CHAPTER FOUR

4. LAND DEGRADATION ASSESSMENT

Why Understanding **Land Degradation Assessment?**

To improve understanding of causes, impacts, degree and acquaintances with climate, acquaintances with climate, soil, water, land cover and socio- -economic factors. A primary goal in decision support systems for reversing degradation

Assessment: identification of site with high degradation risk

In order to prevent land degradation, it's essential to first evaluate the current land degradation status and underlying causes.

LADA (Land Degradation Assessment in Dry lands project)

is a scientifically-based approach to assessing and mapping land degradation at different spatial scales – small to large – and at various levels – local to global. It was initiated in dry lands, but the methods and tools have been developed so as to be widely applicable in other ecosystems and diverse contexts with minimal required adaptation.

To avoid a negative bias due to a focus only on land degradation, LADA also assesses and maps land improvement or sustainable land management (SLM). The LADA- set of tools and approaches provides balanced information and mapping capabilities on land resources status and trends in any given area, as well as on their causes, impacts and the actual and potential future responses.

LADA's main objective, using its mapping and assessment tools, is to identify and understand the causes of land degradation and the impacts of land use, including the effectiveness of current/recent responses, thereby enabling adequate and sustainable land management solutions to be devised. LADA provides a global monitoring and assessment system and an interlinked national and local level assessment and decision-support system on land degradation and improvement that enables stakeholders (national multi-sectoral teams) and agencies with land users at local level to identify and prioritize required national planning and policy interventions and actions on the ground for promoting the wide adoption of sustainable land management (SLM).

LADA provides:

- A multidisciplinary approach involving the range of concerned institutions and other stakeholders at national level and also in a few pilot areas at local level;
- A specific methodology for each scale / level for making an inventory, an assessment and a mapping of land degradation, conservation and improvement;
- A framework for linking the various scales and levels;
- Guidelines for the use of indicators;
- Capacity building nodes in most regions;
- A functional and well-maintained LADA knowledge base and website.

Tools for land degradation assessment

Tools	Advantages	Disadvantages
Expert Opinion	Rapid, Low Cost	Subjective, Unreplicable
Remote Sensing	Mod. Rapid/Mod. Low cost	Focused on land cover only
Field Monitoring	Objective, direct	Slow, High cost
Productivity Measurements	Direct observation of effect	Variation due to other factors
Participatory	Surveys Grass roots , Driving factors	Subjective, mod high cost.

An essential assessment of the current state of land degradation

Land degradation has sharply increased over the last 60 years, in both developed and developing countries, because of population growth and industrial development. Fighting this process is now a priority, particularly in developing countries, which host 75% of the World's population and where three out of four people work in agriculture. Restoring degraded land is expensive than prevention. In order to prevent land degradation, it is essential to first evaluate the current land degradation status and the underlying causes. So far the main obstacle to achieving such evaluations has been the lack of a standard streamlined international assessment procedure.

A simple method for assessing human-induced land degradation

This method is used to evaluate and map the current state and causes of land degradation. It can be applied at different levels, ranging from the farm to an entire country. This streamlined procedure can be implemented in different regions, but is most tailored to tropical and subtropical regions..

A map of the land degradation status has thus been developed, which is simple to use and understand by non-scientists. This map is based on a single composite land degradation index. It is also accompanied by a database managed via a geographical information system (GIS) that contains all data required to draw up and make effective use of this map.

This method consists of Two phases:

In the laboratory: processing of available data on the natural environment and socioeconomic setting (maps, archives, statistics, field data, etc.) These data highlight physiographic units* within the study area, which then form polygons** when plotted on a topographical map. Each unit may therefore be made up of one or several polygons dispersed throughout the target area. Aerial and satellite images are also processed to obtain an even more precise delineation according to the land-use pattern. At the end of this phase, a provisional polygon-based map is drawn up of the study area.

In the field: identification of three indicators in preselected test sites within the polygons. These indicators are: the degradation type, extent and intensity. Six complementary variables are also determined: degradation rate, trend, history, causes, soil vulnerability and off-site effects. Each polygon defined in phase 1 is characterized by these three indicators, in addition to its physical and socioeconomic characteristics, and land-use patterns.

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4.1. Indicator of land degradation

Early warning indicator

Early warning indicators are very important because they help society be better land status . For example, interms of natural plants the occurrence of ferns is typical of very acid soils that need to be corrected. Occurrence of termites is very common in overgrazed pastures and certainly the microbial population is affected.

Use of indicators

Generally, indicators are selected and used because people think that they reveal an underlying pattern that ties a cause with a problem or a problem with an effect. However, local

circumstances may be so different in one respect or another that the same indicator is a reflection of very different underlying relationships than the one it is thought to reveal. Global indicators (e.g. of soil erosion) are not directly applicable to regional, national nor local and farm levels, nor can regional indicators be applied to national or local and farm levels.

Thus indicators need to be developed for different levels. However, a set of criteria on which the indicators have to be based are required to ensure the relevance and usefulness of developed indicators and also consistence.. The group of indicators that has been developed by experts for use at global, regional, national, local and farm levels mentioned in FAO (2003 is too long and it is difficult to apply them directly. This was why the LADA project recommended using this list only as a starting point.A long list of recommendations is difficult for land users to apply and this may lead to missing important information which then may lead to biased conclusions. On the other hand, a small number of indicators may not be realistic across ecological boundaries.

Indicators need to be usable, measurable and have recognizable applicable data constraints. many scientists propose that indicators should be SMART: specific, measurable, achievable, relevant, and time-bound. Notably, indicators for land degradation assessment need to include evaluation of both on-site and off-site effects of the problem. Burning and Lane stressed careful evaluation of the relationships between biophysical condition in the context of changes in demographics, policy, land use, technology and management practices and natural events. Therefore, evaluation of on- and off-site effects will provide a basis for informed management decisions by a range of stakeholders from resource users and managers to technical advisers, planners and policy makers. This means that indicators for such specific purposes should be developed by people with a good understanding of the problem and its root causes and impact on the land.

. The good side of indicators is the high adaptability and applicability level, even by non-experts. As indicated above, indicators need to be developed by people with a good understanding of the problem and its root causes and impact; both scientific and local knowledge are required in this process. Local knowledge needs to be integrated with and validated by scientific knowledge to provide greater depth of explanation, and to help quantify the extent and magnitude of change.This is true in order to assure that local people will understand and so that it will be easy for them to apply the methods.

However, it is equally important to critically assess local perceptions against scientifically accepted principles and knowledge to allow room for improvement and avoid getting stuck in old ideas and practices. Science can provide measurements which are useful in informing management strategies; however local knowledge's of the ecosystem and land degradation are deeply, socially embedded and constructed within specific land management contexts, and this is not always reflected in scientific degradation assessments.

4.2. Method of land degradation assessment

The most common methods used to assess land degradation are: expert opinions, land users' opinions, field monitoring, observations and measurement, modeling, estimates of productivity changes and remote sensing. The methods have been applied to different approaches which use either qualitative or quantitative measures or both. Table below summarizes the systems assessed; assessment methods used; factors/processes/ and parameters of the land that is being assessed; and the units or values in which measurements were given for the different assessments of land degradation at different levels. Details are identified at the global, national, regional, and local and field/farm level. Below is a summary of the different assessment methods used in assessing land degradation processes in different systems at different levels.

The Summary of system of land; assessment method used; what was assessed and units/values at different levels

a. Global level

units/Systems assessed	**methods used**	**what was assessed**	
Full Cover Analysis Partial cover (soils/ rangelands/ agricultural lands/ drylands, etc.)	**experts opinion** (e.g. indicators, Questionnaires, etc.) **Remote sensing and GIS** (e.g. mapping)	Land/soil degradation: (severity, degree, extent) Soil (erosion, fertility, Productivity, etc.) Vegetation change Biodiversity loss	

b. Regional level

Systems assessed	methods used	what was assessed	

Dry lands, rangelands, grasslands, forests, deserts, etc., Soils, Rivers systems, etc.	**expert opinion** (e.g. indicators, questionnaires, interviews, focus groups, etc..) **Remote Sensing and GIS** (e.g. NDVI, MODIS, etc.) **Modeling** (e.g CORINE, PESERA erosion models, etc.) (mainly for croplands) **Field Monitoring and Measurements** (measurements to verify models) -pilot areas **Grid System Monitoring**	Land/soil degradation: - severity, degree, extent, impact, causes, & risks - Soils (erosion, fertility, productivity, etc.) Vegetation change Land cover Land uses Slopes Climate (rainfall, temperature) for modeling Biodiversity loss Landscapes/ Ecosystem Function	

c. National level

Systems assessed	**methods used**	**what was assessed**	
Lands (agricultural lands, grasslands, forests, conserved area, deserts, etc.), Soils, Rivers, Rangelands systems	**Expert Opinion** (e.g. indicators, questionnaires, interviews, focus groups ect.) **Land Users Opinion** (e.g. indicators, etc.) **Remote Sensing And GIS** (e.g. NDVI, MODIS, MSDI ect.) **Modeling** (e.g CORINE, PESERA models, etc.) **Field Monitoring and Measurements**	Land/soil degradation: - severity, degree, extent, impact, causes, & risky - Soil (erosion, fertility, Productivity, etc.) Vegetation change Land cover Biodiversity loss Land uses	

	(measurements to verify models) - pilot areas		
		Rangeland health/conditions, Climate (rainfall, temperature), etc.	

d. Local and Field/Farm levels

Systems assessed	**methods used**	**what was assessed**	
ealth – extremely unhealthy, etc.), t/ha/yr Lands (cropland lands, grasslands, forests, conserved area, deserts etc.), Soils, Rivers, Rangelands, etc.	**Expert Opinion** (e.g. indicators, questionnaires, interviews, focus groups, etc.) **Land users opinion** (e.g. indicators etc.) **Remote Sensing and GIS** (e.g. NDVI, MODIS, MSDI ect.) **Modeling** (e.g USLE/ RUSLE, CORINE, PESERA models, etc.) **Field Monitoring and Measurements** (verify models) - farm plots **Estimates of Productivity Changes**	Land/soil degradation: - severity, degree, extent, impact, causes, & risks;, Soil erosion (Sediment yields) Rangelands Health/ condition Soil condition (quality, salinity, stability, fertility, etc.), Crop yield & suitability, Soil condition, Landscape/ ecosystem function, Land cover, Biodiversity loss, Land uses, Climate (rainfall, temperature), etc.	

Local assessments have a triple purpose:

- To validate the sub-national assessment exercise;

- To collect additional data, in particular of a socio-economic nature, that help to clarify the causes and impacts of land degradation and sustainable land management, to assess responses and propose options to reduce degradation and promote appropriate land use and management practices;
- To provide a baseline for future monitoring.

Local assessments are more expensive than those at smaller (less detailed) scales, as they require interdisciplinary teams operating for several weeks in field work, analysis and reporting. A key task is therefore to choose carefully the areas where they will take place. LADA recommends that these areas should be representative of the major land use systems in the country and include both degraded land resources and improvements resulting from recent interventions.

4.3. Available model for different level/ scale

Modeling of Soil erosion and Land Cover

Assessment of soil erosion both by water and wind has been carried out using models designed for the purpose. The mathematical models are continually being improved and scientists from many countries have adopted them to meet the requirements of their local conditions Many more models have now been developed and used by different countries in different regions. Below is a summary of several models for measuring soil erosion and land cover used in different environments.

a. USLE Model

The Universal Soil Loss Equation (USLE) have been used worldwide to assess soil loss by water and wind erosion. They were first developed by the United States Soil Conservation Service (USSCS) in 1935. The equations have proved to be successful in assessing agricultural lands but not as suitable for rangeland assessment.One reason among others is that rangelands are said to be not uniform like agricultural fields. The society for Range Management, a USA-based

association of rangeland specialists, rejected the use of the USLE equation for assessing erosion on rangelands.

The USLE has been used widely in assessing long-term annual soil loss. An example cited here for the USLE comes from Italy, where, in an attempt to identify erosion-prone areas in the Mediterranean, a project was initiated to assess erosion risk at national level (EUSOILS, 2008).

An approach based on the Universal Soil Loss Equation (USLE) was adopted. The method only accounts for rill- and inter-rill erosion by water, but gully erosion, which is a major problem in

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b. RUSLE Model

The Revised Universal Soil Loss Equation (**RUSLE**) was applied to the whole alpine space of the Alps, with a specific setting on mountain areas for slope and rain erosivity parameters The alpine territory includes Italy, Switzerland, France, Austria, Germany, and Slovenia. The study produced maps that show the rate of soil erosion by water in the alpine territory. The map was basically derived from the RUSLE model, which calculates the actual sediment loss by soil erosion using Arnoldus's formula to determine the rainfall erosivity factor. The index values indicate the intensity of the soil erosion rate. The equation for RUSLE uses all factors of USLE, but P-factors for Human Practices aimed at erosion control were added.

RUSLE is still intended primarily to meet the needs of the USLE user, concentrating on predicting long-term annual average erosion by water on disturbed slopes.They said that the RUSLE effort followed the lead of the USLE in realizing that the users are not specifically erosion science experts, and emphasized making both the model use and the logic behind the calculations accessible to users. The results from a study in the western US rangelands shows that RUSLE provides routines specifically to model erosion on rangeland sites, including descriptions of rangeland vegetative communities and of range improvement field operations.The changes in RUSLE make it useful for estimating erosion and sediment yield, not only for agronomic settings but also for situations involving construction, mine spoils, and land reclamation..

c. CORINE Model

CORINE methodology is a standard method used by the countries of the European Community to determine the erosion risk and qualities of the land being studied.Countries of the European Community sharing the Mediterranean region have completed their erosion maps and classification of their lands using CORINE methodology.

The CORINE method of erosion mapping analyses several factors for the determination of actual erosion risk. These factors are: vegetative cover, land slope, meteorological condition and soil properties. The study utilized remote sensing (RS) and geographic information system (GIS) methods. They concluded that the existence of plant cover had highly reduced the potential erosion risk in the basin.

d. PESERA Model

The Pan-European Soil Erosion Risk Assessment (PESERA) is a run-off based model used to predict run-off with a daily time step, estimating changes in soil water storage capacity and vegetation interception and links this estimated run-off to soil loss. PESERA uses a process-based and spatially distributed model to quantify soil erosion by water and assess its risk across Europe.

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