Food and Agriculture Organization
of the United Nations

Guidelines for the national assessment and mapping of land degradation and conservation

DECISION SUPPORT FOR
MAINSTREAMING AND SCALING UP
SUSTAINABLE LAND MANAGEMENT

WOCAT
World Overview of Conservation Approaches and Technologies

gef

Decision Support
for Mainstreaming and
Scaling Up Sustainable
Land Management

Guidelines for the national assessment and mapping of land degradation and conservation

By

Monica Petri
FAO Land and Water Division,

Riccardo Biancalani
FAO Land and Water Division,

Lehman Lindeque
United Nations Development Programme

and

Freddy Nachtergaele
FAO Land and Water Division

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2019

Required citation:
Petri, M.; Biancalani, R. and Lindeque, I. 2019. *Guidelines for the national assessment and mapping of land degradation and conservation.* Rome, FAO. 52 pp. Licence: CC BY-NC-SA 3.0 IGO.

ISBN 978-92-5-131363-3

Contents

Tables

Figures

Abbreviations and acronyms

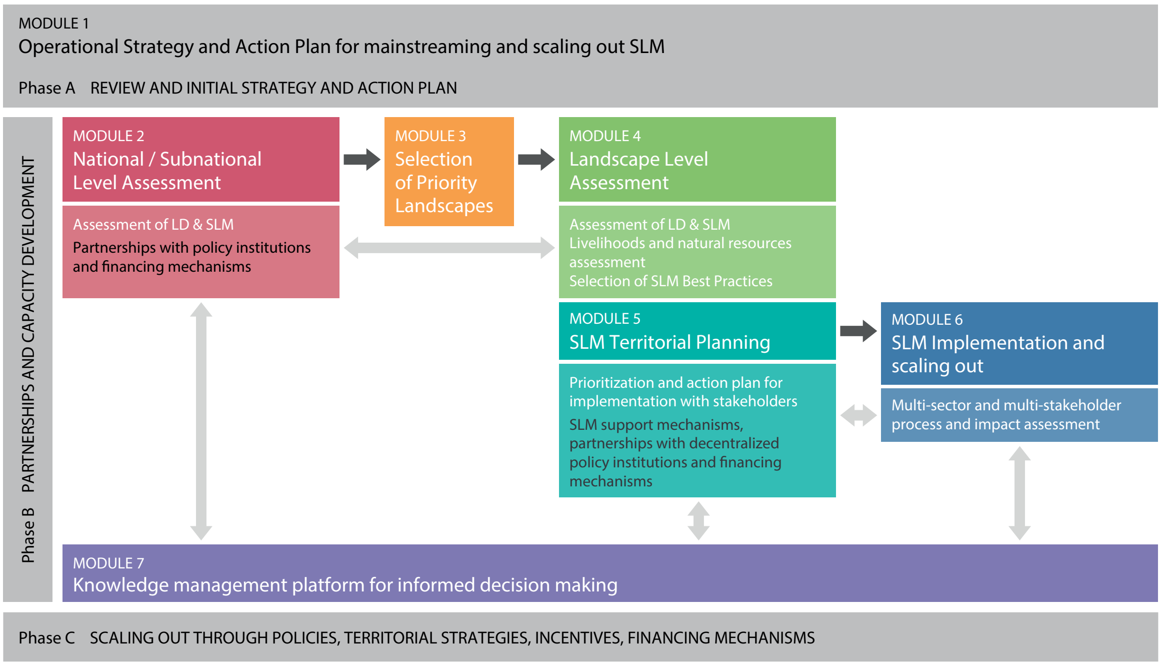
DS-SLM	Decision Support for Mainstreaming and Scaling Up of Sustainable Land Management
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility
GIS	Geographical information system
GPS	Global positioning system
ha	hectare(s)
Kagera TAMP	Transboundary Agro-ecosystem Management Project for the Kagera River Basin
km	kilometre(s)
LADA	Land degradation assessment in dry areas
LD	Land degradation
LUS	Land use systems
QM	Questionnaire for mapping land degradation and sustainable land management
SLM	sustainable land management
WOCAT	World Overview of Conservation Approaches and Technologies

Introduction

The Decision Support for Mainstreaming and Scaling Up Sustainable Land Management (DS-SLM) project is coordinated and implemented by the Food and Agriculture Organization of the United Nations (FAO) and the Centre for Development and Environment/World Overview of Conservation Approaches and Technologies (WOCAT) Secretariat. It is funded by the Global Environment Facility (GEF) allocations of participating countries and by the GEF's global fund. Operations are run in close consultation with national executing agencies in 15 countries: four in Africa (Lesotho, Morocco, Nigeria and Tunisia); four in Asia (Bangladesh, China, the Philippines and Thailand); three in Europe and Central Asia (Bosnia and Herzegovina, Turkey and Uzbekistan); and four in Latin America (Argentina, Colombia, Ecuador and Panama). The main objective of the DS-SLM project, which will run until 2018, is the implementation of national-level decision-support systems to effectively address desertification, land degradation and drought at the national and subnational levels; it includes assessments of the state of land degradation (LD) and sustainable land management (SLM) in each of the 15 countries to assist decision-making. Decision-support systems will guide users through a process to select SLM practices suitable for mainstreaming at the national or subnational levels. Suitable practices also need to be included in national planning and investment processes to enable nationwide adoption and implementation. The LD and SLM assessments use the Land Degradation Assessment in Drylands (LADA)–WOCAT mapping methodology, a standardized tool for mapping LD and land conservation (FAO, 2011, 2013; FAO and WOCAT, 2011).

As illustrated in Figure 1, the DS-SLM project has various modules. These modules may work cyclically, with the outputs of a given module needed for the next one, or separately, as countries may initiate and focus in any of those modules, according to their priorities. At the national level, an Operational Strategy and Action Plan for mainstreaming and scaling out SLM (Module 1) shall be designed for supporting the decision making-processes related to policy, finance and territorial planning, by making use of national and local level assessments. The results of national or subnational LD and SLM assessments (Module 2) enable the building of partnerships with natural resource management experts, scientists and policy makers for the selection of priority areas (Module 3).

FIGURE 1
Support framework for sustainable land management mainstreaming and scaling up



This document is designed to support and guide national experts and institutions in preparing and implementing participatory national and subnational assessments of LD and SLM (module 2 above) in a stepwise approach. It will also enable national authorities in the 15 countries involved in the DS-SLM project to increase their understanding and application of LADA–WOCAT mapping tools. The method includes the definition of mapping units for national assessments and the development of base maps to guide the participatory assessment of LD and SLM.

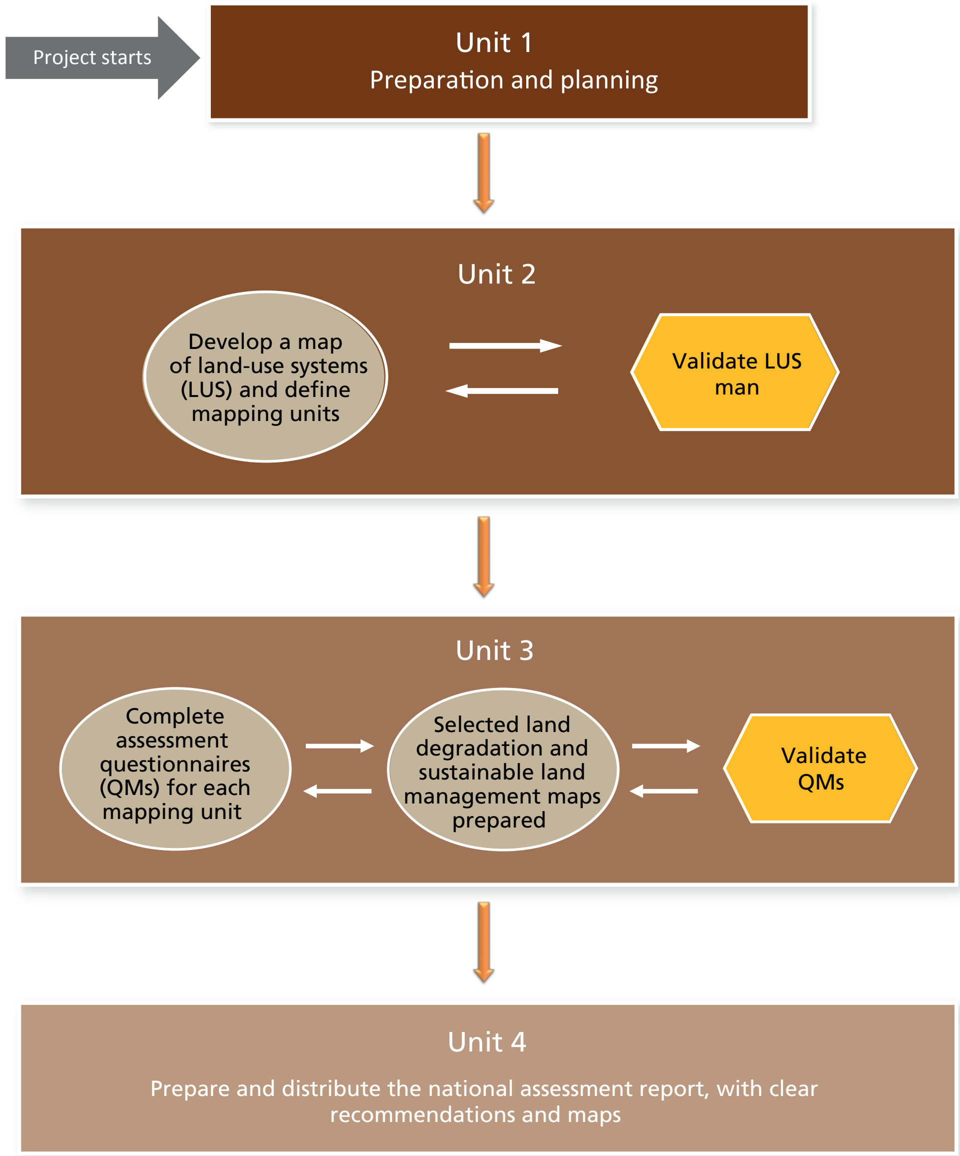
Figure 2 synthesizes the four key steps involved in the implementation of the LADA–WOCAT mapping methodology (FAO, 2013), which can be summarized as follows:

1) The preparation and planning step includes obtaining authorization for the assessment, discussing data availability and necessary intergovernmental agreements for data sharing, the hiring of experts, establishing a project office, and developing a work plan for the implementation phase.
2) The project team develops a base map, or "land-use systems" (LUS) map, to guide the assessment process. This step is participatory and requires the involvement of various entities within the country. It includes data collection and analysis in a GIS environment, and an iterative field-level validation. The LUS map, with its well-defined mapping units, is used as a basis for the assessment of LD and SLM in step 3.
3) The LD and SLM assessment is done using the LADA–WOCAT Questionnaire for Mapping Land Degradation and Sustainable Land Management (QM). The QM and data capture processes are performed through negotiation and consensus among a broad set of national-, district- and local-level experts, usually through one or more participatory expert assessment (PEA) workshop. These experts need to be invited in such a way as to ensure that all LUS included in the map are represented by at least one expert, thereby ensuring that the expert-based assessment includes, to the greatest extent possible, the points of view of the

full variety of land users. The QM assessment data are fed into a GIS system for analysis and to prepare maps and data summaries for planning and decision-making. All mapping products and data summaries are subject to an iterative field-level validation to ensure data quality and accuracy.

4) The national assessment report is prepared, including maps and summary, along with appropriate technical and communication materials. The final report should include clear recommendations for policymakers aimed at promoting SLM and scaling up best practices.

FIGURE 2
Flow diagram of the LADA–WOCAT mapping process



The details of each step are explained in the following four modules. Each module can be read independently and can be considered as a stand-alone guide to that step in the assessment process. Thus, in the remainder of this document:

- **Unit 1** discusses the general planning of activities and presents what needs to be done before the assessment process starts.
- **Unit 2** describes the LUS mapping process. This unit has three independent subunits – i) the prerequisites for LUS mapping; ii) map preparation; and iii) validation.
- **Unit 3** discusses the QM mapping phases for assessing LD and SLM. This unit also has three subunits: i) the prerequisites for implementing the QM approach; ii) map preparation; and iii) validation.
- **Unit 4** describes the development of national assessment reports.

Note that this guide only describes the steps to be taken to implement the LD and SLM assessment; it does not provide significant detail on the evaluation method. The implementation of the LADA–WOCAT methodology should be undertaken using appropriate manuals and materials, including the following:

- FAO. 2011. Land *degradation assessment* in *drylands: mapping land use systems at global and regional scales for land degradation assessment analysis*. Version 1.1. Rome (also available at: www.fao.org/docrep/017/i3242e/i3242e.pdf).
- FAO. 2013. *Land degradation assessment in drylands:* methodology and results. Rome (also available at: www.fao.org/3/a-i3241e.pdf).
- FAO & WOCAT. 2011. *Questionnaire for mapping land degradation and sustainable land management (QM).* Version 2. Rome (also available at: www.fao.org/docrep/017/i3240e/i3240e.pdf).

Unit 1 – Preparation and planning

Learning objective for Unit 1

Obtaining an understanding of the:
- objectives of a national LD and SLM assessment (why should it be done?); and
- the activities involved in the preparation and planning phase of a national or subnational assessment.

OBJECTIVES OF THE NATIONAL LD AND SLM ASSESSMENT[1]

The overall objectives of national LD and SLM assessments are to:

- Obtain a reliable picture of the state of natural resources and their use in a country.
- Analyse ongoing LD and land rehabilitation processes at a general scale.
- Identify existing SLM best practices.
- Validate the assessment results in selected farms and catchments with field assessments of LD processes and SLM performance. This includes verifying the severity, causes and impacts of LD and the scale and effectiveness of SLM measures and the barriers and constraints to their wider uptake.
- Share assessment results with policymakers to enable more appropriate planning and budgetary allocations by the concerned technical sectors at the district, decentralized and national levels, inform decision-making, and prioritize DS-SLM project investments. Such planning involves not only identifying priority areas for intervention but also giving guidance on best practices for interventions in those areas.
- Establish a national monitoring and assessment system on land use, LD and land management.
- Load assessment results into an easily accessible database as a baseline data layer for monitoring and evaluation. This will form the basis of comparison in future assessments and help in determining progress in addressing LD at the national level.
- Identify areas of greatest concern (i.e. areas with the highest levels of LD) and interest (e.g. areas with effective SLM measures in place) for detailed local assessments as a way of increasing understanding of the vulnerabilities and processes for various uses and users.
- Use the results to inform decision makers on the wisest uses of land, biodiversity and water resources to ensure their long-term sustainable use and achieve positive socio-economic outcomes.

[1] This unit builds and improves on an unpublished document prepared by Biancalani, Nachtergaele and Petri in 2010 and merges it with a document published by Petri and Bunning in 2016.

- Obtain a solid basis for reporting to UN conventions such as the United Nations Convention to Combat Desertification, the Convention on Biological Diversity, and the United Nations Framework Convention on Climate Change, as well as the Sustainable Development Goals.

ACTIVITIES IN PREPARATION AND PLANNING

The preparatory and planning step will vary between countries depending on the availability of, for example, resources, capacities and infrastructure. It may include some or all of the following activities:

- Obtaining the necessary authorizations for the national LD and SLM assessment project.
- Conducting a stakeholder analysis to determine who should be involved in the project.
- Developing a detailed project plan with stakeholders and key policymakers, including activities, timeline, budget and responsibilities, based on specific country needs.
- Securing a project budget for implementation, and creating agreements and contracts with stakeholders, contractors and partners involved in project implementation.
- Obtaining the services of experienced and capable geographic information system (GIS) specialists, purchasing (or obtaining open-source) GIS software, and setting up GIS infrastructure such as computers, printers and internet access.
- Discussing data availability and the interinstitutional agreements needed to ensure data sharing.
- Hiring personnel such as facilitators, GIS experts and other support staff, as required.
- Establishing a national project office for coordinating project implementation and appointing a national project coordinator who, as head of the national project office, will have overall responsibility for the effective and efficient implementation of the project.
- Designing and establishing a work plan for project implementation.
- Developing a communication strategy to ensure regular feedback and awareness of project activities and achievements among key stakeholders and the wider public.

Project communication and feedback can be undertaken using various methodologies and means. An awareness-raising campaign, for example, can be based on the information and materials developed for key decision makers and technical entities. Organizing a national project inception workshop early in the project lifecycle can be an effective way of raising awareness and getting buy-in for a national assessment project. Such a workshop can explain the objectives of an inventory of baseline data and information and involve multiple disciplines (e.g. agriculture, livestock, forests, statistics, natural resources and environment) and multiple stakeholders (e.g. national institutions, research organizations, civil society and producer groups). National project inception workshops provide an overview of the status of inventories in ministries and line institutions related to land resources (e.g. soil, climate, land cover and topography), land use (e.g. cultivation, livestock, forestry and conservation) and good agricultural, rangeland and forest management practices. The availability of relevant socio-economic data and information at the national and subnational levels should also be discussed.

A national workshop conducted in the early stages of project implementation can set the scene for the involvement of the technical and scientific communities and civil society in the assessment and help determine the scale and quality of assessment outputs. It can also serve as a basis for agreement on conditions for improving collaboration among relevant institutions and stakeholders. The outcome of a national project inception workshop should include agreement on the lead institution to coordinate the work, a work plan with responsibilities and an indicative timeline, and arrangements between institutions and ministries on sharing data, the personnel to carry out the baseline study, and financial arrangements.

The national project inception workshop can be held back-to-back with the first workshop described in unit 2 of the assessment methodology.

Unit 2 – Preparing an LUS map

Learning objective for Unit 2

Obtaining an understanding of the:

- requirements for preparing an LUS map;
- steps involved in developing an LUS map; and
- process for validating an LUS map and obtaining agreement on the detail required forthe LD and SLM assessment.

REQUIREMENTS FOR PREPARING A LUS MAP

An LUS map is an essential part of the LADA–WOCAT methodology because it acts as the base map and provides unique mapping units for the assessment of LD and SLM variables. The LUS map and assessment outcomes can be used to determine locations for detailed local assessments, among many other uses. The LUS map should not be confused with a land-cover map: an LUS map includes data on land management, inputs and socio-economic conditions, which are not included in land-cover maps.

LUS mapping usually does not involve the collection of new data, but access to specific existing data layers is required (see FAO, 2011). Thus, no expertise is required in analysing raw data (e.g. data from remote sensing), although it is necessary to combine spatial data layers and undertake simple data modelling and interpolation.

- **Step 1.** Build awareness and get agreement on map characteristics and ensure that all stakeholders understand the importance and function of the LUS map within the LD and SLM assessment. A session could be organized as part of the project inception workshop (see unit 1) to discuss the availability of national data layers for developing the LUS map and to explain the procedures and inputs needed to develop the map. This could include discussing and getting agreement on the issues listed below.
- **Step 2.** Ensuring appropriate financial support.
- **Step 3.** Explaining the database and logistical structure that will support the data and logistics involved in map preparation.
- **Step 4.** Summarizing existing national datasets.
- **Step 5.** Ensuring the availability of experienced GIS experts to help in the development of the LUS map. Such experts must have experience in the LADA–WOCAT methodology and in handling data in raster format.
- **Step 6.** Reaching agreement on accessing datasets, particularly those owned by other ministries and external organizations, ensuring that data layers are made available on the project database for use within the framework of LUS map preparation.

- **Step 7.** Securing the availability of experts in natural resource management and other SLM-relevant fields (e.g. land use, land management and socio-economics) for validating and correcting the LUS map.

Step 1. Awareness and agreement on map characteristics

The LUS map is an unusual cartographic product. Many people, including experienced GIS specialists, may find it difficult to prepare, and they might argue that a more conventional land-cover map would fulfil the same need. In some cases, depending on the area, soil or hydrographic network maps might be considered good substitutes, but this will not always be the case. Although it might be possible that a map that could be used as an LUS map already exists in a country, it is essential that it shows the relationship between the natural environment and human activities (i.e. land use). In other words, a map of natural resources will be insufficient on its own.

There may be scepticism about the value of developing an LUS map, and LUS mapping workshops – to be convened to develop the map – should explain how the map will be used, which is especially to provide information on the drivers and impacts of LD according to the "driving forces, pressures, state, impacts and responses" (DPSIR) framework. Maps without a land-use component would not serve this purpose. Project managers should ensure that team participants understand and agree on the need for an LUS map and obtain consensus on an appropriate method that meets the requirements of the LADA–WOCAT methodology and suits national circumstances. Importantly, those national experts participating in the national LD and SLM assessment need to familiarize themselves with the LUS mapping units. Experts are required with knowledge on how specific areas of land are used and managed to they can provide specific information on the various LUS mapping units.

TABLE 1

Examples of consensus related problems related to the preparation of a LUS national or of a multi-country map

Country	Example National workshop	Example Regional workshop
Consensus level	• GIS training strongly required (participants were even waiting for a GIS instead of a LUS course) • No consensus in map preparation (participants were not informed that that this was a workshop to prepare a LUS map) • The concept of LUS was not clear to participants and they were introduced to it during the workshop • Participants didn't know that a LUS map can help assessing land degradation • Very poor GIS infrastructures (use of personal laptops)	For country A: • GIS level expertise was very high • No consensus in map preparation (participants were not informed that this was a LUS course) • Extremely good GIS infrastructures • No perceived need for such a map, participants felt the LD methodology fulfil their national needs Or other countries: • The GIS level was quite low • Participants were informed and interested
Results	However, the workshop was a success. A LUS map with a LUS database was prepared.	The LUS workshop was a success. A LUS map with a LUS database was prepared. However, for country A the LUS map was not used. Later the country focused on preparing a new land cover map.
Notes	Success of the LUS course was due to: • good willingness and strong commitment of participants • facilitator with high LUS and GIS skills was able to rapidly solve technical problems	Country A participants were pushed in undertaking their task by less experienced colleagues from other countries. Country A participants complained as they felt some additional financial compensation should be provided to experts.

Step 2. Financial support

The successful development of a national LUS map requires the availability of sufficient funding. The cost of LUS mapping will vary depending on the size of the country or other area to be mapped. The bigger the area, the higher the cost and the longer it will take to complete the map.

The case of the Kagera Transboundary Agro-ecosystem Management Project (Kagera TAMP) can be used to demonstrate the costs involved in preparing an LUS map and how savings can be achieved. In that project, however, the cost of preparing the LUS map was difficult to separate from the cost of the actual assessment and completing the QM, which were conducted simultaneously. The Kagera TAMP operated in four adjoining countries, and expenses were reduced, for example, by involving two or more countries in the same workshop. Costs were also reduced by inviting facilitators of a workshop in country B to the workshop of Country A to help in training trainers. The involvement of experienced facilitators helped shorten workshops while obtaining high-quality outcomes, thereby achieving further savings (although such facilitators might be more expensive). Workshops were used as training platforms (see Box 1), not only for facilitators but also for GIS experts. The total cost of the LUS and QM process in the Kagera TAMP was a little more than USD 100 000 for work that took less than six months, from the collection of input data to the production of usable maps for an area of about 60 000 km² (approximately twice the area of Belgium). Table 2 presents details of the cost of the process, not including the cost of the project management structure, project infrastructure and field validation.

TABLE 2

Cost of the LUS map and QM preparation for the Kagera TAMP project

Work description/notes	Cost (USD)
LUS workshop language 1	5 400
QM workshop language 1	17 500
Multi-country LUS workshop language 2	16 700
Several country QM workshops language 2	38 300
Consultant(s) – management of workflow, LUS facilitation, QM facilitation	23 500
TOTAL	**101 400**

Notes: Costs exclude those involved in the project management structure, project infrastructure and field validation. Activities took place between 2011 and 2014. National languages varied between countries.

Step 3. Supporting structure

A supporting structure in the form of subject-specific technical experts is required to provide appropriate technical and logistical support for the duration of the LUS preparation process and the validation of the LUS map. A technical expert should support the national project coordinator and assist with:

- The selection of appropriate GIS experts, supported, as appropriate, by technical experts in FAO lead technical units. The GIS experts should be from both the private and public sectors to ensure access to important data sources for developing an LUS map.
- The collection of data layers needed for the LUS map. GIS experts should maintain contact with those national partners and ministries able to provide the project with data.

To ensure that the GIS experts have effective logistical support, the following should be considered:

- The selection or establishment of a GIS lab with appropriate hardware and software.
- Interaction and communication with LUS technical experts on suitable operating systems (e.g. regarding computing power, GIS software and GRID capabilities).
- The availability of a secure internet connection in the GIS lab to enable the downloading of data from the public domain (although this may not be required).
- The provision of colour printing facilities.

Box 1. Notes on planning and conducting a hands-on training workshop

In certain circumstances, a hands-on training workshop on developing LUS map might be required to train experts, speed up the GIS process and undertake the mapping in a collaborative manner. The logistics of such a workshop usually involve managing the travel of participants to and from the workshop location and ensuring comfortable and reliable accommodation. Buffet lunches and light coffee breaks should be provided. Coffee and other breaks should be held as scheduled to ensure efficient time management.

If GIS facilities are unavailable for the training workshop, a comfortable room should be booked and experts requested to bring their own computers with GIS software. If no GIS licence is available, experts should be advised to install appropriate open-source GIS software before the workshop. It is not ideal to use personal laptops in workshops: they may have varying specifications and software, which would likely hamper workshop success.

GIS facilities should be comfortable, with sufficient light and appropriate heating or cooling, and they should be conveniently located for ease of catering. Computers should have the necessary RAM and graphics capacity. GIS software should have the capability of working in raster format. Ideally, a sufficient number of computers with the latest ArcGIS 10 and Spatial Analyst extensions should be available, or there should be a similar setup for open-source software. The Arc Toolbox is recommended but not essential, and printing facilities should be available. The ArcGIS software is mostly used in FAO-supported processes, although FAO can also provide support for open-source software.

Step 4 Existence of baseline data

A large quantity of data is needed to prepare a proper LUS map for assessment purposes. Tables 2–4 list examples of typical data layers needed for the LUS database. It is not the end of the world if some layers cannot be obtained; the project should make the best use of what is available. The first step is to compile all available data layers and determine what layers need to be sourced. Global datasets may provide information on land cover and other parameters, but locally produced data are usually best. Tables 3 and 4 indicate existing global data sources; Annex 1 provides further information on global data sources.

TABLE 3
Potential data sources for use in producing LUS maps

Class of LUS input	Example of national inputs	Global LUS input
Land cover	Land-cover national maps; national maps referring to forests, wetlands, natural parks; any other useful map. Possibly including percentage of areas in land-cover categories	GLC2000 Globcover European Space Agency Climate Change Initiative – Land Cover
Irrigation	National map of irrigation, areas equipped for irrigation, irrigated croplands. Possibly including quantity and irrigation intensity	FAO's Global Map of Irrigated Areas
Urban	National maps of urban areas, rural centres and land cover	Global Rural-Urban Mapping Project database at the Center for International Earth Science Information Network
Protected areas	National maps of protected areas	World Database on Protected Areas
Pastoralism	National maps of pastoral areas (intensity); national maps or statistical data on pastoralism by region or province; maps of biomes for grazing types	Gridded Livestock of the World
Croplands/ plantations	National maps of cropland (intensity/ harvested area); statistical data on croplands by region or province	AgroMAPS until about 2010; CountrySTAT; other statistical data
Administrative boundaries	National map of subnational administrative boundaries (regions or provinces)	FAO's Global Administrative Unit Layers (if statistical data are used, a map of administrative boundaries is needed)

TABLE 4
National data for implementing attributes of LUS maps

Class of LUS attribute input	Examples of national inputs	Global LUS input
Climatic or ecosystem maps	National maps of climate classifications (depending on availability, these can be developed from temperature, rainfall, length of growing period, etc.). Classifications may or may not take into consideration elevation, slope and aspect	WorldClim 1970–2000; FAO's Global Ecological Zones (2010)
Pastoralism	National maps of typology of pastoralism (livestock species or other attributes that qualify as pastoralism); statistical data on pastoral species (e.g. number of head) or pastoralist presence, by region or province	Gridded Livestock of the World
Croplands/plantations	National maps of cropland (cropland species/ rotation); statistical data on croplands (production/yield or other attribute of interest), by region/province	AgroMAPS until about 2010
Soil properties	National soil maps	Harmonized World Soil Database
Terrain characteristics	National maps of elevation, slope and aspect; terrain index maps derived from one or more of those inputs	FAO/International Institute for Applied Systems Analysis Global Agro-ecological Zones (2006)
Population presence	National maps of population density; statistical data on population by region or province	Global Rural-Urban Mapping Project database at the Center for International Earth Science Information Network; LandScan (2012)
Poverty	National maps of poverty or other economic indicators; statistical data on poverty and other indicators such as gross domestic product, by region/province	Center for International Earth Science Information Network

TABLE 5
Optional national data for development of LUS maps

Class of LUS attribute input	Example of national input
Land ownership categories/land tenure	National maps of land tenure; statistical data on land tenure by region or province. Land tenure data can be used to create LUS units or as attributes; field size data (land cover) can be used as attribute
Input use, fertilizer use, inorganic fertilizer use	Can be used as attribute and for database
Management intensity	Intensity of management in rural areas
Mechanization; terracing	Can be used as attribute and for database
Other data	Other available country-specific data can be used to define LUS units or as attributes. Examples include: wetland exploitation; soil salinization; pastoralism migration; health issue presence; regional environmental legislation; education; and nutrient and sediment loads and eutrophication. Experts may propose other data

Step 5 Availability of experienced professionals in LUS mapping and the LADA–WOCAT method

When all available data layers have been collected, the next step is to combine those layers into a suitable and workable national or subnational LUS map. Countries lacking access to experienced professionals to guide this process will need to secure the services of experienced professionals on LUS mapping, well in advance of implementation. Such experts, who should be familiar with the LADA–WOCAT methodology, are available at FAO as well as in LADA–WOCAT pilot countries. In some cases, an expert in natural resource management decision support could also be of assistance. Another option is to organize LUS workshops to enable national experts to prepare the LUS map with the support of a facilitator. FAO's land-use manual (FAO, 2011) can be used as a starting point.

The appropriate use of GIS during the process is fundamental, whether by an independent group or a national-level technical unit. The GIS experts participating in the GIS LUS mapping exercise should have at least five years of experience (although ten years or longer is preferred), and they should be able to work with raster formats. Ideally, they should also be able to do modelling. Collectively, the GIS experts should have experience in agronomy, forestry, natural resources and livestock, among others, to ensure they can guide the LUS mapping process (Box 2). Involving experts who are sufficiently "high level" to make decisions on map preparation on behalf of their institutions or governments can reduce the time required to complete the task. This can be difficult in practice, however: in many cases, those with sufficient experience are managers and lack the time to do the mapping, and those in lower ranks might have the time but no decision-making power.

If no GIS experts with the entire set of expertise are available, other experts should be involved, even if they lack GIS capability. The quality of the LUS map will be greatly improved by, for example, the presence of highly skilled livestock experts, who might be requested to participate only in the first few days of the assessment.

Box 2. The GIS team for LUS mapping

A well-balanced GIS team for LUS mapping might include:

- One or more GIS expert with land cover mapping expertize (in LCCS method if the national land cover is produced using such method). Land cover is the main input, so a land cover expert is key;
- One or more GIS expert with expertise in agronomy, forestry, natural resources, climatology (some of these experts might even don't have GIS expertize);
- One or more livestock expert (even without GIS expertize);
- One person with experience in socio-economic indicators (even without GIS expertize).

The responsible organization should identify any fields that might present particular difficulties and ensure that experts in those fields are present in the group. For example, in a country in which land use is strongly affected by soil salinization, the GIS team should include an expert in that phenomenon.

Should a country request support from FAO in the LUS mapping process, it is the country's responsibility to provide the best candidates for supporting the FAO experts in LUS mapping. As part of the process of selecting participants and building the appropriate expert group, information should be distributed to prospective participants on the activities to be undertaken; in that way, they will know the project's objectives and what to expect in its implementation, and they can make informed decisions on whether they could make significant contributions.

Step 6 Collecting baseline data and making them available for use

The accessibility of data – which are required in GIS or tabular format – might sometimes be a problem. LUS mapping could be conducted over a relatively long period, and the country team may have time to collect data as they are needed. If, however, the LUS map needs to be prepared in a workshop, steps must be taken beforehand to minimize data gaps: for example, the expert facilitator should request all participants to bring with them any useful data to which they have access. Agreements with external entities should be made well in advance of the mapping process to ensure data availability. Another option is for an international expert to collect data during an in-country mission, but this is not recommended because it can increase costs, extend the time needed, and reduce country "ownership".

Approaches for increasing data availability are addressed above. Obtaining consensus on the need for an LUS map can help in "opening doors" and reaching agreement on issues such as copyright. Recognition of the need for a national or subnational LD and SLM assessment is crucial, including at the political level. The availability of financial incentives to participate in the assessment also helps.

Box 3. Identifying important stakeholders to contribute to LUS mapping

A detail stakeholder analysis can help in screening experts to determine who should be part of the LUS mapping process and who should be invited to the LUS mapping workshop. Consideration should also be given to the various classes of LUS, ensuring that expertise in each is represented and data are available (bearing in mind that one individual might have expertise in several LUS, such as dryland cultivation and irrigation, in a given area). If difficulty is encountered in finding suitable experts, recommendations from known experts could be sought.

Step 7 Secure experts to validate data

The last step required in preparing a base LUS map for LD and SLM assessment is validating the data and ultimately the LUS map itself. This is important for ensuring that the LUS map is workable and practical, with mapping units that are recognizable and useful to users. Validation should ensure that the map is thematically balanced and does not overemphasize, for example, biodiversity or specific layers such as livestock presence. Thus, the final product should be subject to review by experts with different backgrounds, who comment on the validity of the map and where and how it should or could be changed. This exercise can also be done in a validation workshop.

PREPARING A LUS MAP

The preparation of a LUS map can be done by GIS experts in collaboration with other national experts by following the guidance and methodologies set out in FAO (2011).

Examples of LUS maps can be found on the LADA webpage (www.fao.org/nr/lada) and the Kagera TAMP webpage (www.fao.org/in-action/kagera/activities/mapping).

The technical preparation of the LUS map is an inherently GIS exercise that goes beyond the scope of this document. It can be done independently by a national GIS unit, or with the support of a consultant or an FAO officer. The two main options for external support are as follows:

- The national team receives basic training and then continues to work with remote support.
- The national team receives intensive training involving the actual preparation of the LUS map as part of the learning or capacity-building process (“learning by doing”).

When the LUS map has been prepared, experts might need to decide on the most appropriate scale for collecting data during the LD and SLM assessment workshops. A LUS map with many layers, overlaid by relatively small administrative units such as local municipalities or wards, could result in a large number of mapping units. This would complicate the assessment process (because a QM needs to be prepared for each mapping unit) and also require a very long assessment that would consume considerable resources (Box 4). The assessment is designed to inform and guide decisions at an appropriate scale (e.g. national or subnational) and should therefore demonstrate the major trends in LD and SLM at that scale.

Box 4. The relationship between the number of mapping units and the duration of the assessment

The mapping unit is the smallest unique unit identified in the LUS map development process. For example, a mapping unit could be: "Subsistence rainfed cultivation in the xyz local municipality of country A". The number of mapping units to be assessed in the next unit (i.e. completion of the QM for each mapping unit) is the single most important determinant of the cost and time needed to complete the LD and SLM assessment. The more administrative subdivisions included, the greater the number of mapping units. The more layers used in LUS map preparation, the more divisions or classes and the more mapping units created. The more mapping units, the longer the assessment and the more expensive it will be. Greater detail at the subnational level will increase the accuracy of the assessment's findings, but it is important to find the right balance between, time, cost and reliability. For medium-sized to large countries, 4–6 subnational regions could be identified for decentralized consultations and assessments. Given the importance of prevailing agro-ecological conditions in land use and land management, it is a good idea to combine smaller administrative units within the same agro-ecological zone as single mapping units, thereby reducing the overall number. Alternatively, differing agro-ecological zones (e.g. savanna and grassland) in the same administrative unit managed in the same way and with similar degradation problems could be combined into single mapping units. The aim is to determine relatively homogenous units based on socio-economic and biophysical characteristics. The scale could vary between 1: 50 000 for small countries (e.g. Tunisia) to 1: 500 000 for medium-sized countries (e.g. South Africa). It is usually advisable to make a reasonably detailed LUS map and to limit it to 1–2 administrative levels so as not to exceed a total of 500–600 mapping units. Mapping units can also be grouped to simplify the LUS map and shorten the QM procedure.

After the LUS map preparation unit and before the map is published, the LUS map requires validation.

LUS MAP VALIDATION

Validating an LUS map should be a simpler process than validating a new map because it has been derived by combining existing, previously validated data. A detailed explanation of LUS map validation is beyond the scope of this document; this section set out the minimum requirements for the validation process in light of the specificities of LUS maps.

Which parts of an LUS map should be validated?

The elements of validation vary but should include cartographic verification (e.g. precision and completeness), processing verification (e.g. inverting features and area errors), and thematic verification (e.g. ground checking).

Cartographic verification examines the impacts of uncertainty resulting from GIS manipulation. A comparison between the LUS map and available satellite images or Google Earth can provide a first check and help identify major errors. Positional accuracy detects manipulation arising from the incorrect use of base information and whether the mapped area has been displaced in the GIS system. Accuracy errors can be difficult to detect without comparing results with accurate base data or through field verification. Completeness might also be an issue, with the borders of different maps potentially causing pixel disappearance ("shivers"). The date and relevance of data sources used in preparing a LUS map should be verified and the question posed as to whether more recent and more relevant layers are available.

It is important to verify the process followed in preparing the LUS map. For example, "correctness" is a common error arising from the misidentification of individual features or due to misclassification within the LUS interpolation.

Thematic verification is essential. This can be done as a desktop exercise in which the accuracy of a test dataset is validated by comparing it with other (external) data sources on the topic or issue; it can also be done with the support of satellite imagery and Google Earth. Ideally, the validation outcome should state the accuracy of the validated data relative to reference data.

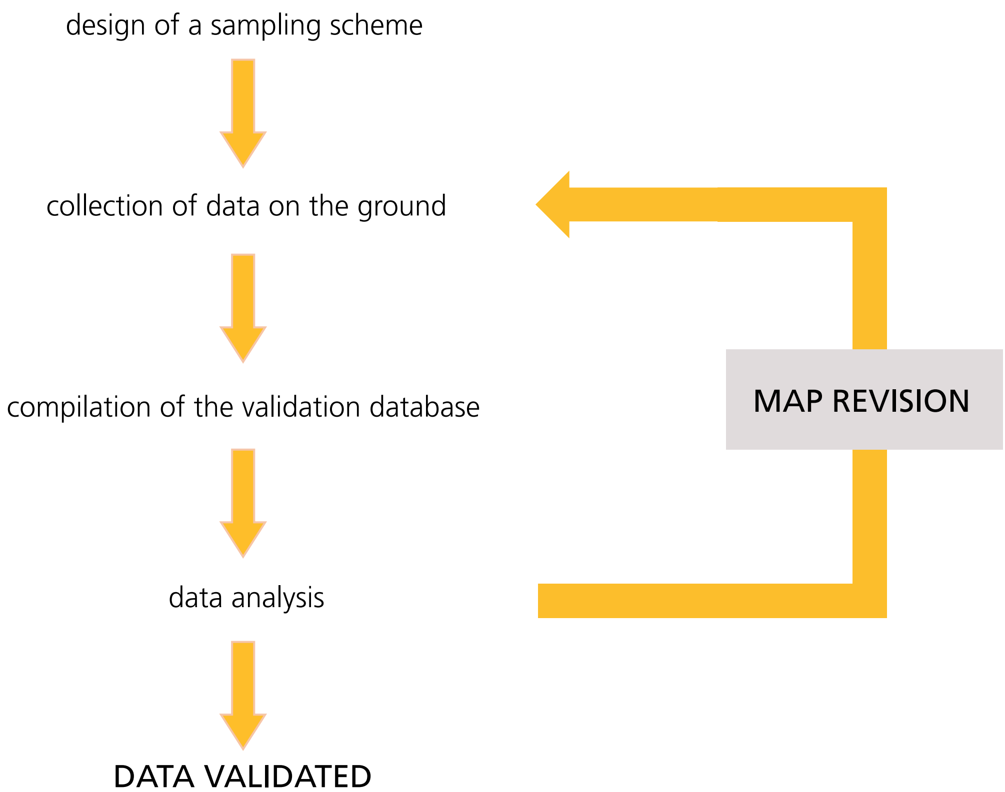
Field validation

Although cartographic and process verification is done at the desk level, the overall LUS map should be verified at the ground level through fieldwork. This can be done quickly by driving through a given landscape with the help of a global positioning system (GPS) linked to a laptop, thereby checking the overall reliability of the LUS map (although it does not verify all boundaries because it is limited to existing roads and by scale). Documentation with georeferenced observations and photos of the various LUS, and of LD and SLM by LUS, will help immensely in facilitating the mapping exercise.

As shown in Figure 3, validation usually involves the following four steps:

1. Design of a sampling scheme.
2. Collection of validation data on the ground or from existing data.
3. Compilation of validation data in a suitable geographic database.
4. Analysis of data – this is an iterative process in which the map and the compilation of mapping units is revised until a consensus is obtained.

FIGURE 3
Ground-truthing validation steps



A detailed description of the sampling scheme is beyond the scope of this document but is available in FAO (1989). Sampling design should aim to minimize bias;[2] thus, the number of samples, and how they will be distributed, should be determined before the validation process starts. Adjustments may need to be made to accommodate practicalities such as budget, security and access to sampling points. The collection of field samples should always be associated with accurate coordinates of latitude and longitude and, ideally, it should be accompanied by a geocoded photograph of the sample site. Where data collection is especially difficult, priority should be given to the most relevant information or to areas where there is a lack of agreement among land-use experts.

The field survey procedure should include analysis of the following aspects:

- LUS boundaries.
- Verification of the land-cover classes used in the LUS map (similar to the validation of, for example, a land-cover map or a natural capital inventory).
- Verification of land uses within each land-cover class (to ensure that the LUS map accurately reflects what is happening on the ground).
- The accuracy of the natural capital inventory (e.g. soil, water and vegetation).

The compilation of a validation database (see step 3 in Figure 3, and also Box 5) is crucial. For each sampling point, the classification value (i.e. land-use type) determined in the field must be recorded, and the classification and validation value (reference data) should be tallied in a contingency table to facilitate analysis.

The validation should identify mistakes made during the LUS mapping exercise through analysis, using simple formulas to generate probabilities using for data in contingency tables. A synthesis of validation results should be able to respond, for example, to the following questions:

- If I select any “grassland + livestock” pixel on the LUS map, what is the probability that I will be standing in a rangeland when I visit the field location of that pixel?
- If I know that a particular area is rangeland, what is the probability that the LUS map will correctly identify that pixel as “grassland + livestock”?

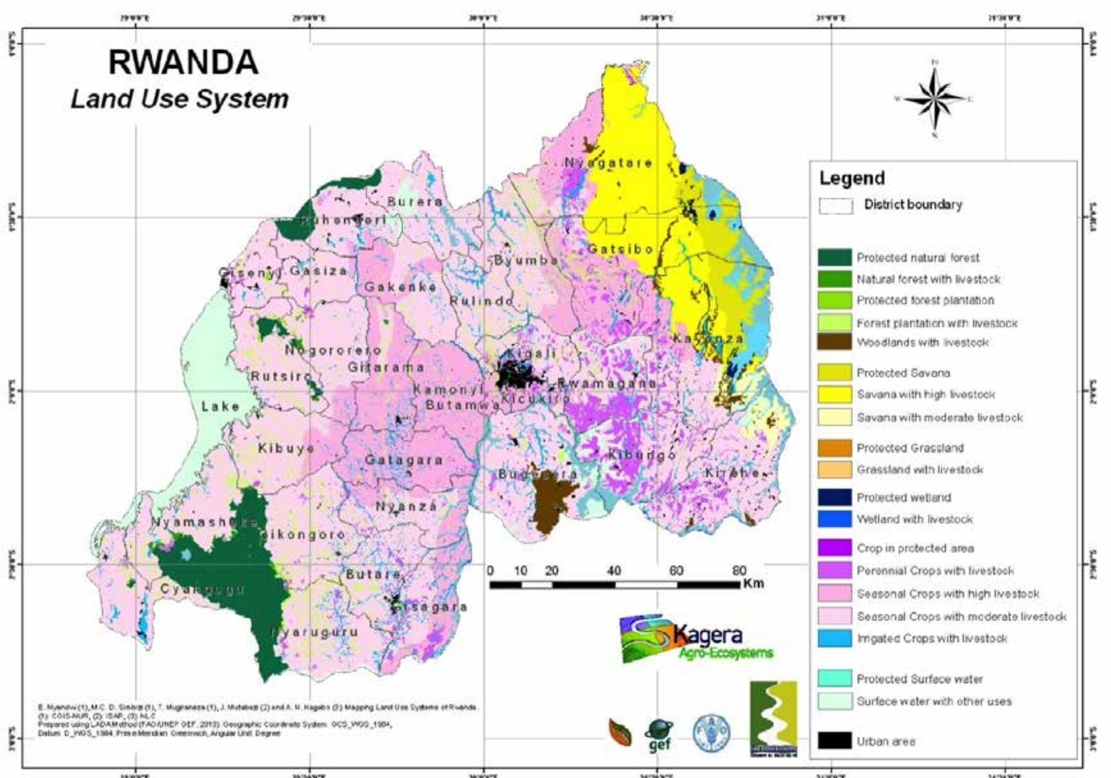
Such analysis should improve the map (by estimating product errors), or indicate that it requires revision and modification (see Figure 3). Figure 4 presents an example of a completed LUS map.

2 Sampling bias occurs when samples of a stochastic variable are selected incorrectly and do not represent the true distribution for non-random reasons (Panzeri *et al*., 2008).

Box 5. A note on the validation of maps

To ensure correct evaluation, validation data should generally be collected in the same timeframe as the data used to create a map. However, the LUS map is a collection of data obtained from various sources, using data potentially collected over many years and designed for diverse purposes (e.g. livestock and land cover). Thus, it is unlikely that the validation data will ever be collected in the same timeframe in which the source data were collected, potentially creating correctness errors. This should be borne in mind during LUS map validation.

FIGURE 4
A land-use systems map for Rwanda



Unit 3 – Assessing land degradation and sustainable land management using the WOCAT/LADA Questionnaire for Mapping (QM)

Learning objective for Unit 3

Obtaining an understanding of:

- Background on the assessment of LD and SLM through a participatory expert assessment process and the development of consensus maps on the state of LD and SLM.
- The steps involved and important points to remember in preparing for a participatory expert assessment (PEA).
- How to successfully facilitate and complete a typical participatory expert assessment workshop.
- How to validate the QM assessment results.

BACKGROUND ON THE ASSESSMENT OF LAND DEGRADATION AND CONSERVATION

As indicated in the introduction, these guidelines are designed to assist countries in undertaking national and subnational assessments of LD and SLM. Units 1 and 2 explain the importance of a proper base map for assessment – the LUS map. The process for producing an LUS map has been described.

This unit assumes that an LUS map is ready for the country or subnational region and it is therefore possible to proceed with the LD and SLM assessment. The unit describes the preparation needed, as well as the elements of the actual assessment.

The following important points about the QM approach should be borne in mind:

- The QM approach is an internationally accepted methodology and was developed over many years with inputs from many countries and institutions. Recently, the United Nations Convention to Combat Desertification identified the QM methodology as "best practice".
- The QM methodology is scale-independent; in other words, the same methodology can equally be applied nationally and at the scale of a single farm.

- The foundation of the QM methodology is the LUS map. As explained in unit 2, assessments cannot be performed without an LUS map with clearly defined, well-recognized mapping units.
- Resources – especially time and money – are important considerations in assessing LD and SLM. At one extreme, such an assessment could involve dozens of experts engaged in detailed surveys and assessments of all types of LD, but to do this for an entire country would take years and would probably cost millions of dollars. An alternative approach called "participatory expert assessment" (PEA) can bring together experts, scientists and land users in workshops to assess the various mapping units, drawing on their knowledge and experience of the area, at much less expense and in a much shorter time.
- The PEA approach is mainly qualitative, and it is strongly based on the perceptions of contributing experts. It is important, therefore, to ensure that contributing specialists negotiate among themselves and reach consensus on the actual state of the natural resources.
- Good facilitation is essential for effective PEA workshops. Facilitators need to have sufficient knowledge of LD and SLM to explain important concepts, and they must also be able to work well with people, obtain consensus in a group with varying opinions, and maintain momentum to ensure the timely success of workshops.

PREPARING FOR A PARTICIPATORY EXPERT ASSESSMENT WORKSHOP

The QM methodology does not involve the actual measurement of LD and SLM in the field. Rather, one or a series of PEA workshops is held to collect data from contributing specialists; PEA workshops, therefore, are based on the compilation of existing information and expert judgements through an informed system (see FAO and WOCAT, 2011). Successful PEA workshops create an environment in which participants are able to judge inputs, express opinions, and discuss and eventually reach consensus on the state of LD and SLM.

Preparing for PEA workshops involves four steps to be taken by the institutions and individuals responsible for national LD and SLM assessments:

1. Decide on the number and duration of PEA workshops.
2. Identify experts to participate in the PEA workshops as contributing specialists and invite them to do so.
3. Finalize logistic arrangements for the PEA workshops.
4. Collect existing information on LD and SLM in preparation for the PEA workshop.

These four steps are explained in detail below.

Step 1: Deciding on the number and duration of PEA workshops

Two early decisions to be taken in preparing for PEA workshops will have an impact on total project cost: the number of PEA workshops to be held throughout the country, and where (spatially) they will be convened. The more workshops and the further they are separated geographically, the more travelling required, the higher the cost and the longer it will take to complete the overall assessment.

Using the LUS map, a good way to approach these decisions is on the basis of appropriate administrative boundaries. South Africa, for example, is divided into nine provinces, 52 district municipalities and 226 local municipalities. For a national-level assessment, it would make sense to hold a workshop in each of the provinces, for a total of nine PEA workshops. Lesotho, on the other hand, is smaller than the smallest of the South African provinces and might require only one or two PEA workshops for the entire country. If administrative boundaries are used as the basis for determining the number of PEA workshops, the assumption is that all LUS classes will be assessed at each PEA workshop.

Another approach is to use LUS classes, as identified on the national LUS map, as a basis for determining the number of PEA workshops. In this approach, experts would assess all LUS classes related to, for example, rangeland management in a single workshop. This works especially well in smaller countries like Lesotho where it would be feasible to bring experts from all over the country to a central venue. The workshop addressing rangeland management need not be held as a stand-alone: a single national PEA workshop could bring together expert groups for each of the major LUS classes.

A last consideration in determining the number of PEA workshops is the number of mapping units to be assessed at each PEA workshop. Each workshop should assess roughly the same number of these. The maximum number of QMs can be calculated by multiplying the number of LUS classes by the number of administration units. If a country has 20 LUS classes and 20 administrative units, for example, up to 400 QMs will need to be completed, although is unlikely that all LUS classes will be present in all administrative units. A group of 5–10 experts might require 3–5 days to complete 30 QMs and it would therefore require 13 (i.e. 400/30) groups of experts to work for one week to complete the assessment. If each group consists of ten contributing experts, a total of 130 people would be involved in the assessment and up to 13 weeks would be required.

Table 6 give a broad indication of the number of PEA workshops, the number of mapping units assessed, and the duration of the PEA workshops for various countries.

TABLE 6

Examples of QM assessment schemes for various countries (numbers are approximate)

Country	No. of LUS classes	No. of administrative units	No. of members in expert group	No. of meetings	Days per meeting
Burundi	20	10	35 highly skilled	1	5
Cuba	10	10	10 highly skilled	1	5
South Africa	18	52	20 on average	33	2
Uganda, 5 regions	20	5	30 people, young	1	5

Notes: numbers are approximate. The number and duration of meetings are determined partly by the number of LUS classes in each administrative unit, which can vary widely. Expert groups with larger memberships are likely to be able to complete questionnaires more quickly than small groups.

It is important to know the extent of each LUS class in each administrative unit. In some cases, LUS classes might appear in some administrative units due simply to interpolation mismatching (e.g. a land use is situated in an administrative unit due to a GIS precision error). In such cases, misidentified classes do not need to be assessed in those administrative units.

In some cases, budgets and timing impose limits on PEA workshops. Pragmatic decisions might need to be taken to reduce the number of mapping units and therefore the number of QMs to be completed (Box 6). However, reducing the number of mapping units will reduce the detail and quality of the assessment and is not recommended.

Box 6. Reducing the number of questionnaires

The key determinant of time and cost in the LADA–WOCAT methodology is the number of QMs to be completed; thus, reducing the number of mapping units created by the overlapping of LUS classes and administrative units will decrease costs. Actions to decrease the number of QMs include the following:

- Excluding mapping units that cover less than a specified area (e.g. less than km^2 or pixels) or aggregating land-use classes (e.g. two land-use classes that are driving LD in a similar way – but care should be taken to avoid excluding significant areas, such as those that are highly degraded or feature important SLM practices).
- Excluding areas for which other assessment typologies exist (e.g. natural parks and other areas assessed using other methods).
- Excluding areas where interventions may not be possible (e.g. outside project areas).
- Excluding water bodies.
- Aggregating administrative units. However, this is not recommended because the administrative units characterize the enabling and policy environments.

Note that excluding areas also means creating maps with data gaps and discontinuities. On the other hand, aggregating areas simplifies results.

Step 2: Identify and invite experts to participate in PEA workshops as contributing specialists

Experienced experts from various disciplines familiar with the areas to be assessed are at the heart of PEA workshops. A stakeholder analysis is a good way to start in identifying relevant experts and ensuring that all role-players are invited. This should encompass government (e.g. extension officers and soil conservation technicians); non-government organizations (NGOs); community-based-organizations (CBOs); farmers' unions; universities and agricultural colleges; farmer study groups and field schools; project leaders; major conservation and SLM projects; and conservation managers.

It is important to have at least one expert for each LUS class, and more than one is preferred. The QM methodology is based on participatory principles and achieving consensus among experts, so it is important to ensure that different perceptions are normalized and calibrated. A conservation manager working in a protected area or nature reserve, for example, may perceive cultivation to involve the total loss of biodiversity, while an agronomist might argue that, through conservation agriculture, cultivated lands can still be managed sustainably. Experienced facilitators would help ensure that such differences in perspective are discussed productively with the aim of reaching consensus.

Invitations should be sent to the identified experts as soon as the dates, times and venues of the PEA workshops are decided. In addition to listing the objectives and aims of the workshops, invitations should include a request to bring along relevant information and data on LD and SLM.

To reduce the subjectivity of the assessment and provide a robust background for the expert evaluation, all existing information on the status and trends of LD – such as maps, photos and reports – should be collected and analysed by the assessment team before completion of the QMs. Such information is likely to be useful even if it does not cover the entire country or assessment area. Outputs from provincial and district-level initiatives, projects and university research can all be extremely useful in this step of the QM methodology.

It is advantageous for one or two of the GIS experts who participated in the LUS mapping process to be present at the PEA workshops to assist in the preparation of key LD and SLM maps during and after the workshops. Such experts should be selected during the LUS mapping workshops and informed early to ensure their participation. An additional benefit of their attendance is that they can help explain how the LUS map was prepared and also prepare maps during the QM exercise as examples. The production of maps during the QM exercise can help motivate participants by enabling them to glimpse the potential final outcome.

National LD and SLM assessments should respond to clearly expressed needs. In some countries, this has been a straightforward exercise involving a relatively small group of experts. In other countries, however, the process has taken years to complete. Although the complexity of the process might vary, ensuring a constructive process requires that participants are informed about and aware of the scope of the mapping and agree on the need for a QM database. This is especially true in situations in which implementing the QM methodology requires a significant number of experts and time.

Step 3: Finalize logistic arrangements for the PEA workshops

Successful PEA workshops require an appropriate level of financial support (Table 1 provides an indication of potential workshop costs). Moreover, the supporting structure should provide appropriate technical and logistical support until the QM preparation process is complete and QM maps have been validated. The logistics of the QM process can be complex and involve many workshops (for example, South Africa organized more than 30 subnational workshops).

Points to address in organizing PEA workshops include the following:

- Suitable venue.
- Catering for participants.
- Transport for participants.
- Accommodation (when workshops span more than one day).
- The provision of data forms, QM manuals and large satellite maps or aerial photos to help participants orientate themselves.
- Facilitators and GIS experts.

Other important issues related to the logistical arrangements for PEA workshops are discussed below.

Composition of workshop participants

The selection of national QM workshop teams should consider the geographic location of the participants as well as their knowledge, experience and availability. Workshops should be composed of experts living and working in the areas under assessment with direct knowledge of ongoing issues and access to existing data and information on which the expert evaluation will be based. The level of experience of participants – especially in LD and SLM processes – is likely to vary depending on national capacity. In South Africa, for example, workshop participants were required to have had at least three years of experience; in some other countries, experts were required to have had 5–10 years of experience. Generally, participants should have at least 3–5 years and ideally more than ten years of experience. Land-related processes tend to be slow, and the assessment capacity of experts is directly proportional to their experience; the longer the experience, therefore, the more reliable the assessment. Participants should be involved directly or indirectly in LD and SLM assessment and the implementation of SLM principles and technologies in the field. The most effective participants tend to be land users, extension officers and district officers. Technical expertise should include agronomy, land management, hydrology, climatology, rangelands, livestock, forestry and socio-economics. Crucially, participants must represent all the LUS classes identified in the assessment area, and they should be willing and able to articulate their experiences.

Number of workshop participants

The optimal number of workshop participants will vary depending on the size and complexity of the area to be assessed. For a small country (e.g. Burundi), the team should be composed of at least 20 experts who work and live in the diverse areas to be assessed. If necessary, the number of participants can be adjusted so that all typologies of expertise are covered over the full extent of the assessment area. Groups of more than 30 people can be hard to facilitate, however, and should be avoided. Note that a person who grew up in area A but has been working in area B for most of their working life will not necessarily be the best person to assess area A.

Facilitator

The facilitators of QM workshops require, among other things, a good knowledge of LD and SLM theory and practice, the QM manual (FAO and WOCAT, 2011), and the LADA–WOCAT method (FAO, 2011, 2013), as well as considerable facilitation experience (Box 7).

Box 7. Facilitators

Townsend and Donovan (1999, cited in Lindeque, 2010) describe facilitation as a process of "making things easy". In the context of PEA workshops, facilitators make things easier by "using a range of skills and methods to bring the best out in people as they work to achieve results (assessment of natural resources)".

PEA workshop facilitators must be able to cope with uncertainty and with knowing that things may not turn out as predicted or hoped for. They must be able to use the power of their credibility to help people address issues. They need to be calm when emotions are high and when others are stressed or confused, and they need to be able to empathize with people and listen well. Facilitators need to support people during the assessment; describe in understandable ways the process and systems used during the workshops; mobilize energy in themselves and in workshop participants; navigate difficult issues and help others to do so; and not take themselves too seriously.

Source: Lindeque (2010).

The best facilities

Undertaking assessments and completing the QMs for all mapping units means long periods spent in meeting rooms. It is essential to provide a comfortable space – the best meeting room available. The logistical support required for the QM process is described in the training manual for South Africa (Box 8).

Box 8. The working environment for the QM process

The ideal environment for a QM workshop includes the following:

- Good audiovisual equipment.
- Appropriate seating patterns.
- Comfortable chairs.
- A good writing surface for each participant.
- Thermostatically controlled temperature (ideal ambient temperature = 18 °C).
- Independently controlled ventilation (air conditioning or windows).
- A good supply of coffee/light lunches.
- An adequately sound-proofed room with an area of 5 m² per participant.
- Enough natural daylight.

The "bistro" seating pattern (see Figure 5) provides a suitable learning environment.

FIGURE 5
The bistro seating pattern

LEARNING ENVIRONMENT
SEATING PATTERNS

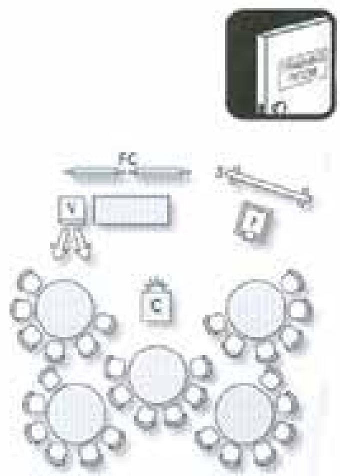
4 'Bistro'
Advantages

- Ideal for 'teambuilding' sessions and small group workshops
- Informal: encourages maximum trainee participation/identification
- Original: encourages open-mindedness
- Trainer can 'circulate'

Disadvantages

- Some participants have poor visibility or may be constantly at an angle to screen/flip chart
- May foster lack of attention and encourage side conversations
- Encourages splinter group identification

28 **FC = Flip Chart / P = Projector / S = Screen / C = Carousel / V = Video**



Source: Lindeque (2010).

Information material (printed maps and manual)

QM workshop participants should be provided with the following materials in the national language:

- A list of QM questions and answers extracted from the manual (FAO and WOCAT, 2011).
- The LUS map in at least A3 format.
- If required, the paper-based forms (assessment matrix) for completing the QM (Annex 2).
- If required, computers equipped with LADA software and projectors.

Google Earth images of the assessment area (printed or projected) would be useful for orienting participants, enabling them to see the area in context and indicating, for example, the extent of a specific type of LD. Aerial photographs, if available, could perform similar functions. If GIS experts are present at the workshop, they may be able to tailor maps on the spot, based on requirements.

For collecting information, the workshop can be organized in one of two ways. Ideally, the workshop group completes the QMs using the QM software; this requires that each group has a laptop and a projector. In the second kind of approach, likely to be preferred in countries that lack sufficient infrastructure, the QM is completed in paper form (Annex 2) and the information later digitized using the QM software.[3]

The direct use of the software simplifies GIS mapping during workshops and reduces errors associated with transcription. On the other hand, some participants may be more comfortable using paper-based forms, especially those lacking experience in computing. When paper-based forms are used, ideally the data are put into the QM database during the workshop to enable the preparation of at least some maps before the end of the process. Table 7 presents the equipment requirements for the two approaches. Most often, a mix between the two types is used, in which groups that are most comfortable working with paper-based forms do so and use laptops and projectors for identifying areas and otherwise guiding their assessment. Simultaneously, one person – often the GIS expert – inputs data using the digital form.

TABLE 7
Equipment for a QM workshop

	Laptop	Database installed in laptops	Projectors	Paper-based maps	Paper-based forms
Equipment for direct input of QM data	1 per expert group + 1 per GIS expert	Yes	1 per expert group	Yes	No
Equipment for use of paper-based forms	1 per GIS expert	Yes	2 for final validation*	Yes	Yes

Note: * It is suggested that two projectors are used for validation towards the end of the workshop. Workshop participants can be divided into two groups that work in separate rooms, each assisted by a GIS expert.

Step 4: Collect existing information on LD and SLM in preparation for PEA workshops

The importance of collecting all available information on LD and SLM in preparation for PEA workshops is discussed in Step 2. For example, if a report exists on the extent of soil erosion in a specific area, this can inform experts when the variable "the extent of land degradation" needs to be estimated.

Before a workshop, facilitators should work through the available information on the area to be assessed to familiarize themselves with the types, causes and impacts of LD in the area.

FACILITATING AND COMPLETING A TYPICAL PEA WORKSHOP

The facilitation of a PEA workshop typically involves the following seven steps:

1. Step 1 Opening, welcome and participant introduction.
2. Step 2 Workshop context and rules of engagement.
3. Step 3 Explaining the LUS map and agreeing on mapping units to be assessed.
4. Step 4 QM completion –
    - Part 1: Land-use change assessment
    - Part 2: LD assessment

[3] The QM software is available at www.fao.org/nr/lada/QM.zip

- Part 3: Conservation and SLM assessment
- Part 4: Expert recommendations.

5. Step 5 Verifying data and initial assessment results.
6. Step 6 Way forward.
7. Step 7 Workshop evaluation and close.

Each of these steps is discussed below (and Table 8 presents a typical workshop programme). Note that these are guidelines only and that the number of steps, and their order, can be changed to suit specific needs.

Step 1 Opening, welcome and participant introduction

The opening and welcome is usually done jointly by the hosting institution and the project leadership. The project manager then introduces the facilitator, who takes over the facilitation. After introducing himself or herself, s/he invites participants to introduce themselves and explains the programme, the logistical arrangements and the day's timetable. Participants will want to know the timing of breaks and the location of bathroom facilities.

In some countries, participants need to complete a form containing their details before commencement of the workshop. This is good practice for all workshops because it can serve as a database of workshop participants.

Step 2 Workshop context and rules of engagement

This step can be presented by the facilitator or the project manager – explaining the project to participants and outlining why a national LD and SLM assessment is needed and who decided to initiate the process. At the end of this session, participants should understand why they are at the workshop and what is expected of them.

Participants should agree on the rules of engagement, or "ground rules", for the PEA workshop. Because such workshops are usually highly participatory, the facilitator and participants should agree on a set of rules that will ensure the workshop proceeds effectively and efficiently. These ground rules should be written on a flip chart and later posted on a venue wall as a reminder to participants.

Step 3 Explaining the LUS map and agreeing on mapping units to be assessed

Because the LUS map forms the basis of the LD and SLM assessment, a good understanding of the LUS map and the LUS classes is essential. This step can be presented by one of the GIS experts who led the process to develop the LUS map, or by the project manager.

Participants need to understand not only the map but also the mapping unit concept and the spatial scale at which they need to provide information. Printed LUS maps will help in this step. Participants need to understand that a QM must be completed for each mapping unit. A list of the mapping units is shared with participants in this step, corresponding with the combination of LUS and administrative classes.

When there is a shared understanding of the LUS map and the number of mapping units to be assessed, the process of filling out the QMs can begin.

Step 4 QM completion

This step will take the most time; it relies mainly on inputs from participants and will take 1.5–5 days, depending on the number of mapping units to be assessed and the capacity of workshop participants.

A detail explanation of the QM methodology is contained in FAO and WOCAT (2011).

The following are pointers on handling this part of the workshop:

- Divide participants into thematic groups according to LUS classes. For example, divide participants according to administrative boundaries (e.g. districts) when there is sufficient representation for all LUS classes in each administrative unit. An alternative to this approach is to put all participants with expertise in a given land use (e.g. rangeland management, farming or protected areas) into separate groups, which are then responsible for completing QMs for all mapping units in which that LUS class is dominant. The facilitator must ensure a balance between groups in terms of both the number of participants and the workload.
- New concepts and variables should be introduced consecutively to allow groups to discuss each in turn, reach consensus and complete that part of the assessment matrix. This might be time-consuming but ultimately it will save time by reducing the scope for confusion. As soon as each group has obtained sufficient understanding of the variables, it can continue at its own speed. The facilitator can move between groups to ensure a consistent approach to variables and definitions and to answer queries.
- Ideally, each group will capture data on a hard-copy form. Groups might prefer to input data straight onto the computer, but it might be a good idea to also keep a hard copy as backup. Often, digitized data are not saved properly and hours or even days of work can be lost.
- The facilitator must ensure that the workshop progresses at an even pace and that all groups move forward effectively and efficiently. Facilitators should be aware that this kind of work can be tiring. Should energy levels fall among participants, it might help to call a 20-minute break and send participants outside for fresh air and exercise.
- It is important to achieve consensus within and among groups. Groups may discuss issues but, after a certain limited time, they should be requested to reach consensus and move on. The process of reaching consensus is often time-consuming and may need to be managed by the facilitator. A good approach is to appoint a discussion leader and a timekeeper for each group; these positions can rotate within the group.
- If a participant in one group raises an issue that is relevant to all groups, it may be worthwhile to meet briefly in plenary to discuss it. In a qualitative assessment based on perceptions, it is crucial that participants have a common understanding of important concepts. This principle also applies between workshops. What is said and explained to participants at PEA workshop 1 must be explained in the same way at PEA workshop 2. For this reason, it will help if facilitators keep notes of discussions as the workshops proceed.
- Participants are free to use the maps, documents and other information they have brought with them to inform their estimates and the values they assign in the assessment matrix.

Step 5 Verifying data and initial assessment results

As soon as sufficient data have been digitally captured in the assessment, the GIS experts present at the workshop can start processing the data and preparing maps. Although these are only initial results, they can play important roles in achieving consensus between groups – as illustrated in the following example:

Participants from four administrative districts are present at a PEA workshop in country A. Each district includes cultivated land, and the assessment matrix has been completed in groups representing the districts; thus, different groups have assessed the cultivated land in each of the four districts. The GIS experts process the data and display the results in a map, showing, for example, the percentage of the total mapping unit subject to LD. The extent of degradation on cultivated land has been indicated at 20 percent for district 1, 30 percent for district 2, 15 percent for district 3 and 80 percent for district 4. The representatives of districts 1, 2 and 3 want to know why the extent of LD is so high in district 4 compared with other districts. After discussion, the representatives of district 4 realize they have overestimated the extent of LD and adjust their estimate accordingly (similarly, the representatives of districts 1, 2 and 3 might realize they have underestimated LD).

Ultimately, all participants should agree on most of the results and produce what might be termed "consensus maps". Additional information, if available, can be used in this verification process. The adjusted values must be corrected on both the hard-copy and digital forms.

Step 6 The way forward

Towards the end of a PEA workshop, participants usually want to know what will be done with the collected data. In answering this question it is important to assure participants that their efforts have been worthwhile. Explain how the data will be analysed, how analysis will be used for informed decision-making, and how ultimately the process will help address LD and SLM. Emphasis should be placed on how the QM assessment data will be used to better understand LD in the country and to identify priority areas for intervention, thereby enabling the best use of resources to address the problem. Ensure that participants receive copies of the final assessment reports.

Step 7 Workshop evaluation and close

Before closing the workshop, give participants an opportunity to evaluate the overall workshop process as well as elements such as facilitation, venue and logistics. This feedback should be used in organizing future PEA workshops. The project team should build on the positive feedback and address negative issues.

TABLE 8
Example of QM workshop programme (Using paper form)

DAY 1
8.30 Registration
9.00 Salutations of authorities
9.30 Facilitator presents the method, the LUS map and examples of QM results from other countries and, with the help of the national coordinator, asks participants to split into groups based on their geographical expertise
10.00 QM compilation (LUS change trend)
10.30 Coffee break
11.00 QM compilation (completion of LUS trend, start LD assessment) (Facilitator discusses data collection with GIS experts)
13.00 Lunch
14.00 QM compilation (LD assessment continued) (GIS experts start working)
15.30 Coffee break
16.00 QM compilation (LD assessment continued)
17.00 Wrap-up and close by facilitator, potentially presenting an LUS trend map of the area
DAY 2
8.30 QM compilation (LD assessment continued)
10.30 Coffee break
11.00 QM compilation (LD assessment continued)
13.00 Lunch
14.00 QM compilation (SLM assessment)
15.30 Coffee break
16.00 QM compilation (SLM assessment continued)
17.00 Wrap-up and close by facilitator, potentially presenting one or two LD maps
DAY 3
8.30 QM compilation (SLM assessment continued)
10.30 Coffee break
11.00 QM compilation (SLM assessment continued)
13.00 Lunch
14.00 QM compilation (SLM assessment continued)
15.30 Coffee break
16.00 QM compilation (some groups might complete early and leave)
17.00 Wrap-up and close by facilitator, potentially presenting one or two LD maps created by GIS experts (GIS experts stay until all data collection is completed)
DAY 4
8.30 Validation (general presentation of some maps, presentation of data in table format and checking; all experts check all results)
10.30 Coffee break
11.00 Validation (continued, in groups that include people from different areas; each group has a nominated facilitator)
13.00 Lunch
14.00 Validation (continued)
15.30 Coffee break
16.00 Presentation of final data by GIS experts. Facilitator wraps up and closes meeting

Note: the length of each item is indicative only and is dependent on the size and complexity of the country and the number and capacity of participants.

MAPPING AND VALIDATING OUTCOMES OF PEA WORKSHOPS

As the assessment results are captured at a PEA workshop, GIS experts start preparing maps to be used during the workshop to harmonize results between groups and to help obtain consensus among participants on the status of LD and SLM in the assessment area (examples are presented below).

The overall outcomes of the assessment need to be verified. It would be expensive to verify all results; therefore, a sample should be selected usually comprising a "red-spot" area with serious LD and a "green-spot" area with good SLM measures in place.

Mapping questionnaire results

The maps in Table 9 were produced in the Kagera TAMP using simple indicators and interpolations of the QM results. Although PEA workshops are generally conducted with the support of GIS experts, it is unlikely that all potential maps will be ready by the end. It is necessary, therefore, to plan time for map preparation. Ideally, one or more of the GIS experts who participated in both, the LUS mapping and QM phases, are put in charge of this unit, which might take 2–3 weeks to complete depending on the capacity of the GIS experts, country interests, the testing process, the size of the country and the number of maps required. The assessment variables can be combined in various ways, but not all these need to be mapped. Several LADA-participating countries did not produce a large set of QM maps. It is essential that sufficient time and funds are committed to the mapping phase, which is just as important as previous phases because of the effectiveness of maps as decision-making tools. On its own, the raw geographic database would be too complex.

A training manual is being prepared to simplify GIS mapping processes; it will feature the Kagera TAMP, in which 80 maps per country were developed. Table 9 lists some of the maps prepared for each country involved in the Kagera TAMP; it shows biological degradation types, but maps can be prepared for any degradation type.

TABLE 9
List of maps prepared for each country involved in the Kagera TAMP

General maps
1. Trend of LUS change
2. Trend in LUS change intensity
3. Degradation extent
4. Degree of land degradation
5. Degradation rate
6. Extent of SLM practices
7. Effectiveness of existing SLM practices
8. Degradation with impact: negative high and very high
9. Principal types of land degradation
10. Total degradation index or degradation severity
Maps by type of land degradation (the example used is *biological degradation* based on the general map 9)
Compare: Degradation extent Degradation severity
List most important direct causes due to *biological degradation*
Most important indirect causes of *biological degradation*
Compare: Types of impacts of *biological degradation* on ecosystem services Level of impacts of *biological degradation* on ecosystem services
Negative impact of *biological degradation* on ecosystem services
Comparison of degradation versus conservation on *biological degradation* Compare: Effectiveness of existing SLM technologies and measures against *biological degradation* Severity of *biological degradation*
SLM practices against *biological degradation* Compare: Effectiveness of existing SLM technologies and measures against *biological degradation* Effectiveness trend of existing SLM technologies and measures against *biological degradation*
Conservation – *biological degradation* Groups of conservation technologies
SLM extent and objectives of adopted measures – *biological degradation*
Compare: Objectives Extent of SLM technologies against *biological degradation*
Zones where *biological degradation* is addressed by SLM. Compare: Degraded areas (with *biological degradation*) SLM intervention against *biological degradation*
Conservation practices (agronomic, management, structural and vegetative maps)
Types of conservation impacts and of SLM on *biological degradation.* Compare: Types of degradation impacts on ecosystem services Types of conservation impacts on ecosystem services
Positive impact of SLM in areas with *biological degradation*
Best practices against *biological degradation*

Note that the QM results can also be mapped without following particular rules, and each country can combine, merge or interpolate indicators and maps based on specific country requirements; indeed, they are encouraged to do so by customizing the available options and producing results based on their needs. This means regular communication with policymakers and decision makers at the national and subnational levels to ensure that their specific information needs are clear. A tendency of mapping only the database's simple QM indicators without interpolation has been observed, but this could be considered reductive.

Validating the QM maps

Unit 2 presents the general approach to validation for LUS maps. Contrary to the validation of LUS maps, however, the QM validation process mostly involves a qualitative assessment of the LD and SLM estimates (the misidentification and misclassification of LD and SLM are common errors), in which in-depth field surveys are conducted in sample areas within major LUS categories to verify the findings made by PEA participants. The validation process should involve LD/SLM experts and should verify the appropriateness of the technical judgements made. The field procedure has three major components:

1. Organization of the validation.
2. LD and SLM impact assessments.
3. Final data management.

Each of these is described in more detail below.

Organizing the validation

To avoid undue bias in validation results, the validation team ideally comprises a different group of experts to that involved in the PEA workshops, although this may not be possible if there is a lack of available expertise. Alternatively, it is suggested that only one participant of a PEA workshop take part in field verification, assisted by experts in the functioning of the main LUS classes to be verified (they might include, for example, an agronomist, a botanist, a livestock specialist, a forester, a sociologist, a soil scientist and a water resources specialist).

The equipment needed includes GPS- and GIS-equipped laptops and all-terrain vehicles. The process involves geo-referenced observations and photographs that illustrate LD and SLM features and the extent and severity thereof. LD features are often at specific locations and positions in landscapes where the negative impacts of a given LUS are amplified. It is highly likely, for example, that livestock watering places and corridors will be affected by compaction; sloping areas are much more likely to show water erosion features; and peat soils are likely to show subsidence features. Such areas could be focused on for documentation.

Sampling strategy

Because the objective of the LD and SLM assessment is to promote SLM interventions, it is recommended that sampling and verification focus not only on those LUS that cover the largest areas in a given administrative region (which is easily derived from the LUS map) but also on areas where management shows a high degree of sustainability. Usually there will be several of these in each administrative region, so one or two should be selected for field verification by random or stratified sampling. A detailed explanation of how to set up such a sampling scheme is beyond the scope of this document but is available in FAO (1989). An important consideration is the time and resources available:

in any case, priority should be given to major LUS and those with high sustainable indices and which are moderate to large in extent. Limits on the verification should be established (for example, no more than four LUS classes per administrative region should be surveyed).

The approach used should be straightforward because the polygons used as the basis for the QMs have already been validated through the LUS mapping process. Here, the aim is to verify the overall reliability of LD characteristics, biophysical causes, socio-economic drivers and land management systems, together with the livelihood conditions within the LUS. It needs careful preparation. Not every parameter can be checked and verified: the extent of LD features is a good example of a parameter that is difficult to estimate, even at the local scale. The exact number of hectares affected by, say, gully erosion (which extends well beyond the actual gully) or groundwater pollution (which extends well beyond the points at which it is observed) are hard to estimate accurately. Even if this were possible for a village or community, it would still not be possible to extrapolate to other villages within the same LUS.

It is suggested that 1–2 observations are made for each LUS selected in the sampling strategy. Over the entire area, a few villages or communities should be selected for a closer examination of the indirect causes of LD. An option to reduce the time and number of observations is to pass, by car, through the various LUS over main roads to assess the biophysical correctness of the assessment, then to choose a small number of zones to analyse the assessment in detail with the support of experts and communities. Note that, in this approach, the validation process will be limited by road infrastructure.

The field survey procedure

The field ground-truthing procedure should include all the following aspects (with the types of people who should be involved shown in brackets):

- Characterization of type, status and trends of LD (soil, water and vegetation scientists).
- Direct and indirect causes of LD (sociologists in discussion with villagers and user groups).
- SLM in place and its effectiveness (technical experts such as agronomists and foresters).
- The impacts of LD and SLM (technical experts and sociologists).

The survey questions posed will depend on the national and local context and can be customized based on the questions contained in the QM. The time taken to develop these to suit the local context is usually well spent: in Burundi, for example, detailed advance preparation meant that the entire field verification procedure in one LUS took only a few days.

Data analysis

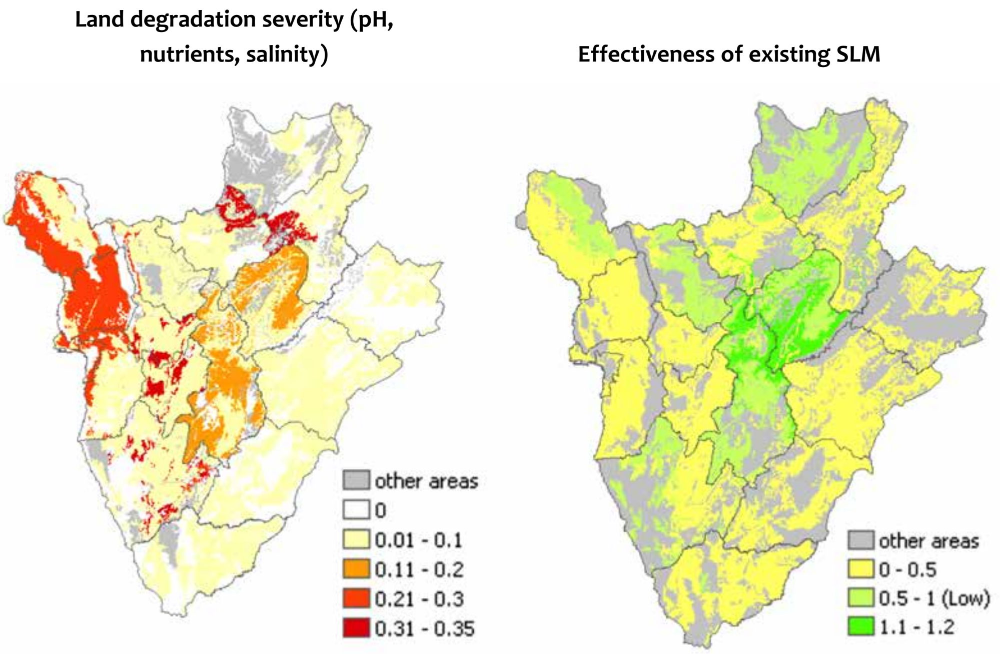
As for the LUS mapping validation, a database with the results of the QM validation process should be prepared and a desk analysis undertaken. Survey responses are compared with the QM database and maps and a contingency table (real versus QM) is created to determine map correctness. If the results of the validation are considered insufficient, the QM process will need to be repeated (see Box 9). Although convening additional PEA workshops might seem expensive and problematic, it has occasionally been necessary in the past to achieve reliable results.

Box 9. National correlations of subnational results and feedback

In cases where validation is conducted by several decentralized teams, national-level coordination is required (e.g. by a national team leader) to harmonize results. Harmonization can be achieved through at least one meeting of all teams during the final desk exercise and by convening a correlation workshop after field verification at which all results (particularly those in bordering mapping units) are discussed. Where differences along borders are significant and opinions divergent, a joint visit to the contested area could help establish the true extent or nature of LD and SLM. The need for such visits can be minimized and differences resolved using the documentation and photographs taken during the verification process.

Figure 6 presents an example of completed and validated QM maps for Burundi.

FIGURE 6
Land degradation severity and land management effectiveness, Burundi



Unit 4 – Developing an assessment report

Learning objective for Unit 4

Obtaining an understanding of:

- The importance of developing and publishing the national LD and SLM assessment outcomes.
- Aspects and topics to be addressed in the national assessment report.
- Final steps towards project closure.

THE IMPORTANCE OF PUBLISHING NATIONAL LD AND SLM ASSESSMENT OUTCOMES

From units 1–3 it is clear that much time, money and effort by various stakeholders is invested in national LD and SLM assessments. It would be a waste if this new knowledge and understanding were not shared as widely as possible.

The team's creativity is the only limitation on the means by which assessment outcomes are distributed. Some governments might require a formal or technical report, and some might require only an executive summary and policy recommendations, with details published on a website.

The final step in the assessment, therefore, is the preparation of maps, atlases, leaflets and other dissemination and awareness-raising materials. National authorities can decide on the type of information to be distributed and on the extent to which the assessment database will be made accessible to stakeholders and the public. Materials can be disseminated via a public-access interactive website or printed for distribution to decision makers and participants in the assessment process. It is crucial that the assessment outcomes are available in a useful form for those decision makers with responsibility for prioritizing SLM interventions. Although the communication of assessment outcomes to ensure effective SLM interventions is beyond the scope of this document, the following points should be considered:

- Provide decision makers with a picture of the state of natural resources and put it in context by summarizing the extent to which land is seriously degraded in the country and in each of the main LUS.
- Tell the stories of the most common types of LD for the most common LUS, summarizing the main causes and trends and the impacts of LD on ecosystem services.
- Tell the stories of successful SLM interventions in the country, including the commonly deployed SLM measures for various LUS and their effectiveness in mitigating LD.

- Identify and geo-reference best SLM practices and approaches for scaling these up.
- Report on SLM implementation and performance and analyse barriers to further uptake.
- Inform policymaking on appropriate planning approaches and advise on priorities for budgetary allocations.
- Build a dataset to serve as a baseline for SLM approaches and their monitoring and assessment.
- Identify areas for detailed local assessments.
- Use results to inform decision makers on the wisest uses of natural resources.
- Provide a solid basis for reporting to relevant UN conventions (particularly the United Nations Convention to Combat Desertification, the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change) and the Sustainable Development Goals.

A public repository or website should be used to host relevant documents, multimedia products (e.g. a photo library), the GIS database and maps. A user access policy should be developed: ideally, all stakeholders involved in the process will be able to access all information, and other users should be able to access at least summary products. Networks of related users could be established to maximize map use.

The planning, implementation, assessment and verification of LD and SLM at a national scale can be a daunting exercise. A second national assessment will be needed in 5–10 years, and the first assessment provides an opportunity to build knowledge and skills among the next generation to ensure that subsequent assessments are efficient and effective. Succession planning will help ensure that crucial roles and responsibilities are passed on to the next generation through involvement, mentoring and the transfer of skills and knowledge.

Finally, these guidelines show the importance of good planning for obtaining the best results and the importance of validating expert opinions. In the assessment process described in this document, land users and experts jointly determine the agenda, process and actions. Most importantly, all stakeholders are involved in producing, analysing and reflecting on the information generated, and the conclusions reached are based on their knowledge and experience. Participatory research involves inquiry, action and discussion on the problems faced, their possible solutions, and the actions that need to be taken. This process is reflected in the maps produced and the recommendations made by participating experts.

References

FAO. 1989. *Sampling methods for agricultural surveys*. FAO Statistical Development Series No. 3. Rome (also available at: www.fao.org/fileadmin/templates/ess/ess_test_folder/Publications/SDS/3_sampling_method_for_agricultural_survey.pdf).

FAO 2011. *Land Degradation Assessment in Drylands: mapping land use systems at global and regional scales for land degradation assessment analysis. Version 1.1*. Rome (also available at: www.fao.org/nr/kagera/tools-and-methods/ lada-local-level-assessment-manuals/en).

FAO. 2013. *Land degradation assessment in drylands: methodology and results*. Rome (also available at: www.fao.org/3/a-i3241e.pdf).

FAO & *WOCAT*. 2011. *Questionnaire for mapping land degradation and sustainable land management (QM). Version 2*. Rome (also available at: www.fao.org/docrep/017/i3240e/i3240e.pdf).

Lindeque, L. 2010. *Training manual for the assessment of land degradation and sustainable land management based on the LADA/WOCAT mapping methodology (QM).* LADA country report: South Africa (also available at: www.fao.org/nr/lada/index.php?option=com_docman&task=doc_download&gid=583&Itemid=165&lang=en).

Panzeri S., Magri, C. & Carraro L. 2008. *Sampling bias*. Scholarpedia, 3(9): 4258.

Petri, M. & Bunning, S. 2013. Case study 2.7. Assessing ecosystem services at a territorial scale – options for policy making, planning, and monitoring in the Kagera river basin. In: *Climate-smart agriculture sourcebook*, pp. 70–72. Rome, FAO (also available at: www.fao.org/docrep/018/i3325e/i3325e.pdf).

Annex 1 – Downloadable GIS global data

GLC2000	http://forobs.jrc.ec.europa.eu/products/glc2000/glc2000.php
Globcover	http://due.esrin.esa.int/page_globcover.php
European Space Agency Climate Change Initiative – Land Cover	http://www.esa-landcover-cci.org/?q=node/169
Global map of irrigated areas (FAO)	http://www.fao.org/nr/water/aquastat/irrigationmap/index10.stm
Global Rural-Urban Mapping Project database at the Center for International Earth Science Information Network	http://sedac.ciesin.columbia.edu/data/collection/grump-v1
World Database on Protected Areas	https://www.iucn.org/theme/protected-areas/our-work/world-database-protected-areas
Gridded Livestock of the World	http://www.fao.org/ag/AGAinfo/resources/en/glw/home.html
AgroMAPS until about 2010; other statistical data	http://kids.fao.org/agromaps/
CountrySTAT	http://countrystat.org/
Global Administrative Unit Layers (note: if statistical data are used, a map of administrative boundaries is needed)	www.fao.org/geonetwork/srv/en/metadata.show?id=12691
WorldClim 1970–2000	http://worldclim.org/version2
Global Agro-ecological Zones	www.fao.org/nr/gaez/en/
Harmonized World Soil Database	www.fao.org/soils-portal/soil-survey/soil-maps-and-databases/harmonized-world-soil-database-v12/it/
SRTM_1km.tif CGIAR	http://srtm.csi.cgiar.org/
gpw-v4-population-density UNWPP	http://sedac.ciesin.columbia.edu/data/collection/gpw-v4/methods/method1
LandScan (adjusted 2012)	
Center for International Earth Science Information Network infant mortality rate	http://sedac.ciesin.columbia.edu/data/set/povmap-global-subnational-infant-mortality-rates

Annex 2 – Data entry table

This annex comprises the paper-based QM form, with one form to be completed for each mapping unit (LUS by administrative unit). Paper copies of the form should be made available at PEA workshops, as required.

Name of LUS__________________________ Administrative unit _______________________

a) LUS area trend	b) LUS intensity trend	c) Remarks (e.g. reasons for trend)

Land degradation

type			b) extent	c) degree	d) rate	e) direct causes	f) indirect causes	g) impact on ecosystem services	h) remarks
i)	ii)	iii)							

Name of LUS________________________ Administrative unit ____________________

Conservation

a)name	b)group	c)measure			d)purpose	e)% of area	f) degradation addressed			g) effectiveness	h) effectiveness trend	i)impact on ES	j)period	k) reference to QT	i) remarks

Expert recommendation

Expert recommendation	Remarks and additional information

ISBN 978-92-5-131363-3

9 789251 313633

CA3999EN/1/04.19