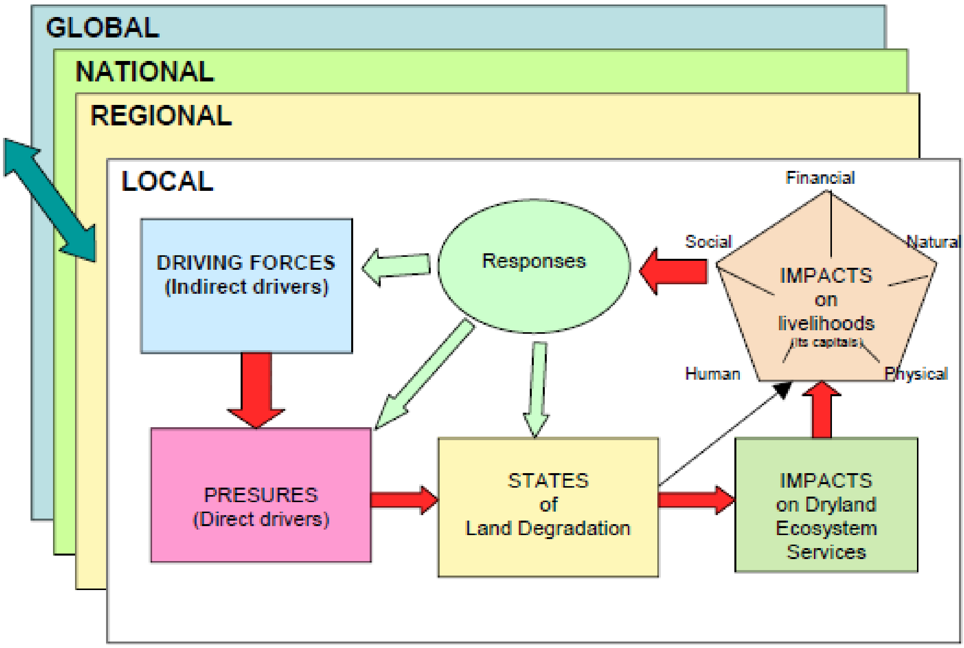


Figure 2. The DPSIR Framework Applied to the LADA project

4.2 Ecosystem Services (ES) framework

The Ecosystem Services (ES) Framework focuses on the benefits people obtain from ecosystems: ecosystem services. This framework encourages the assessment team to think broadly about the range and scale of impacts of LD/SLM. Some impacts are easy to quantify, others not; some are felt locally and very differently according to the socio-economic status of the land-user, others are felt nationally or globally.

Ecosystem services can be grouped into four interrelated categories: provisioning, supporting, regulating and cultural services (Figure 3)[4] where

- ***Provisioning services*** refer to the products obtained from ecosystems;
- ***Regulating services*** are the benefits obtained from the regulation of ecosystem processes;
- ***Cultural services*** include non-material benefits people obtain from ecosystems such as cognitive development, reflection, recreation, and aesthetic experiences;
- ***Supporting services*** are those necessary for the production of all other ecosystem services.

Supporting services differ from provisioning, regulating, and cultural services in that their impacts on people are often indirect or occur over a relatively long time period, whereas changes in the other categories have relatively direct and short-term impacts on people.

[4] As used in The Millennium Assessment (MA, 2003), NB, ecosystem services have been categorised in different ways, for example, De Groot et al (2002) identified 23 services and categorised them by function into regulation, production, habitat, and information services.

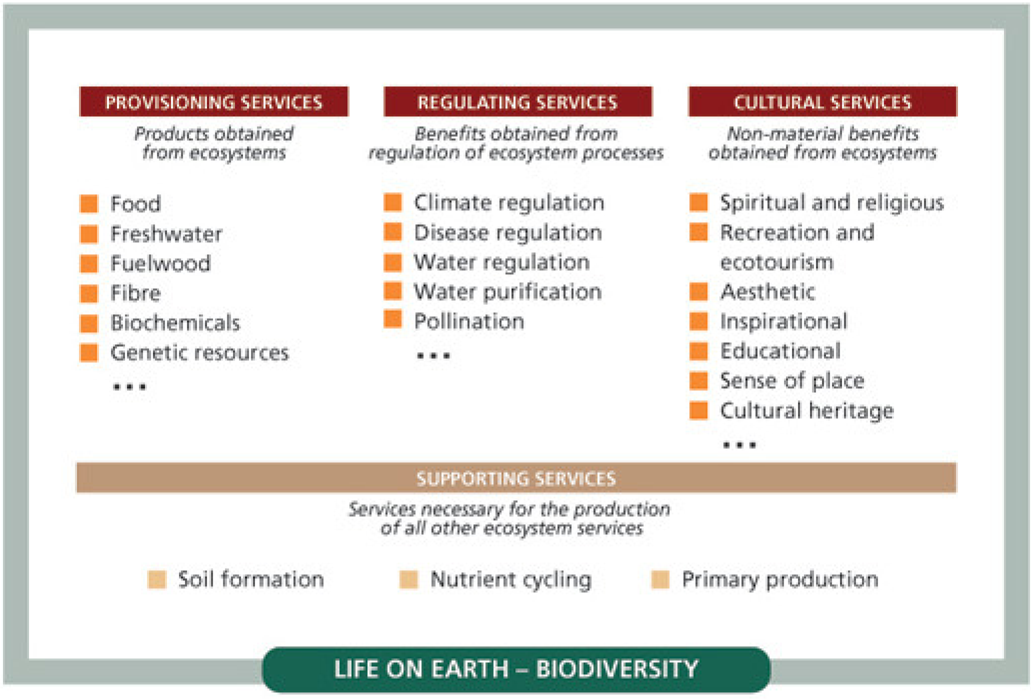


Figure 3 - Ecosystem services categories

Some important observations on ecosystem services:

- land degradation is often a consequence of over-exploitation or poor management of one or more provisioning service (e.g. food production, water extraction for irrigation etc.), impacting negatively on key supporting and regulating services such as water regulation or nutrient cycling. Negative impacts in these areas can then undermine the provisioning services on which the land-users rely.

- Trade-offs and potential conflicts between services or groups of services are common. The most important challenges in decision-making about ecosystems can be around understanding these trade-offs and using this understanding to improve the decision making process. For example,

  - increasing the flow of one service from a system, such as increasing the provision of timber to meet demand, may decrease the stock or flow from other services, such as carbon sequestration, water quality regulation or the provision of habitat.
  - the short term increase in the flow of a provisioning service locally may have a negative impact on services and flows that are less easy to quantify or that are valued more at the global rather than local scale (e.g. C sequestration or biodiversity).
  - over-exploitation of a provisioning service may lead to demand exceeding the ability of the system (via supporting/regulating services) to maintain key stocks (e.g. nutrients, water, vegetation).

  All of these impacts should be considered when trying to improve the management of the system.

- Cultural services are difficult to assess quantitatively. Qualitative information on some of these (as listed in Fig 3) is generated from community discussions and land-user interviews. It is easy to undervalue cultural services, however, and studies have shown that these are often highly valued locally and they can be adversely affected by land degradation or improved by SLM.

The ES framework is brought in more during the synthesis and analysis of findings of the land degradation assessment. In most cases those responsible for the analysis and assessment output will need to infer various impacts of land degradation on ecosystem services rather than measuring them directly.

4.3 SUSTAINABLE LIVELIHOODS (SL) APPROACH

The Sustainable Livelihoods framework or approach is used for understanding how household livelihood systems interact with the natural, socio-economic and policy environment. Impacts can be in both directions i.e. many pressures leading to land degradation arise from the activities of land-users and LD/SLM causes impacts on land-users' livelihoods. In this assessment the SL approach is used to help understand both:

- the drivers and pressures leading to LD/SLM and
- the impacts of LD/SLM on people.

There are a number of variants of the SRL frameworks in the public domain ranging from the one popularised by DFID to modifications proposed by different authors (e.g. Scoones, 1998; Ellis, 2000 etc.) and organizations (e.g. IFAD, 2002). For the purposes of local assessment of LD/SLM there is no need to distinguish the differences between the variants and a relatively simple one is shown in **Figure 4**.

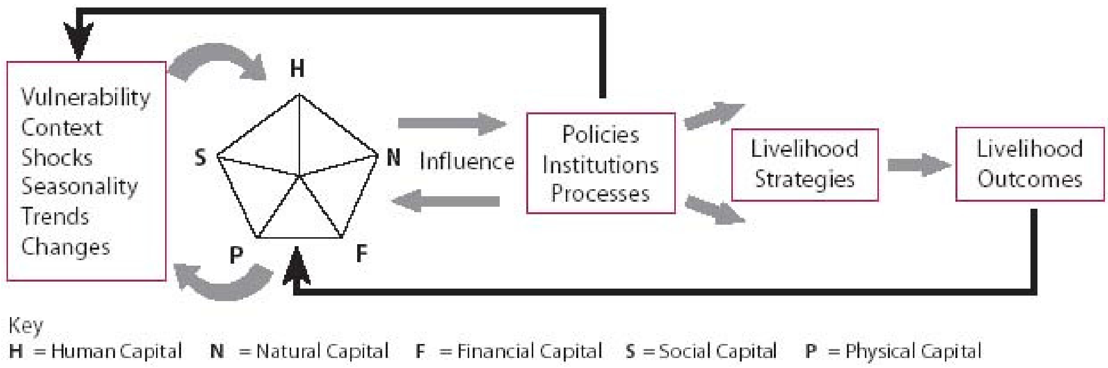


Figure 4. The Basic Livelihoods Framework (Source: Ellis & Allison, 2004*)*

The platform or core of a household's livelihood is its assets, classified into five classes and denoted by a pentagon. Both the vulnerability context (on the left hand section of Figure 4 and policies, institutions and processes (or "institutional context", in the central box) affect the access people have to key assets and what they can do with them. The livelihood strategies of different individuals and categories of households are shaped by their asset base and by the vulnerability and institutional context in which they live. When tracking back from LD/SLM pressures to driving forces it is often in these two contextual areas (vulnerability and institutional) that the driving forces are found.

Five concepts are crucial for understanding the linkages within the framework (from left to right in the diagram)

i) the vulnerability context
ii) livelihood assets
iii) institutions
iv) livelihood strategies
v) livelihood outcomes

i) Vulnerability context (or "risk exposure") comprises cycles (e.g. seasonality), trends and shocks that are beyond the household's control. Some examples of these are provided in Box 3 . An understanding of how people succeed or fail in sustaining their livelihoods in the face of shocks, trends and seasonality can help with the design of policies and interventions to assist peoples' existing coping and adaptive strategies. Some examples are improving access to education and health care facilities, strengthening rights to land for settlement and agriculture, reforming local tax and licence systems, providing financial and enterprise development services (and not just credit for farm equipment) and promotion of diversification.

Box 3 Vulnerability context (illustrative examples)

- **Weather-related shocks and natural calamities:** drought, earthquakes, hurricanes, tidal waves, floods, heavy snow, early frost, extreme heat or cold waves
- **Pest and disease epidemics:** insect attacks, predators and diseases affecting crops, animals and people
- **Economic shocks:** drastic changes in the national or local economy and its insertion in the world economy, affecting prices, markets, employment and purchasing power
- **Civil strife:** war, armed conflict, failed states, displacement, destruction of lives and property
- **Seasonal stresses:** hungry season food insecurity
- **Environmental stresses:** land degradation, soil erosion, bush fires, pollution and
- **Idiosyncratic shocks:** illness or death in family, job loss or theft of personal property.
- **Structural vulnerability:** lack of voice or power to make claims

All communities are heterogeneous and the most vulnerable are often also the poorest. Commonly these people are most affected by land degradation and sometimes also responsible for the pressures leading to LD. As part of understanding the vulnerability context it is important to understand how important socio-economic divisions such as wealth, gender, ethnicity and so forth influence LD/SLM.

ii) Livelihood assets[5] refer to the resource base of the community and of different categories of households. The pentagon in Figure 4 represents the different types of assets available to local people – human (H), natural (N), financial (F), physical (P) and social (S). These assets are owned, controlled, claimed, or by some other means accessed by the household. The physical capital or assets are key in determining livelihood activities and the quality of land/natural resources management. Some assets that open up opportunities for people are: credit, education, labour, secure land tenure, rights to use natural resources e.g. harvesting fuelwood, road access to market. It is not just access to assets that is important; the ability to use the assets productively and sustainably is often determined by the vulnerability and institutional context.

Box 4; Types of livelihood assets (illustrative examples)

- **Human capital:** household members, active labour, education, knowledge and skills
- **Physical capital:** livestock, equipment, vehicles, houses, irrigation pumps, and at community level, access to infrastructure such as road networks, clinics, schools etc
- **Natural capital:** access to land, forests, water, grazing, fishing, wild products and biodiversity
- **Financial capital:** savings/debt, gold/jewellery, income, credit, insurance
- **Social capital:** kin networks, group membership, socio-political voice and influence

iii) Institutional context of people's livelihoods. This includes formal and informal policies and regulations; social relations, markets and organisations. In many cases the main obstacles to progress or opportunities for change are in this area and the SL approach encourages us to ask important questions about these: How do institutions or policies influence how people use the land resources and what people can or cannot do? Where are there policy gaps? Are there perverse outcomes (indirect negative effects) associated with some policies/legislation?

iv) Livelihood strategies. Most people are trying to follow some kind of strategy in terms of their lives and household wellbeing and the SL approach encourages attempts to characterize these, with a focus on what people are already doing or trying to do. A lot can be learned from looking at innovators, entrepreneurs etc. and asking: Why they are succeeding? What needs to happen for others to be able to follow, etc.

In dryland areas these strategies are often quite diversified, comprising a mix of crop cultivation, livestock and off-farm work (often seasonal). In a single study area it may be possible to identify several different strategies: perhaps a group focusing on intensifying their crop or livestock farming; others whose livelihoods are characterised by their mobility or their diversified nature. The use of assets is often very strategic with important trade-offs operating e.g. natural assets (forest, land quality) may be drawn down in order to build up human capital in the form of education or health care). Short and long-term measures to ensure survival are often distinguished as 'coping' and 'adapting', respectively (Ellis, 1998).

V) Outcomes. A livelihood is sustainable if people are able to maintain or improve their standard of living related to well-being and income or other human development goals, reduce their vulnerability to external shocks and trends, and ensure their

[5] "Assets" are synonymous with "capitals" in the livelihoods literature.

activities are compatible with maintaining the natural resource base – their land resources.

5. Introduction to the Components of Local Level Land Degradation Assessments

This section presents and briefly discusses definitions of land degradation. It then provides an overview of the assessment methodology and the tool-kit provided in Part 2.

5.1. DEFINING LAND DEGRADATION

Drylands are fragile and particularly susceptible to land degradation. When land is degraded, its productivity is reduced and many other ecosystem services are affected. Land degradation is primarily cased 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.

There are many definitions of land degradation

- LADA defines land degradation as *"the reduction in the capacity of the land to perform ecosystem functions and services (including those of agro-ecosystems and urban systems) that support society and development" (LADA, 2005)."*

- the 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 contain a broad view on the nature of land resources (they include soil, vegetation and water) and on the range of products, goods and services people require from the land.

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"*. Hence at the international level desertification is not regarded as a separate form of land degradation, so much as the end product of a variety of degradation processes that have adversely affected the productivity of the land resources within 'dry-land' areas. In the People's Republic of China further confusion comes when the Chinese characters for sandification are mistranslated as desertification. The build up of wind blown sand deposits and formation of mobile sand dunes (sandification) represents just one of the degradation processes contributing to desertification (land degradation) in the drylands of China.

The three broad types of land degradation considered in the LADA methodology are:

- Soil degradation
- Vegetation and biodiversity degradation
- Water resource degradation

The assessment team needs to identify the main LD/SLM processes occurring across the study area and to assess the severity of their impacts in each of the main land use types and land units. **Annex 4** provides some background information on these for each land degradation type.

Observations of effects of land use type and management practices (such as burning, drought, overgrazing, etc.) on soil, water and vegetation indicators need to be triangulated and supplemented with feedback from land users/key informants explaining reasons for change in land use or management, and constraints to adoption of SLM practices. The process of identifying the main drivers and pressures of land degradation with the land users helps the assessment broaden its scope and relevance.

In addition to direct effects of land use and management practices three specific drivers need to be given due attention as they may lead to a lower productive potential, notably:

- Climate change
- Land conversion
- Pollution

The first two are often but not always drivers of land degradation in dry-lands, pollution always is.

The rest of this section provides a linked overview of the assessment approach to demonstrate the linkages, progression and complementarity of the different assessment components. The aim of the local assessment is to bring the findings together to produce a holistic and integrated assessment of land degradation.

5.2 AREA CHARACTERIZATION

The local level assessment should avoid focusing on those areas which are the most degraded and which are most costly and difficult to recover. It should cover a range of situations and support the identification of options for preventing, mitigating and rehabilitating land resources and maintaining ecosystem services. These will include measures that can be taken up by the local populations with, and without, external support and should provide decision makers with options.

A number of tools (Tools 1-6) are provided in Section 1 of Part 2 for characterizing the study areas. These are included to provide the context for the detailed assessment and help identify the sites for measurement. Without this characterization it will be difficult to generate a good understanding of the drivers, impacts and dynamics of LD/SLM.

5.3 LIVELIHOODS ASSESSMENT

Particularly with poor land-users in marginal areas (common in the drylands) there are many factors relating to resource and market access, institutional and policy environment (e.g. rights and tenure) and the characteristics of poverty itself that influence the perspective land-users have on his/her land resources. These factors can enhance or constrain their ability to practice sustainable land management, land degradation control or rehabilitation.

The socio-economic (livelihoods) component of this assessment aims to deliver an improved understanding of how socio-economic, cultural and institutional factors influence land-users' views and management of their land resources. A guide to conducting a livelihoods interview, likely to be relevant in many study areas, is provided **in Part 2 (Tool 7).** Some of the broad questions, relevant in many areas, that the assessment team may attempt to answer using these tools are given here:

- 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 one objective of this part of the assessment is 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 policy).

  The key drivers will differ from place to place. It is important throughout the socio-economic component of the assessment to think frequently about what are the main drivers of behaviour leading to land degradation.

- 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 links to the earlier question above on the importance of understanding the strategy of the land-user. Particular trade-offs frequently form part of adopted land use strategy.

5.4 ASSESSING SOIL DEGRADATION

Soil degradation often impacts directly on provisioning and other key ecosystem services. A good understanding of the condition of the soil (state) the change dynamics and the processes involved is thus required.

Soil degradation occurs as a result of adverse changes in the soil biological, chemical, physical and/or hydrological properties. Such changes can increase the vulnerability of the soil to further degradation. Sheet, rill and gully erosion by water and scouring and deposition of soil, by wind, are visible symptoms of degradation but a number of other degradation processes (e.g. nutrient mining) are not directly visible but very widespread.

Indicators for soil degradation can be identified for these different soil degradation processes:

- soil biological degradation – decline in soil organic matter and biodiversity of soil organisms[6] affecting useful functions of soil (e.g. mineralization, nitrification, nitrogen fixation); increase in soil pests.
- soil chemical degradation - decline in soil fertility, nutrient imbalances and toxicities, soil acidification, alkalinisation and salinisation
- 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;
- degradation of a soil's hydrological properties - water-logging and aridification (decline in soil moisture retention)
- soil erosion- loss of soil through erosion by water- sheet, rill, gully erosion - and by wind and effects of sediment deposits and sediment load in waterways.

There are three main sets of tools for assessing soil degradation:

- Tools 5 and 11. Visual indicators and measurements of soil erosion
- Tools 12.1 and 12.2. Visual indicators and measurements of soil properties

[6] Assessment of biodiversity of soil organisms, particularly micro-organisms, is difficult so cannot be part of a rapid assessment methodology. Simple soil visual indicators are used in this assessment as indicators of soil macrofauna health (earthworm numbers, Tool 12.1).

5.5 ASSESSING VEGETATION DEGRADATION

Vegetation degradation is an important aspect of land degradation although more attention has been paid in the past to soil degradation and water shortage. Vegetation degradation can occur in:

- **grasslands and rangelands**, which cover a large share of drylands, and are largely used for livestock production by agro-pastoralists and pastoralists
- **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; and
- **croplands**, where selected trees and shrubs and areas with herbaceous species are maintained in or along borders of fields and homesteads for various purposes (wood, forage, fertilizer, windbreaks, shade)

In this methodology most emphasis is placed on assessing vegetation degradation in grasslands and rangelands as these are most closely linked to the provisioning services on which land-users rely. Detailed assessments of forests and woodlands are not covered though can be added if particularly important at an assessment site. Similarly, detailed tools are not provided for assessing crops or other vegetation in croplands though these should be visually assessed using indicators proposed in Tool 15.

The most important indicators of vegetation degradation are:

- Reduced vegetation cover (plant and litter)
- Changes in vegetation structure and plant community composition
- Decline in species and habitat diversity
- Changes in abundance of indicator species (e.g. of high or low pasture quality or poor soil quality and invasive species).
- These are in turn linked to land productivity in terms of biomass and quality of products and in pasture/ rangelands also in terms of livestock productivity.

These are briefly discussed below:

Plant and litter cover

Directly affects infiltration, runoff and erosion rates as well as soil organic matter and nutrient restoration and hence will affect productivity, the wider hydrological cycle and capacity to cope with climate change especially drought (rainfall variability and increased temperatures).

Vegetation structure and composition influences water use efficiency, use of the soil profile and nutrients 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 and the deep soil profile and protect the ground from erosion more than a field of cereals;
- compared to grassland, a wooded savanna provides shade and exploits the deep soil profile for water and nutrients and may provide a cooler microclimate.

Vegetation diversity

Biodiversity degradation can be assessed at three levels:

- **Reduced habitat diversity** is reflected by fewer habitat types in the study area, which may be due to fragmentation of farms, fields and grazing lands and reduced farm size which will drive intensification and reduce farmer options to maintain natural vegetation on the farm. Implications could include loss of wild foods and other useful plants and loss of ecological functions such as pollination and beneficial predation;
- **Loss of or reduced species diversity** means a reduced number of species in a given area. It can be measured at a particular time in pasture/ range/cropland or over a year or several years e.g. a crop or grazing rotation. Implications could include reduced adaptive capacity and increased vulnerability to drought or climate change.
- **Loss of or reduced varietal/land-race diversity** means fewer plant varieties or livestock species and breeds being used in a given area e.g. study area or farm.

Particularly in marginal areas, plant genetic diversity plays an important part in traditional livelihood strategies of dryland populations by contributing to stability of yield of crop or livestock enterprises, adaptation to local environments, 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 sustainable use in traditional farming systems, and the diversity within them is usually much greater than is the case with commercial farming.

Much of the information on trends in species diversity will come from the community, particularly for species with economic value.

A broad consideration of the impacts of LD/SLM on biological diversity (plants, animals, microbes) and related ecosystem services is covered as part of the analysis in section 6. Plant biodiversity (species and habitat) in rangelands and woodlands is considered to a limited extent in the field assessments but detailed inventories are beyond the scope of a rapid assessment.

Plant Indicator species

Specific plant species can indicate various aspects of land resources quality, notably,

- increase in invasive species ; these may be "colonising" species that benefit from the reduced competition that follows habitat degradation and they may be more tolerant of grazing or burning;
- change in share of noxious/unpalatable species for livestock or nutritious pasture/browse species;
- increase in weed species 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;
- decline or loss of other useful species (fuel wood, thatch, medicinal etc.).

Vegetation quality and productivity

In cropping and forest systems, the productivity is largely determined by soil properties but can also be assessed through crop measurements and identifying symptoms of crop deficiencies or damage by pests or diseases. In pasture and rangelands, vegetation quality is the most important component of the land for the land-users, as it is directly linked to livestock productivity which is the main livelihood activity on which rural populations depend in dry-lands. After assessing vegetation degradation in pasture and rangelands (veld) it is important to look at the effects of this degradation on livestock productivity **(Tool 13.2** and **Annex 1** of **Part 2**). It is important to identify any relationships between intensity and type of management practices and the condition (health) of the pasture/rangeland or wood/forestland as well as its sensitivity/ resilience to degradation.

Seasonality and inter-annual variability

Vegetation growth is dynamic and determined by meteorological as well as geological and topographical factors. 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. high altitude), landscape diversity and the problems of sampling very large areas, as well as issue of livestock mobility.

The assessment indicators and methods are described in

- Tool 4. rapid vegetation assessment, as part of the study area characterisation and
- Tool 13. Detailed vegetation assessment for the selected assessment sites.

5.6 ASSESSING WATER RESOURCES DEGRADATION

Water resources, their management and degradation will be important land resource components in most dryland assessment sites. Water resources degradation and effects of land degradation on water, should be assessed in more depth in areas where this is reported to be a critical issue. Of particular concern:

- effective use of rainwater for direct consumption, for productive purposes and for recharging surface and ground-water supplies
- reduced water quality through pollution and over-exploitation (by domestic, agricultural, forest and industrial users).
- reduced water quantity/availability for consumption (human and animals) and other uses
- maintenance of the hydrological regime – in catchments and watersheds (an important ecosystem service).
- extent and performance of water resources management alongside soil and land use/ vegetation management for mitigating effects of desertification and drought/climate change.

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 problematic. This is therefore one of many parts of this assessment where it is important to triangulate direct observations and measurements with secondary data (e.g. from rainfall records and water boards) and with more qualitative information derived from land-user accounts to build up a reliable picture of water resource status and trends and to draw on secondary information from water, agriculture and health authorities.

This assessment focuses on obtaining information on water resources degradation from several main areas:

- Data obtained from secondary data and key informants, backed up if possible by information from land users/households, on:
    - Climatic conditions seasonality and trends - rainfall, evaporation, drought, flood Water management practices such as water 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
- 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;
    - Water quantity/availability from different water bodies, for different users, and uses;
    - Pressure/demand on water: water use/consumption, water withdrawal/abstraction, proportion of illegal water withdrawals, water infrastructure;
    - 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 during the assessment, where:
    - On-site causes include: use pressures on the water body, removal of protective vegetation, overgrazing or cultivation around the water body; or changes to the water body through drainage, irrigation or other infrastructure or due to natural events such as erosion or floods.
    - Off site causes may include changes in land use that affect the upstream/ catchment area such as: fertilizer or agro-chemical run-off from farmland or other pollutants that affect water quality; change in water regime (increased floods; reduced flows or change from perennial to seasonal flow); damming for water storage, irrigation or recreation.

The indicators and methods are described in:

- Tool 6. Rapid overview of water resources degradation
- Tool 14.1. Key informant interview on water resources
- Tool 14.2. Semi-quantitative assessment of water resources
- Tool 14.3. Additional assessment of specific water body degradation

5.7 ASSESSING LAND RESOURCES - PRODUCTIVITY INTERRELATIONS

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

The assessment will generate information on the condition and change dynamics in the important land resources components. Some direct measurements of productivity may be possible but the knowledge of local land users/experts will be very important in liking the biophysical information to effects on productivity, for example identifying species or other variables that indicate high and low quality pasture and good or poor soil conditions. Such information can be availed during community focus group discussion and from informants during transect walks. Older people in the community tend to have a particularly rich knowledge of these linkages.

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 and effects of climate change and for information on yields /productivity of crops and livestock in the area.

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 remote-sensed data. Likewise long term trends in rainfall and water resources can be obtained from water boards and authorities and meteorological offices. The aim is to triangulate the various pieces of information for validation purposes.

The indicators and methods that can be used for assessing effects of land degradation on productivity are specific for croplands, grasslands and forest lands

5.7.1 Cropland degradation and effects on 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 (Table 4).

Table 4 Degradation processes in croplands

Degradation type	Indicators
Soil biological degradation	– loss of soil OM decline in plant nutrients
Soil chemical degradation	– increase in salt levels (salinisation); chemical toxicity (excess fertilisers, agro-chemicals)
Soil physical and hydrological degradation	– loss of soil physical structure (compaction, crusting, excess tillage); – water-logging due to impeded infiltration or a high water table; inadequate retention of soil moisture;
Soil erosion	– splash, sheet, rill and gully erosion (water erosion); and – removal of topsoil by wind action and subsequent deposition of wind blown soil particles (wind erosion).
Water resources degradation	– reduction in the quantity and quality of the ground and surface water resources available for irrigation.

These factors will all affect productivity and can be assessed through looking at yields, growth characteristics and nutrient deficiency symptoms in crops (Tool 15)

5.7.2. Rangeland degradation, productivity and 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 though other forms of degradation contribute (Table 5).

Table 5 Degradation processes in grass/rangelands

Degradation type	Indicators
Vegetation and biodiversity degradation	– reduction in biomass of grasses and other herbaceous plants; – replacement of high value fodder species by those of lesser value; – reduction in protective vegetative cover /increase in bare ground – impoverishment of natural grassland vegetation - decline in species and reduced vigour of remaining plants – destruction / disturbance of grassland habitats due to unregulated grazing.
Soil biological degradation	– loss of soil organic matter associated with the decline in vegetative biomass and ground cover; – soil fertility decline – nutrient removal by grazing and fodder harvesting exceeds that returned in animal manure;
Soil chemical degradation	– salinisation following overgrazing and removal of deep rooted vegetation;
Soil physical /hydro-logical degradation	– surface compaction and loss of topsoil structure through the impact of animal hooves
Soil erosion	– increased water and wind erosion following the loss of the protective vegetative cover.
Water resources degradation	– reduction in the quantity and quality of the ground and surface water resources available for irrigation.

Changes in the vegetation (Tool 12) address declines in the percentage and absolute number of desirable (palatable) species, combined with decline in plant vigour leading to less forage biomass production. In the case of rangelands this will result in a decline in condition or quality and a reduced livestock carrying capacity. (Tool 13.2 and Part 2 Annex 1). In turn this has an adverse effect on livestock productivity with livestock owners finding that they can keep fewer animals within the same area of rangeland or that animal condition declines.

Box 5. Sequence of stages in rangeland deterioration

The deterioration of rangelands through overgrazing and/or excessive uncontrolled burning usually takes place in the following sequence (after Ivy, 1969)

i. An adverse change occurs in the species composition of the rangeland. The original stand of closely spaced vigorous perennial grasses which provide an almost complete cover of litter between the grass bases deteriorates, frequently by reduction in the number of palatable species and a corresponding reduction in the total number of species present.

ii. The vigour of perennial grasses declines; many of the larger tufts die (mortality) and fewer seedlings of the desirable species survive (regrowth), while undesirable species of perennial and annual grasses increase in number.

iii. In consequence, the amount of litter and soil cover decreases, this exposing the soil surface to excessive raindrop action. The soil surface becomes compacted and run-off and sheet erosion becomes evident.

iv. Water infiltration into the soil is reduced and further mortality of perennial grasses follows. The amount of bare ground increases, sheet erosion is accelerated, and gullies may start to develop. In locations favourable for the growth of trees and shrubs woody vegetation begins to colonise the bare patches of ground.

v. Patches of bare soil become larger, the soil surface becomes more compacted, infiltration decreases further, and run-off and erosion increases. As the infiltration of rain water diminishes the vigour of the remaining grasses is further reduced. Annual grasses are predominant at this stage. Bush encroachment is accelerated. A further complication is provided by an apparent increase in the activities of harvester termites, whose importance increases as the productivity of the habitat declines.

vi. Run-off and the incidence of induced drought conditions continue to develop. Sheet and gully erosion become more widespread and once permanent streams become intermittent. In the latter stages, trees may die, desert like conditions develop and any thought of production based on the use of the natural grazing has to be abandoned.

5.7.3. Forest/Woodland degradation and effects on 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 take a number of forms:

- Loss of productive forest/wood lands from clearing and conversion of forest/ woodland to other uses, notably for crop and livestock production, or for the building of houses, factories, roads etc.

- Impoverishment and reduced vegetative biomass of forest/woodland areas through over-harvesting - fewer trees and shrubs at lower density; reduced vigour - smaller branches and stems, and less leaves, flowers, fruits, seeds, etc.; and decline in number and productivity of non-woody species, resulting in reduced diversity and yield of forest products - traditional and non traditional).

- Overall reduction in the quality of the vegetative biomass through over harvesting – although the total biomass may be about the same, plant species of high value (for fodder, timber, fuelwood, food, medicines, etc.) will have been replaced by species of lower, or no value.

- Degradation of individual plants through poor harvesting practices– damaged trees/shrubs through excessive removal of above, and below, ground parts for timber, fuelwood, fodder, fruits, food, medicine etc.

- Adverse effects of laws/regulations: The placing of formerly productive forest areas under strict protection or preventing harvesting of forest products in other ways (e.g. through logging bans) may increase pressure on accessible areas.

The major land degradation processes involved in forest degradation are summarised in Table 6.

Table 6 Degradation processes in forest/woodlands

Degradation type	Indicators
Vegetation and biodiversity degradation	– reduction in total biomass of trees and shrubs; – replacement of high value tree and shrub species (for timber, fuelwood, poles, fruits, medicines etc) by those of lesser value; – reduction in protective leaf litter and herbaceous ground cover; expansion of bare ground under trees and shrubs; – impoverishment of natural forest/woodland vegetation - decline in species and reduced vigour of remaining trees and shrubs. – destruction and disturbance of forest/woodland habitats – loss of habitat/species due to unregulated harvesting of forest products
Soil biological degradation	– loss of soil organic matter associated with the decline in leaf litter and herbaceous ground cover; – soil fertility decline as the forest’s natural soil nutrient recycling process is disrupted by harvesting and removal of forest products
Soil erosion	– increased water and wind erosion following the loss of the protective leaf litter and herbaceous ground cover
Water resources degradation	– Forestland degradation in upper catchment areas can also contribute to water resource degradation

6. Analysis and Reporting on the Local Land Degradation Assessments

6.1 Introduction to the Analytical Process

Many of the more interesting results of the assessment are generated by the synthesis and analysis of the results. This section offers guidelines on this analysis and on reporting. The proposed structure should not be viewed as too rigid, however; there may be good reasons for structuring the report and analysis differently, according to local needs.

Data and information storage

The assessment will generate a mixture of quantitative and qualitative data that will be recorded with aid of the data recording sheets, supplemented by sketches and maps, annotated transect diagrams, and other relevant information from previous or ongoing studies in the local study area. The LADA project aims to provide a prototype database that can be readily adapted by countries for the compilation and analysis of descriptive and analytical data generated by the local assessment. The information and indicators on the recording sheets will be coded to simplify systematic collection, input and analysis of data.

Analytical frameworks

We recommend that the team uses the DPSIR as the main framework to help with analysis and presentation of data. As discussed in section 4, this framework can be quite logically applied at the local level and help link together the results from the different elements of the assessment. It also articulates well with two other conceptual frameworks used in this assessment: the Sustainable Livelihoods (SL) framework and the Ecosystems Services (ES) framework (both are outlined in section 4).

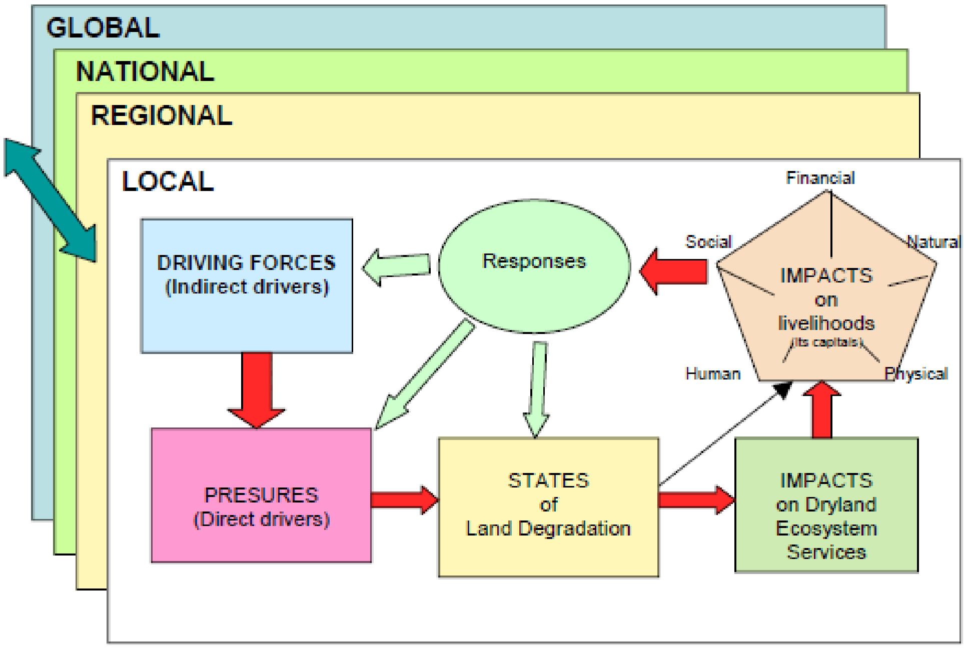


Figure 2 repeat. The DPSIR Framework Applied to LADA

Outputs

The intended LADA-L outputs are listed in Annex 1. The main output is a comprehensive report of each study area (20-30 pages in length plus annexes) .The actual scope and content will depend on the purpose for which the local land degradation assessment is conducted which may vary between countries and locations. The following section concentrates on the preparation of the study area report. At the end of this section, some additional comments are made on reporting at the wider GAA level.

6.2 ANALYSIS AND REPORTING STRUCTURE FOR STUDY AREA REPORTS

The DPSIR framework in association with the SL and the ES analyses is used to help conduct an integrated analysis of land degradation/SLM. **Figure 5** illustrates how DPSIR can be used to link together the different data sets collected by the assessment. It will often be logical to move from step 1 through to 5 when structuring the reporting . The principal sections in the report are considered in sequence below:

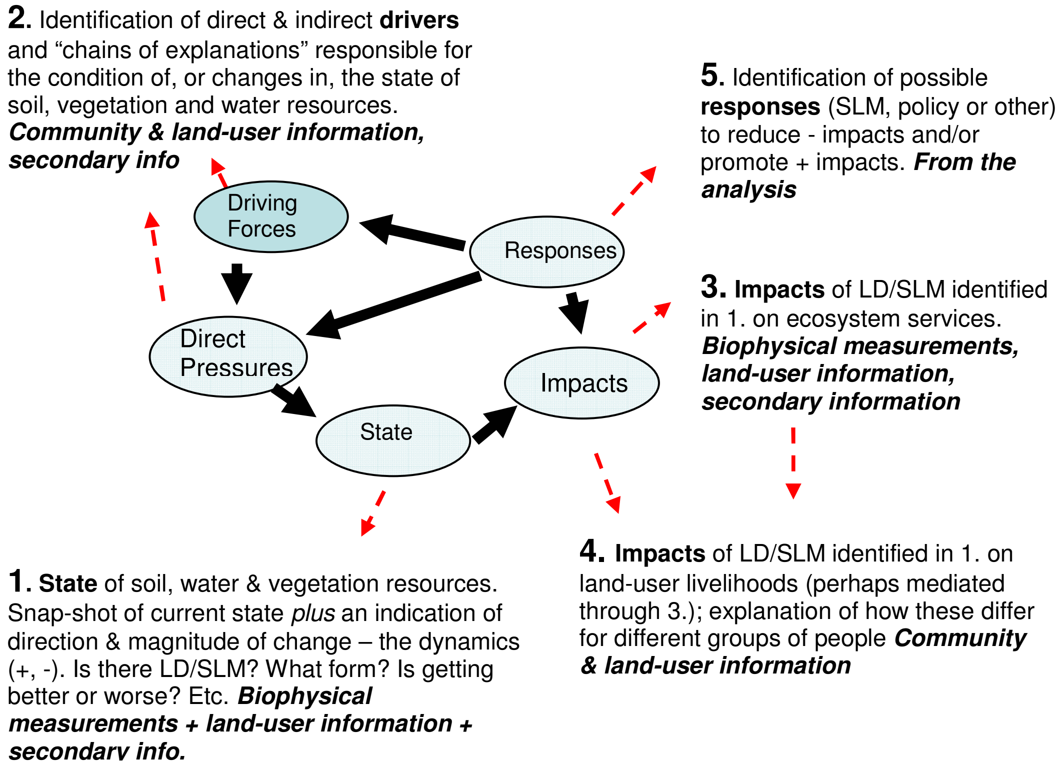


Figure 5. Linking and synthesizing results using the DPSIR framework.

6.2.1 Introductory section

Aspects to include:

- Most important here is to explain the rationale and the process by which the study area was selected and how it fits as a representative sample of the GAA.
- Describe the assessment team composition (covering skills and background of team members) and key elements of the pre-assessment planning.
- Refer to significant existing work relevant to LD/SLM in the area.
- Summarise the approach, highlighting where the LADA-L methodology was and was not followed, i.e. reasons for omissions, additions, changes; problems encountered etc.

– There may (or may not) be specific concerns or questions concerning LD/SLM in the study area that the team hopes the assessment to address (e.g. an explanation of productivity decline in a once productive area). Introduce such concerns here.

6.2.2 Characterization of the study area

The study area can be characterized using the secondary information (from projects and relevant statistics from the district or province if available) and the information collected through the community focus group discussion and mapping (e.g. rainfall amount and distribution and perceived changes, population trends, average farm size, livestock numbers, mortality and management practices, crop production and yields, access to resources and implications of land degradation).

The section will be largely descriptive covering areas such as

- location, population and settlement history (including cultural and socio-economic stratification, demographic trends etc.);
- main forms of land-use: grazing, crop cultivation etc.
- main sources of livelihood; degree of diversification within and outside agriculture. and food security;
- development activities in recent past (last 10 years);
- important formal and informal institutional features identifying changes and trends in the last 5-10 years (land tenure/access regimes; community governance);
- credit and financial aspects; religious institutions);
- indicators of wealth/poverty (to be used for wealth ranking);
- community organizations (e.g. commodity groups, forest or livestock committees); marketing opportunities and restrictions;
- main/ common land related problems and constraints and implications in terms of livelihood strategies (past, present and trends) identifiable at the community level
- identifiable gender / socioeconomic differentiation in land resources management.

This section should contain the participatory community territory map (Tool 2) complemented by a sketch map showing the more detailed characterisation of land units and where possible facilitated by support maps (topographic, soil, etc.) or remote sensing images. These should display as much information as possible, including location of key resources, main areas and types of land degradation, main conservation/SLM measures and detailed study plots.

The study area characterisation should also contain the transect as well as tables/ graphs and figures illustrating specific findings such as climatic, demographic trends based on secondary data. The transect diagram can be further illustrated using a Google Earth image on which the different landscape features, land units, land use types, severely degraded or restored areas can be annotated. See Tool 1b for the characterization of the study area during the focus group discussion.

6.2.3 State of the land (and trends)

This is the section for reporting the analysis of the state of the land resources along with some perspective on magnitude and direction of recent historical change. The term "recent" here (and 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. Though some flexibility is required as, in some cases, specific events may have had significant implications on LD/SLM in a longer period, say the last 20 years or so.

There should be both qualitative and quantitative information available. The quantitative and semi-quantitative data from the biophysical assessments (soil, vegetation, water, landuse-crop/livestock, etc.) should be integrated and triangulated with the information from the group discussions 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 often provide an historical context for the LD/SLM observed.

In many cases information on a particular land resource component or on land degradation process will be generated by several different tools. e.g. The community discussion (Tool 1), the Livelihoods and land user interviews (Tools 7 and 9), the soil erosion tools (Tools 5 and 11.1) and the vegetation assessment tools (Tool 13) 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.

The comparative sampling strategy will also aid interpretation of results. For example A good understanding of the state and recent dynamic of land resources supported a comparison of an degraded area with a better managed area and or an untouched protected area, will allow something to be said about 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 will not be possible to do this in a sophisticated way using only the data provided by this methodology but some elementary scenario development will be possible.

This section should include diagrams, graphics and pictures to present the data collected (soil scoring, vegetation, soil testing in the field, VS-Fast score sheet)

6.2.4 Driving Forces & Pressures

This section tracks back from observations made on the state and dynamics of the key land resources to the causal factors – the pressures (direct) and the driving forces (indirect).

The focus group discussion and the key informants and household interviews 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.

A simple procedure is described below to help with analysis of LD/SLM driving forces and pressures.

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 7 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 5 = most critical). Discuss these further, in as much detail as possible, using specific examples from the assessment results.

Table 7 Recording main direct causes of land degradation in the study area (place codes after the text throughout list)

Direct causes /pressures of degradation	Relevant	Major
s: Inappropriate soil management		
cultivation of highly unsuitable / vulnerable soils (s1)		
(s2) lack or insufficient soil conservation/runoff and erosion control		
(s3) heavy machinery (including timing of heavy machinery use)		
(s4) tillage practice (ploughing, harrowing, etc.)		
(s5) others (specify under column h - Remarks)		
c: Inappropriate crop and rangeland management (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 column h) Remarks)		
f: Deforestation and removal of natural vegetation 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 column h) Remarks)		

Direct causes /pressures of degradation	Relevant	Major
e: Over-exploitation of vegetation for domestic use and hence poor protection through:		
(e1) excessive gathering of fuelwood, (local) timber, fencing materials		
(e2) removal of fodder		
(e3) others (specify under column h) Remarks)		
g: Overgrazing (i.e. leading to a decrease in plant cover, fodder quality, soil compaction and in turn soil productivity decline and erosion.		
(g1) excessive numbers of livestock		
(g2) trampling along animal paths		
(g3) overgrazing and trampling around or near feeding, watering and shelter points		
(g4) too long or extensive grazing periods in a specific area or camp leading to over-utilization of palatable species		
(g5) change in livestock composition: from large to small stock; from grazers to browsers; from livestock to game and *vice versa*		
(g6) others - specify		
i: Land used for Industrial activities and mining (i.e. leading to loss of land resources and their functions for agriculture, water recharge, and causing damage offsite through pollution, etc.		
(i1) industry		
(i2) mining		
(i3) waste deposition		
(i4) others - specify		
u: Land use for urbanisation and infrastructure development (i.e. leading to loss of land resources and their functions for agriculture, water recharge, and causing damage off-site through high runoff, erosion, pollution, etc.		
(u1) settlements and roads		
(u2) (urban) recreation		
(u3) others (specify under column h) Remarks)		
p: Discharges 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		
q: Release of airborne pollutants from industrial activities, mining and urbanisation **leading to:**		
(q1) contamination of vegetation/ crops and soil		
(q2) contamination of surface and ground water resources:		
(q3) others - specify		
w: Disturbance of the water cycle 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		

Direct causes /pressures of degradation	Relevant	Major
(w2) others (specify under column h) Remarks)		
o: Over-abstraction / excessive withdrawal of water:		
(o1) irrigation		
(o2) industrial use		
(o3) domestic use		
(o4) mining activities		
(o5) decreasing water use efficiency		
(o6) others (specify under column h) Remarks)		
n: Natural causes:		
(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.)		

Step 3: Carry out the same exercise to identify the indirect causes of degradation in each site using the list in Table 8 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 5 = most critical). Discuss these further, in as much detail as possible, using specific examples from the assessment results.

Table 8 Recording indirect causes (drivers) of land degradation in the given site (place codes after the text)

Indirect causes/drivers of degradation	Relevant	Major
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.		
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.)		
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.**		
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)**		
Labour Availability (l): **Shortage of rural labour (e.g. through migration, prevalence of diseases, out migration) can lead to abandonment of traditional resource conservation practices such as terrace maintenance. May also alleviate pressure on land resources.**		
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.**		
Education, access to knowledge and support services (e): **Educated land users are less likely to be poor and more likely to adopt new technologies. Land users with education often have higher returns from their land. Education can also provide off-farm labour opportunities.**		
War and conflict (w): leading to reduced options for using the land and reluctance to invest .		
Formal institutions (gf): formal laws, policies controlling access and use of land resources. Government induced interventions.		
Informal institutions (gi): local rules and regulations, social and cultural arrangements & obligations affecting access to resources.		
Others (o): (specify under column h) Remarks)		

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, for example as described in Box 5 below. These interrelations are particularly important if they affect a large number of land-users or if they are found in several land use types or study areas.

Box 6: Example of direct and indirect drivers of LD: 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 her 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 problem 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*.*

6.2.5 Impacts on Ecosystem Services and Livelihoods

The DPSIR framework encourages us to look at 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 effects of LD/SLM on the main provisioning services (particularly food from crops and livestock) as these capture the main productive uses people derive from their land resources and can be more readily assessed at any time of the year. However, it is important to think more broadly about ES impacts. The analysis should generate some information on important regulating, supporting and cultural services from which it will be possible to infer 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- nutrients and carbon, etc.).

A procedure is provided below to help those responsible for the analysis to do a simple analysis of LD/SLM effects on some key ecosystem services. A simple scoring system is provided to assess and prioritize, through detailed discussion, those impacts believed to be most significant.

The information on ES impacts will be derived largely from qualitative information from the 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 water resources, vegetation (biomass quantity and pasture quality) and crop, livestock and tree/forest productivity.

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 11 below and for each suggested indicators and possible proxies are given

Step1: For each sample site, assess the **type of ES impact (I[7])** caused by LD/SLM according to the list of potential impacts in Table 9. Impacts should be assessed in areas with land degradation compared to areas without land degradation (e.g. areas that are already well conserved).

Step 2: For each type of impact identified determine the **level of impact** from -3 to +3. 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 downstream.

Step 3: Identify and, if possible, rank in importance a few of the most significant ecosystem service impacts identified in the study area. Discuss these further, in as much detail as possible, using specific examples from the assessment results.

[7] Refers to indicators of DPSIR framework of degradation and conservation in Annex 3.

Level of impact on ecosystem services:	
-3	High negative impact: land degradation contributes negatively (>50%) to changes in ES
-2	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.
1	Low positive impact: land degradation contributes positively (0-10%) to the changes in ES
2	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.

Step 4: Take care to consider whether the effects of degradation have been partially hidden by various response measures by the land users. For example, fertilizers may be partly used to compensate for the productivity loss caused by soil erosion and nutrient loss; or the treatment of polluted water may be used to compensate for the loss of water quality. Conversely, other factors that are not related to degradation may contribute to yield declines (e.g. pests and diseases, weather influences). When considering the impact of degradation over a longer period (e.g. 10 years) such influences will mostly be levelled out.

Step 5: Provide any additional information on the land degradation impacts on ecosystem services.

Table 9 Recording Types and Level of Impacts of Land degradation on Ecosystem Services

Type of impact on Ecosystem services	**Level of Impact**	**Description of impacts of land degradation 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 and indicators*		
a) Hydrological services:		
(E1) regulation of excessive water such as excessive rains, storms, floods e.g. affecting infiltration, drainage, runoff, evaporation, etc.		
(E2) regulation of scarce water and its availability eg 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 (eg sealing and crusting) and subsoil affecting infiltration,		

Type of impact on Ecosystem services	Level of Impact	Description of impacts of land degradation on ES
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		
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 and indicators		
(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 selected from the Millennium Ecosystem Assessment

6.2.6 Impacts on people and their livelihoods

Land-users create many of the pressures on the state of land resources and also suffer the consequences of the impacts on ecosystem services. The livelihoods component of this assessment provides detailed information in both these areas. 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. This section describes a procedure for using the information on wealth/poverty indicators obtained from the community discussion to identify relevant associations between:

a) wealth/poverty and land-user activity that causes LD/SLM
b) wealth/poverty and the type/severity of impacts

In most situations, “wealth” will be the most useful way to stratify the sample of land-users interviewed in the study area. However, other social groupings such as gender, ethnic group, age, etc. may also be relevant in many areas.

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 asses are given in **Table 1**0. These should illustrate the differences between different categories of land users (better off, average and poor). Any association between LD/SLM or impacts felt and wealth groups should be identified and discussed.

Table 10: Typical Indicators important in determining relative wealth

Capital Assets	Indicators*
	Household Level
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 network, Association, membership organisation, peer group network, Access rights (land/water), Access to technical assistance, Access to market, Access to financial services, Access to health, Access to education, Access to drinking water and sanitation

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

Step 2: Give each household a score 1-10 for each capital asset and fill in **Table 1**1 using Excel

Table 11: Summary scoring (1-10) of most relevant indicator(s) for each asset

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

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.

6.2.7 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.

Feedback loops exist between 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.

Positive Responses to LD

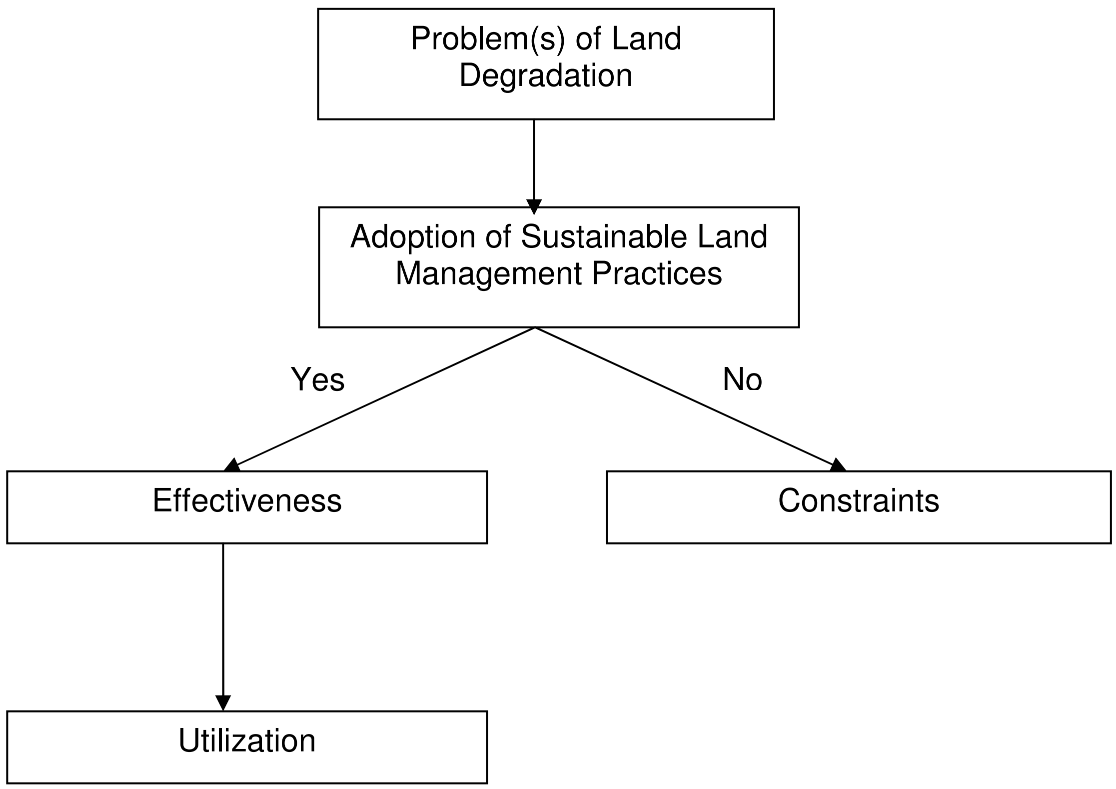


Figure 6: **Interactions between land degradation and adoption of sustainable land management practices**

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 (Table 12).

Table 12: Sustainable Land Management Practices

Land Degradation Problem	Sustainable Land Management Practice	Conservation effectiveness +, neutral or -	Extent of uptake by land users in the GAA (%)	Constraints to Adoption

Constraints: No perception of land degradation. No incentives to adopt SLM practices (e.g. insecurity of tenure, seasonal migration, etc). No capability to remedy (e.g. land shortage, labour unavailability lack of capital) etc.

Box 7: Costs and benefits of soil erosion and conservation

Soil erosion involves a cost to land users in terms of declined crop yield or increased input demand in order to maintain the same yield. By preventing soil erosion through conservation measures a benefit is derived for the land user in terms of yields and easier farming practices.

Comparing the costs and benefits of soil erosion and conservation is essential for land users to make decision on when and where conservation measures to be taken. Most of conservation measures involve extra costs, either labour, material or the land forgone. To determine which conservation measure is more appropriate, a cost-benefit analysis for conservation measures is often needed.

There are a number of powerful cost benefit tools that can be used to quantify the costs of land degradation (Box 7) and the benefits of control (see Stocking and Murnaghan, 2001 for discussion) and these can be used in the analysis if useful.

6.2.8 Conclusions and Policy Recommendations

The recommended responses can be discussed in this section of the report: 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.

Finally, common and/or contrasting findings from each study area in the GAA are highlighted. If there are findings common to all the areas sampled in the GAA then it may be possible to roughly extrapolate from the GAA to a larger regions or similar areas.

Table 13 summarises the guidance on report structure illustrating the over-arching role of the DPSIR framework and the source of information for each section.

Table 13: Report Structure, Analytical Tools and Information used

Structure of the Report	**Tools and information used for the analysis**
1. Introduction	Reason(s) for selecting the area • Land degradation problematic • National priority
2. Characterization of the area	• Secondary Information of the area • Community Focus Group Discussion • Transect
3. State of the land (& Trends)	• Soil degradation and productivity • Soil properties • Vegetation • Water • Ecosystem services • Key informant interview
4. Driving forces and Pressures (indirect and direct causes of land degradation)	• Secondary Information of the area • Community Focus Group Discussion • Key informant interview • Household livelihoods Interview
5. Impacts of land degradation	
5a. Impacts on Ecosystem Services	• Transect • Ecosystem services • Key informant interview
5b. Impacts on Livelihoods	• Community Focus Group Discussion • Key informant interview • Household livelihoods Interview
6. Responses	
6a. Positive Responses	• Community Focus Group Discussion • Key informant interview on SLM • Household livelihoods Interview
6b. Negative Responses	• Household livelihoods Interview
7.Conclusion and Policy Recommendations	• Community Focus Group Discussion • Key informant interview

Reporting at Geographic Assessment Area level

The report for the GAA will contain reports for the separate study areas and one or more sections drawing out common or contrasting findings from the study areas and extrapolating from these to the GAA level. It is also essential to explain the rationale and the process through which the GAA was selected (does it contain LD/SLM interest of national importance? Is it a national priority area? The introductory section should also explain the choice and diversity of study areas within it.

Annexes to Part 1

ANNEX 1: OBJECTIVES AND APPROACH OF THE LADA PROJECT

Summary of objectives and approaches of the LADA project[8]

LADA Project Objectives and Outcomes

In conducting LADA-L it is important to understand where and how it fits into the overall LADA project which is also being implemented at global and national levels. LADA has two principal objectives:

- **LADA Objective 1:** To develop and implement strategies, tools and methods to assess and quantify the nature, extent and severity of land degradation and the overall ecosystem resilience of dryland ecosystems at a range of spatial and temporal scales. The assessment will integrate biophysical factors and socio-economic driving forces.
- **LADA Objective 2:** The project will build national, regional and global assessment capacities to enable the design and planning of interventions to mitigate land degradation and establish sustainable land use and management practices. These objectives are expected to overcome current policy and institutional barriers to sustainable land use in dryland zones and establish incentives to promote the accrual of global biodiversity benefits at national and local levels.

The LADA project has four main outcomes (or planned results) that relate to its objectives. These outcomes are all relevant for LADA-L.

1. **To develop, test and disseminate an improved needs-based and process-driven approach to drylands degradation assessment**. An initial step in achieving this result will be to adopt a standardised methodological and conceptual framework for the assessment of land degradation and its impact in drylands, with guidelines for their implementation in a range of scales.

2. **To present baseline ecosystem (or regional) and global assessments of land degradation for drylands**. Identifying the baseline at a variety of scales is critical to measure how far remedial actions for both the processes of land degradation and its impacts have changed the degradation status. The steps required are: baseline data collection onto an accessible and user-friendly platform, production of baseline maps, and listing of nationally agreed 'hot-spots' and 'bright-spots'.

3. **The delivery of detailed local assessments and analysis of land degradation and its impact.** In order to balance the addressing of critical areas for land degradation) with the learning from areas that largely control /prevent land degradation), local assessments will select from both situations, thereby providing a better platform for linking LADA-L information with policy at national level. To achieve balanced local assessments, training and capacity-building in detailed assessments and analysis will be undertaken along with in-country user-needs assessments. Each participating country will initiate detailed assessments for at least two sites, supported by national-level

[8] **Ref:** Ponce-Hernandez P and Koohafkan P. 2004. Methodological Framework for Land Degradation Assessment in Drylands (LADA), (simplified version), FAO, Rome.

policy forums to create the linkage processes to local bye-laws, national planning and development practice. The process must commence with training of relevant professionals in land degradation assessment, impact analysis and related developmental factors.

4. **The promotion of action and decision-making for the control and prevention of land degradation in drylands using LADA products**. The first step is the design and demonstration of a generic framework for the analysis of critical aspects of land degradation. Success narratives are then analyzed and presented, linked to the policy process.

Through these expected outcomes LADA will meet its principal objectives and its environmental goals of identifying appropriate SLM practices and conservation measures to address land degradation and interventions to address bottlenecks and constraints which will in turn contribute to catalyzing widespread adoption of comprehensive management interventions, notably through having both a validated system of land degradation assessment and the trained people to deliver improvements over and above the baseline condition.

LADA Methodological Approach
LADA follows a participatory, decentralized, country-driven and integrated approach and makes ample use of participatory rural appraisals, expert assessment, field measurements, remote sensing, GIS, modelling and other modern means of data generation, networking and communication technologies for sharing of information at national and international levels.

Key elements of the approach are:
- Participation and inclusion of different perceptions of land degradation,
- Combination of expert assessment & local knowledge,
- Use of adapted assessment tools for specific environments.

The LADA Process - 7-Steps and 12 Major Tasks

The LADA approach and framework comprises seven sequential steps on how to set about implementing the LADA project and 12 major tasks or core sets of activities that describe methodological and procedural options for executing the land degradation assessment. See **Table 12**

Table 12 The LADA 7-Step Approach and the LADA Framework 12-tasks

Steps in the LADA approach	**LADA framework tasks or core set of activities**
Preparation of initial studies	Definition of area and scale
Establishment of national LADA task force	
3.Stocktaking and preliminary analysis	Select Indicators Select methods, procedures and tools Collect existing data and identify data gaps Stratify or partition variability
Developing stratification and sampling strategy.	Design and implement a data collection strategy for missing data
Field survey and local assessments	Analyse data

Steps in the LADA approach	LADA framework tasks or core set of activities
Development of a LADA decision-support tool	Integrate results Identify “hot spots” and “bright spots” Validate results and assess accuracy Map out and report results
Development of a LADA monitoring tool	Monitor changes over time

The 12 major tasks or core set of activities:

1. **Definition of area and scale**: Identify and delimit areas for the assessment and define the working and reporting scales.
2. **Select Indicators**: Identify (from the LADA list or LADA indicators DSS) the set of indicator variables relevant to the selected assessment scale. Include other local indicators and complement the indicators list as appropriate.
3. **Select methods, procedures and tools:** Select from the LADA toolbox the applicable thematic module(s) with the methods, procedures and tools needed for the assessment at the selected scale, according to the indicators identified.
4. **Collect existing data and identify data gaps**: Gather and compile existing relevant data (spatial and attribute) and databases (include satellite imagery, if applicable), identify data gaps and compare to recommended minimum datasets.
5. **Stratify or partition variability:** Stratify variability (bio-physical, socio-economic) in the area into relevant units (zones, terrain/landscape units, land use, etc.) to be assessed.
6. **Design a data collection strategy for missing data:** The data collection strategy should be consistent with data needed and in agreement with technology, local capacities and desired accuracy by: a) Designing a statistically-reliable sampling scheme on the basis of the strata or units for location of sampling sites; and b) Collecting data in the field (if applicable) from sampling sites and surveys, for the relevant indicators and scale of the assessment.
7. **Analyze data:** Analyze data by applying the method and tools selected from the LADA-DPSIR framework “toolbox”.
8. **Integrate results**: Integrate results using the LADA decision support tool (documentation and - digital data) and establish causes, impacts and responses: Integrate findings and seek to establish causality, impacts on livelihoods, including the economic costs of degradation.
9. **Identify “hot spots” and “bright spots”:** From the integration of causes and responses to land degradation, identify areas where degradation is being arrested and even reduced i.e. “bright spots and areas where degradation and degradation risk are high, i.e. “hot spots”.
10. **Validate results and assess accuracy:** Undertake implementing ground validation and verification of results, including finding and reporting uncertainties and assessment of accuracy.
11. **Map out and report results**: Map the spatial distribution of land degradation by designing a LADA-explicit legend (or by adopting the legend suggested in the LADA framework), and report findings.

12. **Monitor changes over time**: Design a monitoring strategy consistent with data availability and in agreement with technology, local capacities and desired accuracy.

LADA-L Outputs add to annex on project:

1. A tested/validated methodology and manual for conducting local land degradation assessments in dryland areas. Important characteristics and elements are:

- User friendly format with a clear methodology dealing with site selection and sampling; linking the different elements of the assessment and giving guidance & recommendations for the analysis and presentations of the results.
- A **core** data set of biophysical and socioeconomic data generated through application of a core set of methods with guidance on how to integrate the different data elements. These will be supplemented in individual countries and LD/SLM areas through selection of additional data collection tools to allow the assessment to be tailored to specific conditions and/or country priorities.
- Recording sheets, score cards, tables (e.g. LUS, LUT and plot)
- Guidance on use of the ES, SL and DPSIR frameworks for analysis and presentation of findings and for identifying results and implications with wider ecosystem and/or policy relevance.

2. Reports for each local assessment area (in sections corresponding to community territories/ sample sites) consisting of approximately 20-30 pages and including a description of land use/management practices and their effects on land resources, data on land degradation status and trends and analysis of apparent causes (drivers/pressures), impacts and policy implications (food security, land productivity, and selected ecosystem functions/services). The report should contain tables summarising data and, where appropriate, maps (participatory and GIS) of the LD/SLM areas displaying collected data (location & condition of land resources, land-use data; information on land degradation and effectiveness of conservation/ improvement measures/SLM; location of detailed sample sites, etc.). Institutional maps, asset pentagons, policy process maps etc. should be included where appropriate.

3. A national report combining the data form all the detailed LADA assessments and extrapolating to give a picture of land degradation and land improvement/SLM at the national level. This national assessment should link to (and where possible validate) the national LADA assessments and also draw out policy implications and broader impacts on ecosystem services.

4. One or more policy briefing document should also be planned for each country summarising the key policy implications arising form the assessments. These briefing documents can be aimed at different stakeholders: politicians, NGOs, public etc.

5. A trained multidisciplinary team in LADA pilot countries able to conduct assessments using LADA-L methodology outside of the LADA project and support capacity building in the assessment approach in other countries in their region.

6. A database for the entry and storage of all quantitative and qualitative data generated by the assessments providing a benchmark and basis for monitoring changes/trends. Proposals for the format will be made drawing on FAO and WOCAT experiences, and to decide whether i) a standard database format should be prepared for use and adaptation by each country; by FAO or by a lead country; or ii) if each country should prepare their own database as appropriate. Options are to:

a) Adopt a similar format to the existing WOCAT database and to link the LADA-L database to the WOCAT database; or

b) Adopt a similar format to the INRA database that has been developed through experiences in Kenya (pilot) and Zambia (national) and based on the forest resources assessment database (national and global).

7. At global level a LADA-L report with findings linking local and national assessments and building on inter-country comparisons. This report will:

- Give guidance on links and synergy between LADA-L and other work
- Identify ways in which LADA-L can be taken up by other programmes/projects

- Publicise land degradation issues, causes and implications and giving guidance for possible responses.

8. Printed outputs in the form of one or more book(s), posters, newsletters etc.

LADA-Local Outcomes:

The overall outcome of the local level land degradation assessments should go beyond the specific outputs described above. Thus, it is important that the production of all these outputs is linked to the communications strategy for the LADA project as a whole. Moreover, assessment results should be convincing for policy makers with a view to mobilize decisions regarding policies and interventions and help set priorities at national level, notably, updating and application of national action plans (NAP) and strategies. In particular, it is expected that:

- LADA-L should be applied in all SLM projects to monitor performance and impacts (and thus included in project documents).
- LADA-L results should be convincing to the Global Environment Facility (GEF) and other donors, to Parties to the UNCCD and to other development partners.

ANNEX 2: EQUIPMENT AND TOOLS REQUIRED FOR THE FIELD TEAMS

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 in **Table 13**. The equipment needs to be ordered well ahead of the start of the field assessment as international ordering can take more than one month.

Table 13 Tools/ Equipment required for each field team.

Tools/Equipment	Number	Additional Comments
Compass (360°)	1	- High precision, in degrees - Waterproof and resistant
GPS receiver (Geographic Positioning System) and extra batteries	1	- 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 GAA
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 • 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 (as required several flipchart sheets can be taped to make a larger sheet)
Clipboards for reporting forms	3	To take notes (with plastic bag to

Tools/Equipment	Number	Additional Comments
Field recording forms	As necessary	protect from rain)
LADA-L Field manual		
Notebooks, pens, pencils, marker pens		
First aid kit	1	

Optional tools/equipment (to be decided in country)		
For measuring soil labile C: – Hand held Colorimeter – conical centrifuge tubes (50 ml) – holding rack – plastic syringe (50 ml) – graduated bulb pipettes 5ml – 5 cm3 soil scoop – KMnO4 (crystalline) – CaCl2 (crystalline)	1 20 1 1 several 1 as necessary	- single (550 nm wavelength) - graduated - - - disposable to make 33 mM KMnO4 solution to make CaCl solution
For measuring soil and water salinity – Electrical conductivity meter		
For measuring vegetation size/quality – Diameter tapes for tree diameter – Callipers - shrub stem diameter	1	- Metric, Auto rewind - Metric,
For measuring water quality – Portable water analyzer (EA513-162)	1	To measure pH, dissolved oxygen, conductivity and temperature
Plant press and newspaper	Optional	For safeguard of plant parts

ANNEX 3: ETHICAL GUIDANCE REFERENCE

This summary has been extracted from the ODG/UEA ethical guidance information. The focus is on issues to bear in mind when designing a research project which involves research with people.

Working with People

The safety and wellbeing of research participants must be assured. It is important that people know that you respect their confidentiality and that where possible you will take appropriate steps to preserve their anonymity. You should explain that participation is entirely voluntary and that they can refuse to take part if they wish. In some settings it may be difficult for people to say no, you should be aware of this and do your utmost to ensure that people do not feel obliged to take part or are put under pressure by others to participate in your research.

When planning research with children you must satisfy yourself that you do need to involve children and that you have familiarised yourself with the relevant legal position in the place where you intend to do the research. If you intend to work with children in schools you must obtain written approval from the head teacher or a person who is *in loco parentis.* Where appropriate the researcher should obtain consent from parents to their child's participation, having clearly explained the research to the parents/teachers. Where consent is given by parents it is still very important to try and obtain real consent from the child, assuming that the child is old enough to understand this principle. The researcher should explain to the child that their participation is entirely voluntary and that they can refuse to take part if they wish.

You must obtain valid informed consent from all participants. When recruiting adults or children, the participants should enter into the research freely and willingly on the basis of the information that you have given them on the objectives of the research, the procedures to be followed and the anticipated outcomes particularly in respect of publication and dissemination of findings. The information given should be in the form of a written description of the research project or other appropriate form of communication in non- or semi-literate societies. People should be told that they have the right to withdraw at any time. It is important that where possible anonymity and confidentiality should be maintained.

Appropriate records should be kept of the procedures followed and records of the participants' agreement.

The obligations of a researcher

The researchers should <u>not</u>

- Convey personally identifiable information obtained in the course of research work to others except where the participants have given permission for this to be done or where you are subject to a legal obligation to disclose information
- Give unrealistic guarantees of anonymity or confidentiality
- Make unrealistic promises about the impact of the research on the community or individuals involved (raising expectations of development aid, legal help or other interventions which are beyond your influence or control)

The researcher should

- Store all data in a secure manner and taking into account the obligations under relevant Data Protection Act or other legislation.
- Take care to prevent data being published or released which would allow the identification of participants to be traced
- Take care to ensure that the research does not put you in any danger and
- Take all possible measures to ensure your own safety and security.

Payment to research subjects

If people taking part in your research are to be offered any payment or incentive over and above appropriate expenses you should explain this in your research proposal and seek guidance from the Committee. Small tokens of appreciation for taking part in a study may be given provided they are not seen as an inappropriate inducement to take part.

Informing participants about the results of research

You should where possible inform participants of the results of the research, explaining where necessary that they may not be able to obtain their individual results. Given that participation in your project is voluntary it is appropriate to provide feedback on the results and explain how the information is being used.

Useful references on the ethics of research with people

- British Sociological Association -- http://www.britsoc.org.uk/about/ethics.htm
- Association of Social Anthropologists of the Commonwealth -- http://www.asa.anthropology.ac.uk/ethics2.html
- Social Research Association -- www.the-sra.org.uk/ethics03.pdf

ANNEX 4: LAND DEGRADATION TYPES

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

- Soil degradation
- Vegetation degradation
- Water resource degradation
- Pollution (soil or water)

A. 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. Sheet, rill and gully erosion, and the scouring and deposition of soil by wind are some of the most visible symptoms soil land degradation but other less visible forms are even more widespread and sometimes more serious (e.g. depletion of nutrients, soil organic matter decline)

Soil physical, biological, chemical and hydrological properties are degraded in different ways:

Key processes that result in degradation of soil biological properties include

- ***Reduction in the numbers or activity of beneficial soil organisms*** such as bacteria, rhizobia, mycorrhiza, earth worms, termites etc;
- ***Increase in the numbers and activity of harmful soil organisms*** such as nematodes, parasitic weeds etc.

Key processes that result in degradation of soil chemical properties include:

- ***Decline in the number and availability of soil nutrients*** (N,P,K, secondary and trace elements) e.g. through leaching, gaseous losses, removal in harvested products etc.
- ***Chemical imbalances and toxicities*** e.g. through application of inappropriate types and quantities of fertiliser, pesticides etc.;
- ***Changes in soil pH*** (acidification or alkalinisation);
- ***Salinisation*** (build up of salts through poor irrigation practices in crop lands and poor grazing practices in grasslands); see below
- ***Chemical pollution*** from over use of agro-chemicals, plastic mulches or poor management of industrial and mining wastes.

Key processes that result in degradation of soil physical properties include:

- ***Surface crusting and compaction*** through the impact of raindrops, animal hooves and farm machinery;
- ***Loss of topsoil structure*** through excessive tillage and loss of soil organic matter;
- ***Sub-soil compaction*** due to the passage of heavy farm machinery and/or ploughing to a constant depth.

Key processes that result in degradation of soil hydrological properties include

- ***Waterlogging*** involving a 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; and
- ***Aridification*** involving a decrease in soil moisture availability, typically due to reduced rain water infiltration following deterioration in the soil's physical structure.

Soil salinization is a particular type of dryland degradation that deserves specific attention. Soil salinization often restricts options for cropping in a given land area as few plants grow well on saline soils. It also degrades 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, such as sulphates of sodium, calcium, and magnesium in the soil
  - a high water table
  - a high rate of evaporation
  - 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 which cause problems of crusting, hard-setting, poor infiltration and water logging.

Excess salts hinder crop growth, not only by toxicity 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: making water less available for uptake by plant roots.

Key soil erosion processes can be grouped into broad categories, which are described separately, however, anyone of them may occur in the same locality, either in combination or at different times of year:

- ***Water erosion*** - is often quite widespread and can occur in all parts of drylands where rainfall is intense (e.g. during a storm[9]) and surface runoff occurs. 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 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

[9] 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.

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. 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.

- ***Wind erosion*** – is also widespread throughout drylands that are exposed to strong winds. It includes both the removal and 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.
    - In farmland areas wind erosion occurs when soil is left bare of vegetation, and the topsoil has been reduced to a fine tilth as a result of cultivation. It also occurs in overgrazed grassland areas that have lost their protective vegetative cover, and in forest/woodland areas following the cutting of trees and shrubs, and 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, and a lack of leaves on the trees in the 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 and rocky slopes and mountain ranges. On sloping land when soil is saturated its weight may be sufficient to exceed the forces holding the soil in place. Under such circumstances the forces of gravity take over and mass movement may occur. This includes all relatively large down-slope movement of soil and/or rock, e.g. landslides, slumps, earth flows and debris avalanches. On steep slopes this mass movement may be very rapid involving the movement of large volumes of soil, usually on an isolated event and localised basis. Landslides may be natural events, however, their frequency and severity may greatly increase following destruction of the natural vegetative cover by logging and/or clearing for cultivation.
- ***Freeze/thaw (frozen and melting) erosion*** - is restricted to high altitude areas and areas with cold climates. It occurs when water in the topsoil initially freezes and expands, and then melts, 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.

B. Vegetation 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, adapted to the local climate, topography and soils. Vegetation degradation involves a combination of processes:

- reduction in vegetative biomass – with fewer plants, at lower density, with reduced vigour and growth producing less leaves, stems, flowers, fruits, seeds, etc. (resulting in reduced yield of grassland, forest and woodland products);
- reduction in vegetative ground cover – with expanding areas of bare ground occurring in formerly vegetated areas;
- reduction in the quality of the vegetative biomass – where, although the total biomass may be about the same, plant species of high value (for fodder, timber, fuelwood, food, medicines etc) have to a lesser or greater extent been replaced by species of lower, or no value; or 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.)
- reduction in species diversity and/or abundance (numbers/populations of specific species). This can happen in natural plant communities or in the diversity of local crop varieties and land-races.

In assessing vegetation degradation we are concerned with adverse changes in the quantity and quality of the plants that are found in grassland, forest and woodland areas.

C. Water Resource Degradation

Water resource degradation includes:

- ***Increased fluctuations in quantity of surface water 'stream' flow*** 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;
- ***Increased incidence of downstream flooding*** as upstream areas become degraded and can no longer absorb the volume of rainfall received during storm events;
- ***Drying up of rivers, springs, lakes, ponds, boreholes, etc.*** more frequently and for longer periods as water is lost in surface runoff rather than infiltrating to replenish groundwater levels;
- ***Reduced groundwater recharge*** due to increased surface rainwater runoff;
- ***Lowering of the ground water table*** due to reduced recharge and increased extraction;
- ***Increased sediment load*** in streams and rivers due to increased soil erosion in their catchment areas;
- ***Reduced water storage capacity*** due to sedimentation of reservoirs;
- ***Pollution of surface and ground water resources*** from human and animal wastes, agro-chemicals, industrial and mining wastes;
- ***Increased salt content of surface and ground water resources*** due to excess salt flushing from irrigated areas. see above soil salinity and salinisation

D. Pollution

Agriculture or indstry can lead to pollution of land resources:

- chemical imbalances and toxicities within the soil, as can occur with the application of inappropriate types and quantities of fertiliser;

- the build up of inorganic pollutants as a result of over use of agro-chemicals and the deterioration in the topsoil of residues left following the use of plastic mulches;
- the accumulation of pollutants/toxicities of organic origin following the planting of certain crops (such as *Jatropha* for biofuel production) which produce in their roots, or leaf litter, chemicals 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).
- toxic chemicals emitted in the smoke from heavy industry settling on the soil surface downwind of the factory;
- uncontrolled discharge of pollutants into water sources which then get onto the land when the water is used for irrigation purposes, or flooding takes place; and

erosion (by wind and/or water) and subsequent deposition, on land downwind/ downstream, of the material from the spoil heaps and other wastes associated with mining and quarry operations.

ANNEX 5 GLOSSARY

Agricultural biodiversity	The variety and variability of animals, plants and micro-organisms which are necessary to sustain key functions of the agro-ecosystem, its structure and processes for, and in support of, food production and food security (FAO).
Biochemical oxygen demand (BOD)	The measurement of pollution in water defined by the amount of oxygen used in the biochemical oxidation of oxygen matter.
Biodiversity	The variability among living organisms from all sources, including, 'inter alia', terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems. (UN- Convention on Biological Diversity)
Biomass	Total volume or weight of plant organic material from a given area.
Bright Spots	Areas that largely control /prevent land degradation as a result of sustainable land management practices that maintain resources and ecosystem services.
Bunds	Linear or contour earth or stone (or mixed material) structures, normally more than 30 cm in height, used in conservation systems to impede or impound runoff. (WOCAT glossary)
Browsing	Animals feeding from trees and shrubs. (WOCAT glossary)
Burning	Setting fire to pasture / rangeland to burn off unpalatable dry grass, and to control bush invasion in some circumstances and burning of crop residues to clear fields and control pests. (adapted from WOCAT glossary)
Bush Encroachment	A degradation process 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.
Community Territory	The land resources accessed and utilized by members of a community. The term community can be quite loosely interpreted: generally it is a collection of individuals or households that share physical space, services, cultural heritage etc. and that have a common leader or community council. The land area depends on the resource being considered for example, it may be larger for access to fuelwood and livestock watering compared to the agricultural land managed by the community.
Cost-benefit Analysis	This is a method of financial appraisal which compares the estimated future costs with the estimated future benefits of a particular course of action. The appraisal goes beyond a purely financial calculation and incorporates social advantages (such as saving time) and social disadvantages (such as noise, loss of farm land) by attaching a monetary value to them. If the net present value of the course of action is positive then it is rational to undertake that action, whereas a negative net present value suggests that the costs of the action outweigh its benefits. ("Field Assessment of Land degradation by M. Stocking and N. Murnaghan")
Cropland	Land used for cultivation of crops, including fallow (field crops, orchards).
Cropping System	The cropping patterns used on a farm and their interaction with farm resources,

other farm enterprises, and available technology which determine their cultivation. (WOCAT glossary)

DPSIR Framework — Driving forces of environmental change; Pressures on the environment; State of the environment; Impacts on population, economy, ecosystems; Response of the society. The DPSIR allows for the identification of the linkages between the driving forces behind the pressures on land resources that cause the current state of degradation, the impacts of such degradation on the components of the environment and ecosystem services and on human livelihoods, and the responses of land users to such state of land degradation and its impacts. DPSIR analysis allows for identification of causative factors and mapping of the linkages to the states (intensity) and types of degradation, all of which should be reflected in a mapping legend for spatial display purposes.

Ecosystem Services — All benefits that humans receive from ecosystems (Daily 1997). These benefits can be direct (e.g. food production) or indirect, through the functioning of ecosystem processes that produce the direct services. The Millennium Ecosystem Assessment, an international assessment of the consequences of ecosystem change for human well-being, classified these ecosystem services in four categories: supporting, provisioning, regulating, and cultural (MA 2005).

Enrichment Ratio — A measure of the proportional enrichment of eroded (and deposited) materials when compared to the original soil from which they were eroded. It is normally assessed by measuring the quantity of nutrients found in the eroded sediment, compared to the quantity in the topsoil from the field which is being eroded. ("Field Assessment of Land degradation by M. Stocking and N. Murnaghan")

Erosion — The removal of soil and rock particles by the forces of water, wind, ice or gravity. ("Field Assessment of Land degradation by M. Stocking and N. Murnaghan")

Focus Group Discussion — A participatory appraisal tool used to obtain important information about the range of land-users, their individual and communal management regimes, the area and its history which. It is usually conducted with a small number (6-10) of community members or elders (male and female) selected on the basis of their knowledge of the community territory, history and land use; and a facilitator with experience of conducting interviews.

Forest Land — Land used mainly for a forest enterprise or management unit i.e. the sum of the productive and non-productive forest land. It includes land used for production of wood and other forest products, for protection of watersheds and river courses and for forest and wildlife conservation. FAO

Geographic Assessment Area — The representative area identified for the conduct of the local land degradation assessment on the basis of the national land use systems and land degradation assessment and government priorities. It may be an administrative area or a delimited physical area such as a watershed. GAAs are usually quite large, several hundred to several thousand km^2 to include a range of situations in terms of degradation (hot spots and bright spots), pressures on land resources and responses.

Gully erosion — A miniature valley or gorge caused by the erosive effect of running water. The water wears away a deep channel in the land surface. Typically water only runs through gullies after rains. ("Field Assessment of Land degradation by M. Stocking and N. Murnaghan")

Hot Spots — Critical areas for land degradation identified on the basis of extent and severity of degradation, or high potential or priority areas with important infrastructure (dams, bridges, highways) that need to be protected from degradation.

Inputs	Mineral fertilisers, organic materials, water and seeds added in crop, livestock and forest based agro-ecosystems.
Key Informants	Community members who are knowledgeable, willing to assist and useful to collect contextual information but also to verify or explain some of the assessment findings. These include local government officials (at community, district or regional level), NGO staff, representatives of land, water and forestry departments, and other service providers.
Land	The physical environment, including climate, relief, soils, hydrology and vegetation, to the extent that these influence potential for land use.
Land Degradation	A reduction in the capacity of land to perform ecosystem functions and services that support society and development.
Land Unit (LU)	An area of land defined in terms of biophysical qualities and characteristics that may be demarcated on a map.
Land Tenure	Land tenure refers to the arrangement or right that allows a person or a community to use specific pieces of land and associated resources (e.g. water, trees, etc.) in a certain period of time and for particular purposes. It includes information on land-holding ownership size and distribution; type and prevalence of renting arrangements; legal status of holding (civil, cooperative, government); etc.(FAO)
Land Use System (LUS)	The sequence and combination of operations designed to obtain goods and services from the land (Nachtergaele, F. and Petri, M., 2007) as mapped and used as the basis of the LADA national and local land degradation assessment.
Land Use Type (LUT)	A land area characterised by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it ("Terminology for integrated resources planning and management", FAO, 1999). These more detailed classes of land use include management, economics and technical specifications for a given physical, economic and social setting. Their attributes may include data or assumptions on: produce and benefits, market orientation, inputs and labour per unit area, power, know-how, infrastructural requirements, size and configuration of the holdings, land tenure, income levels (adapted from Euroconsult 1989).
Livelihood	A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities or assets while not undermining the natural resource base (DFID, 1999).
Overgrazing	Besides damage to vegetative soil cover by actual (over)grazing, other degrading impacts of excessive numbers of livestock are also considered here, such as trampling. The effect of overgrazing usually is a decrease of plant cover, a change to lower quality fodder and/or soil compaction. This may in turn cause reduced soil productivity and water or wind erosion. (WOCAT glossary)
Pedestal	A pillar of soil capped by a more resistant material (such as a stone or root) which protects the soil from rainsplash erosion. (“Field Assessment of Land degradation by M. Stocking and N. Murnaghan”)

Rapid / participatory rural appraisal	Information gathering that requires the active involvement and participation of the rural people being targeted by research and development projects. PRA involves listening to, and learning from, members of rural communities. (“Field Assessment of Land degradation by M. Stocking and N. Murnaghan”)
Resilience	Capacity of a natural system to recover from disturbance. Resilience decreases an ecosystem's sensitivity.(FAO) The ability of a land system, or a livelihood strategy, to absorb and utilise change, including resistance to a shock. (“Field Assessment of Land degradation by M. Stocking and N. Murnaghan”)
Rill Erosion	A small channel formed on the soil surface during erosion. Rills often appear during heavy rains. They are seasonal, in that they can be eliminated by normal agricultural practices. (“Field Assessment of Land degradation by M. Stocking and N. Murnaghan”)
Soil Salinisation	A type of soil degradation where salts increase in the soil water solution. It is measured by an increase in electrical conductivity. (“Field Assessment of Land degradation by M. Stocking and N. Murnaghan”) , It is caused by the build up of salts in surface layers of the soil through evapotranspiration, often associated with irrigation and inadequate drainage. (FAO)
Seasonal Calendars	A participatory appraisal tool to record the main activities and problems which occur during the agricultural year. Cropping patterns, labour availability, food availability, water supply and health status should all be addressed in the calendar. These calendars are a good way to gain information about the farming practices in the community and an understanding of the constraints recognised by land users. (“Field Assessment of Land degradation by M. Stocking and N. Murnaghan”)
Secondary Information	Relevant technical and socioeconomic information that is available on the geographic assessment areas and study areas from local authorities and technical institutions/projects. For example: maps, time series images using aerial photographs or satellite images; land resources and thematic surveys; climate/meteorological records; historical records; project reports; government statistics.
Sheet Erosion	Erosion which removes a thin surface layer of soil as a result of ‘sheet’ runoff. (WOCAT glossary)
Soil Degradation	A process which lowers the current and / or potential capability of the soil to produce goods or services (through one or more of 6 categories: water erosion; wind erosion; waterlogging and excess salts; chemical degradation; physical degradation; biological degradation). (FAO, 1979)
Soil Fertility	The soil's ability to produce and reproduce. It is the aggregate status of a soil consequent upon its physical, chemical and biological well-being. (“Field Assessment of Land degradation by M. Stocking and N. Murnaghan”)
Study Area	The area identified on the ground for the field assessment of land degradation.
Time Line	This technique records changes, trends and events by reference to locally important history as remembered by the informants/community. It can help to pinpoint the causes of problems or changes. (“Field Assessment of Land degradation by M. Stocking and N. Murnaghan”)
Transect Walks	Systematic walks through the landscape and community territory to obtain representative information on the various land units, resources, land uses,

	management practices and degradation features. During the walk the field worker observes the local practices, and discusses how and why things are done with the land users. Information on farming practices, access to land and water, constraints and problems should be recorded using a transect diagram. ("Field Assessment of Land degradation by M. Stocking and N. Murnaghan")
Triangulation	A tool used in research work, involving that combines multiple observers, theories, methods, and empirical materials, to help overcome the weaknesses and inaccuracies associated with single method, single-observer, single-theory studies.
Venn Diagram	A participatory tool that uses small circles of paper to represent and identify community institutions (both traditional and external) and the nature of their relationships with each other. These relationships are presented in such a way as to highlight the relative importance of particular relationships. (FAO 1995)
Waterlogging	State of and in which the subsoil water table is located at or near the surface. In other words, access water is accumulated in the root zone of the soil. If the land is cultivated this results in a reduced yield of crops commonly grown. Uncultivated land is limited in its use because of the high subsoil water table. (FAO)
Water Salinity	Water containing a high concentration of salts, It is measured by an increase in electrical conductivity. An increase in salinity of soil and water which runs over and through the soil reflects a type of degradation
Wealth Ranking	A participatory tool used for determining information on the relative wealth (or well-being) of households in a community where community members define how wealth (or well-being) is perceived locally, and then ranking the households from those with the greatest level of wealth to the least. This technique is best used with individuals, but it should be carried out with at least three community members to avoid inherent biases arising due to the status of the respondents. ("Field Assessment of Land degradation by M. Stocking and N. Murnaghan")
Wetlands	Areas of swamp, marshes, bogs and similar areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions.
Windbreaks	Lines or blocks of trees planted at right angles to prevailing wind to reduce wind erosion and damage to agricultural land and settlements . (WOCAT glossary)
Zero Tillage	A system whereby crops are planted without primary soil tillage beforehand. (adapted from WOCAT glossary) Zero or minimum tillage and direct seeding are important elements of Conservation Agriculture systems which maintain a permanent or semi-permanent organic soil cover to protect the soil physically from the elements and restore nutrients and soil biological activity and also maintain a varied crop rotation for disease and pest control.(FAO)

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