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# EXPERIENCES IN MONITORING AND ASSESSMENT OF SUSTAINABLE LAND MANAGEMENT

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## ABSTRACT

Although sustainable land management (SLM) is widely promoted to prevent and mitigate land degradation and desertification, its monitoring and assessment (M&A) has received much less attention. This paper compiles methodological approaches which to date have been little reported in the literature. It draws lessons from these experiences and identifies common elements and future pathways as a basis for a global approach. The paper starts with local level methods where the World Overview of Conservation Approaches and Technologies (WOCAT) framework catalogues SLM case studies. This tool has been included in the local level assessment of Land Degradation Assessment in Drylands (LADA) and in the EU-DESIRE project. Complementary site-based approaches can enhance an ecological process-based understanding of SLM variation. At national and sub-national levels, a joint WOCAT/LADA/DESIRE spatial assessment based on land use systems identifies the status and trends of degradation and SLM, including causes, drivers and impacts on ecosystem services. Expert consultation is combined with scientific evidence and enhanced where necessary with secondary data and indicator databases. At the global level, the Global Environment Facility (GEF) knowledge from the land (KM:Land) initiative uses indicators to demonstrate impacts of SLM investments. Key lessons learnt include the need for a multi-scale approach, making use of common indicators and a variety of information sources, including scientific data and local knowledge through participatory methods. Methodological consistencies allow cross-scale analyses, and findings are analysed and documented for use by decision-makers at various levels. Effective M&A of SLM [e.g. for United Nations Convention to Combat Desertification (UNCCD)] requires a comprehensive methodological framework agreed by the major players. Copyright © 2010 John Wiley & Sons, Ltd.

KEY WORDS: sustainable land management; desertification; monitoring; impact assessment; methodological framework; multiple scales; participatory approaches

## INTRODUCTION

Monitoring and assessment (M&A) has conventionally been focused more on land degradation and desertification than on the sustainable management of land resources (including soil, water, animals and plants). Extensive research efforts have assessed land degradation—often focusing exclusively on soil degradation—in the field (e.g. Stocking and Murnaghan, 2001; Mortimore, 2009). These efforts tend to address the physical processes of degradation (e.g. Ritsema, 2004), its spatial extent and trends (e.g. Oldeman *et al*., 1991) or its causes and impacts (e.g. Dregne, 2002; Geist and Lambin, 2004). Other efforts have investigated the risks of degradation and desertification (e.g. MEDALUS—Kosmas *et al*., 1999) or produced recommendations (e.g. Barac *et al*., 2004) and provided decision support tools or manuals (e.g. Kellner *et al*., 2003; DESURVEY, 2005). There has been limited assessment of environmental and economic costs of land degradation, except for case studies or focused research (e.g. de Graaff, 1996). These studies have added much to our understanding of the complex problem of land degradation. However, a unified method-

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ology for M&A of land degradation that integrates sustainable land management (SLM), and that can be routinely applied worldwide, is only now beginning to coalesce.

This paper critically compiles current initiatives for the M&A of SLM. Such methodological approaches have been insufficiently discussed in scientific fora, as they have been mainly elaborated by development practitioners, although researchers have also been involved. These approaches have recently been brought together and discussed by an international consortium of scientists in the preparation of the First United Nations Convention to Combat Desertification (UNCCD) Scientific Conference, 22–24 September 2009 in Buenos Aires, Argentina. This paper reviews the current methodological initiatives, draws lessons from these experiences and identifies common elements and future pathways as a basis for a global approach for implementation by the UNCCD.

Land capability classifications emerged in the mid-20th century (Helms, 1992) and can be seen as a forerunner of SLM M&A. Such assessments, identifying biophysically sustainable versus unsustainable uses of particular soils and landscapes, continue to be useful worldwide. They guide society towards optimal land uses as well as indicating options to reduce risks—but they are not designed to provide land quality analysis over time.

In the late-1980s, the Global Assessment of Soil Degradation (GLASOD) produced the first global map of soil degradation (Oldeman *et al*., 1991), which has been extensively utilized by the UNCCD community. It had, however, a number of limitations. The assessment was conducted at a coarse scale (average 1:15Million); it was based on expert opinion and its focus was limited to soils. Two editions of a *World Atlas on Desertification* were published in 1992 and 1997, based on GLASOD and additional data, but at a higher spatial resolution (UNEP, 1997). These were single evaluation exercises at the continental and global scales and oriented towards the dominant environmental narrative of that period—that of a downward spiral of land degradation perceived as being widespread and pervasive (WOCAT, 2007). The World Overview of Conservation Approaches and Technologies (WOCAT) was founded in 1993 as a response to this bias, with a mandate to improve the knowledge base underlying SLM, through gathering information on the application of SLM worldwide. The focus on SLM complements the hitherto technical approach to land management with social and economic dimensions (Hurni, 2000). In response to the encouragement of UNCCD during the fourth Conference of the Parties (COP-4) to assess land degradation using the latest techniques, United Nations Environment Programme (UNEP) and Food and Agriculture Organisation (FAO) launched the Land Degradation Assessment in Drylands project - LADA - in 2001, with the financial support of the Global Environment Facility (GEF). Initially, it focused on land degradation, but the collaboration with WOCAT strengthened the SLM component of LADA, and together they are now fostering a comprehensive and cross-scale methodological approach. Likewise, the M&A of SLM had historically received much less attention from the UNCCD community than the M&A of land degradation. However, over the past two decades, SLM has gained recognition as the key means to combat land degradation, not focusing on soil alone as had been the case in the past, but also focusing on the degradation of water and vegetation (World Bank, 2006; IAASTD, 2008; Liniger and Critchley, 2008). The increased efforts and financial means put into the promotion of SLM require proper monitoring and evaluation methods as well as action. The DESIRE project (2007-2012; http://www.desire-project.eu) is developing and testing alternative strategies for desertification-vulnerable areas. Like WOCAT, DESIRE advocates an SLM approach based on inventories of local knowledge. Scientists are currently working in 16 study sites in 13 countries with an integrative participatory approach, in close collaboration with local stakeholders as well as having a sound scientific basis for the effectiveness at various scales.

The GEF (2009) has been the largest development initiative fostering SLM as a strategic intervention through its land degradation focal area. SLM is considered in a comprehensive manner, aiming at a global systems approach with mutual benefits for local people and the global environment (Stocking, 2009). GEF is currently developing tools to monitor and assess SLM progress in its project portfolio through its knowledge from the land (KM:Land) initiative. This project utilizes a hybrid SLM conceptual framework (see Figure 1) which well suits the methods described in this paper, providing an overview of the cause–effect interactions of degradation and SLM on environment and human well-being. It is termed 'hybrid' because it blends elements from two widely-known conceptual frameworks: that of drivers, pressures, states, impacts, responses (DPSIR; Smeets and Weterings, 1999) and the ecosystem services perspective used by the Millennium Ecosystem Assessment (MA, 2005). SLM is considered the 'response' to the 'drivers', 'pressures' and 'states' of degradation, which enhances the provision of ecosystem services and thus improves human well-being and reduces poverty. The 'state' component can be used as a proxy for changes in ecosystem services and subsequently human well-being, since the typical time frame of an intervention often prevents the measurement or observation of changes at this level.

One of the main tasks for scientific support of SLM is to produce evidence of its impact on natural resources and to assess the implications from such impacts on society, the economy and policy (Hurni *et al*., 2006). This is urgently

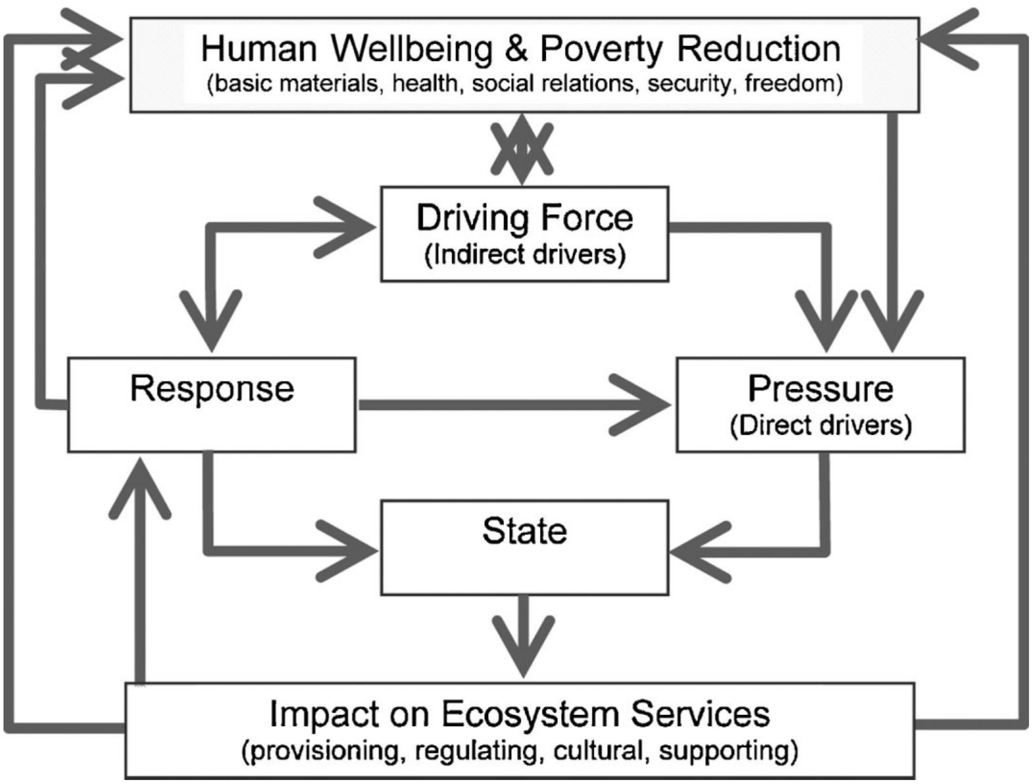


Figure 1. Hybrid SLM conceptual framework for monitoring and assessing impacts from SLM interventions, as suggested by KM:Land.

needed, as it is now widely acknowledged that SLM has potential major global benefits, not just to counter land degradation but to simultaneously sustain ecological functions, contribute to biodiversity conservation and as a tool in the mitigation of, and adaptation to, climate change (e.g. Gisladottir and Stocking, 2005; Cowie *et al*., 2011). There is a wealth of knowledge on technologies for prevention and mitigation of land degradation, and rehabilitation of degraded land. Many of these technologies have been applied and tested in the field or on experimental sites to assess their biophysical effectiveness (Bainbridge, 2007), but assessments of their cost-effectiveness, impacts on ecosystem functions and services, on overall ecosystem integrity and on the economy are still weak (Carpenter *et al*., 2006). Likewise, traditional land use systems and local land management innovations have been inadequately documented or assessed for their combined benefits in terms of productivity, conservation effectiveness and sustainability. However, the success of upscaling SLM depends closely on the cost-effectiveness, the supporting policies and other socio-cultural and economic conditions.

M&A is typically conducted within project settings. While the focus of M&A was conventionally on achievement of project outputs and objectives, attention has recently shifted towards impacts (de Graaff *et al*., 2007). For example, a practical impact M&A instrument, entailing six steps, was developed by an international group of development agencies, universities and individuals (Herweg and Steiner, 2002). It comprises both observation (monitoring) and interpretation (assessment by stakeholders) of the changing context, and aims at finding plausible indications—not scientific proof—of a project's impact. The ultimate goal of M&A is to analyse and document findings for use by decision makers at various levels. Learning and decision support tools built on solid information have been developed for various projects and have evolved to become more participatory, multi-stakeholder, multi-institutional and multi-sector. What is still required is more inter- and trans-disciplinary research to come up with a global approach for the M&A of SLM and to provide a more complete and scientifically proven picture of SLM impacts globally.

## CURRENT METHODOLOGICAL APPROACHES

### *Monitoring and Assessment Methods at the Local Level*

Implementation of SLM takes place at the local level, either by individual land users, communities or through technicians. Many investments in SLM have been made within development or research projects not only by providing new technologies, but also through supporting valid traditions or local innovations. A number of these experiences in SLM have been reported or analysed in research papers, project documents or extension manuals (e.g. Barac *et al*., 2004). Many, if not most, of these have analysed the biophysical effects but at plot scale only. Based on the premise that these SLM experiences are not sufficiently or comprehensively documented, evaluated and shared, the global WOCAT initiative (www.wocat.net) has developed standardized tools and methods to compile and evaluate the biophysical and socio-economic knowledge available on SLM at the local, regional and global scale. Having had an initial focus on soil and water conservation, it has since broadened its scope to embrace SLM. The tools allow SLM specialists (including land users, agricultural advisors, project managers, government officers, etc.) to share their knowledge of SLM implementation in-country and around the world (Schwilch *et al*., 2007; WOCAT, 2007; Liniger and Critchley, 2008).

The basic concept behind the WOCAT methodology at the local level entails

(1) assessing local case studies of successful SLM and their local spread and adoption,
(2) providing a standardized framework that allows comparison and sharing beyond the local scale,
(3) inclusion of socio-economic as well as biophysical aspects,
(4) use of the knowledge of both specialists and land users as data sources, backed up (triangulated) by scientific data where possible and
(5) simultaneously using the same tools for both (self-) evaluation and for knowledge sharing.

The key tools at the local level are two questionnaires on SLM technologies and SLM approaches, and their respective databases. These two applied together constitute a case study, which can be as small as one farmer's field or may represent hundreds of square kilometres (catchments, districts, etc). SLM technologies are the physical practices in the field, which are agronomic (e.g. intercropping, contour cultivation, mulching), vegetative (e.g. tree planting, hedge barriers, grass strips), structural (e.g. graded banks or bunds, level bench terrace, dams) or management measures (e.g. land use change, area closure, rotational grazing) that control land degradation and enhance productivity in the field. These measures are often combined to reinforce each other. The questionnaire addresses the specifications of the technology (purpose, classification, design and costs) and the natural and human environment where it is used. It also includes an analysis of the benefits, advantages and disadvantages, economic impacts and acceptance and adoption of the technology. Impacts are approximated through simple scoring by experts, but supplemented with data where available.

The associated SLM approaches are the ways and means of support that help to introduce, implement, adapt and promote those technologies on the ground. An SLM approach involves all participants (policy makers, administrators, experts, technicians, land users, etc; actors at all levels), inputs and means (financial, material, legislative, etc) and know-how (technical, scientific, practical). Questions focus on objectives, operations, participation by land users, financing and direct and indirect subsidies. Analysis involves monitoring and evaluation methods as well as an impact analysis. Successful approaches are the key to the up-scaling of technologies over larger areas and more land users.

The use of the WOCAT tools stimulates self-evaluation, as well as learning from comparing experiences within SLM initiatives where, all too often, there is not only insufficient monitoring but also a lack of critical analysis (Liniger *et al*., 2004; Schwilch *et al*., 2009). However, monitoring and evaluation of specific SLM implementations have often led to changes and modifications of technologies and approaches, reflected by the fact that SLM is constantly evolving. Successful SLM depends on the flexibility and responsiveness to changing complex ecological and socio-economic causes of degradation, to analyse what works and why and how to modify and adapt to locally specific circumstances and opportunities (WOCAT, 2007). It is this information about flexibility, adaptation capacity and impact, which has been requested by the end-users of WOCAT to extract from the questionnaires, without investing exhaustively in extra documentation time. Although the questionnaires have been continuously revised, shortened and adapted to better address new challenges—such as ecosystem services, adaptation to climate change and poverty alleviation—work is needed to deal with these issues more comprehensively. Nevertheless, the questionnaires are considered too long and demanding by a number of WOCAT users. This is a barrier to the increased demand of investors to acquire cost and impact data from SLM implementation.

The EU DESIRE project has integrated these local level WOCAT tools into a comprehensive participatory approach with a clear link to the regional level. Subsequent to facilitated stakeholder learning and decision support workshops (Schwilch *et al*., 2009) are field trials and monitoring, thereafter feeding into regional simulation and scenario models (Fleskens *et al*., 2009). This allows insights into the causes and effects of SLM strategies on environment and people at the local as well as the regional level. Information on proven and cost-effective SLM strategies adopted and accepted by local stakeholders is funnelled into the policy arena and disseminated to various other stakeholders such as land users, agricultural advisors, governmental authorities, NGOs and scientists. Being only a five-year project (2007–

 

2012), the methods and learning from DESIRE must be integrated and continued in long-term programmes to be ultimately effective.

Besides developing an improved mapping methodology (see Section 2), LADA has developed a manual for degradation and SLM assessment at the local level (LADA local), embracing a broad variety of methods. The manual outlines how to (a) conduct field observations, measurements and interviews with land users and key informants, (b) build on available secondary information and (c) how to analyse and report on the findings. The analysis helps to improve understanding of the drivers, causes, impacts and responses with regard to land degradation and SLM. The methodology has been tested with local communities and stakeholders in 3–6 pilot areas in each of the six LADA countries (Argentina, China, Cuba, Senegal, South Africa and Tunisia), providing a wide range of dryland situations and contexts. A team of approximately five people with multi-sectoral expertise needs 2–3 weeks to implement this assessment, including time for analysis and report writing. Despite the rapid nature of the approach, the methodology is designed to be robust enough to provide baseline data on land degradation and improvement for planning, priority setting and subsequent monitoring activities.

Other initiatives to assess and compile SLM experiences at the local level have focused on best practices or success stories such as those by UNEP (2002), FAO (2002), GM-CCD (Reij and Steeds, 2003) and IWMI (Penning de Vries *et al*., 2008). These have been mainly compiled within time-bound projects and seldom (if ever) entail long-term monitoring and knowledge management of the findings. Nevertheless, the approaches described above would benefit by adopting complementary elements from these and other assessment and monitoring concepts. One improvement would be to include information on varying land potential and land change mechanisms to help explain success or failure of SLM in different regions, and in different parts of the landscape within a region. Federal management agencies of the United States, for example, use the concept of 'ecological sites' to distinguish fine-scaled land units based on differences in the soil- and climate-based potential. The concept of land potential recognizes that several natural plant communities or agricultural uses are potentially observable on an ecological site, and are therefore potentially attainable. State-and-transition models are then developed to represent the possible changes, ascertained through participatory meetings, field inventories and remote sensing. Alternative states or different dynamic regimes are identified that signal either heightened vulnerability to undesirable change (as defined by the participatory process) or areas in which plant communities and ecosystem services will be difficult to restore (as defined by ecological processes). This information is routinely used to define the likelihood of success or failure of SLM at management scales (Bestelmeyer *et al*., 2009). Thus, ecological sites and state-and-transition models could complement the WOCAT/LADA approaches with the observations and local knowledge required for a more detailed understanding of ecological mechanisms.

### *Spatial Assessment Methods at the National and Sub-national Level*

Just as local assessment of land degradation cannot simply be aggregated to a watershed- or country-level, SLM assessments cannot be extrapolated or upscaled easily or linearly. Local case study assessments will never provide a complete overview of the spatial extent and effectiveness of SLM within a country, province or district due to spatial heterogeneity, off-site effects and cross-scale interactions. Research on cross-scale interactions, for example, has revealed nonlinear relationships between the variables measured locally and attributes of SLM at broader scales (Peters *et al*., 2004; Ludwig *et al*., 2007). It is, therefore, important to use separate methods for local and national/global scales, but with the possibility of linking them through a suite of common indicators (see also Reed *et al*., 2011). Common indicators allow integrating multiple spatial scales, which is essential when appraising ecosystem services; recognizing that many services are provided at the local scale, but driven by changes at national or even global scale. Local level M&A of SLM should, therefore, be linked with mapping at the (sub-) national and global scale in order to upscale local impacts of SLM on the one hand, and to support coarse assessments with local evidence on the other. Additionally, the scale at which assessment of SLM is feasible and logical might not necessarily be the same scale at which reporting (and decision-making) is required. This requires a nested approach in which the methods and results are spatially explicit regarding degradation processes, SLM interventions and ecosystem services affected. This also links to the Dryland Development Paradigm Principle 4 which emphasises the nested structure of the human-environmental systems (Reynolds *et al*., 2011). The spatial and temporal scale depends on the envisaged level of planning and decision-making. The assessment can be based on a variety of data sources, indicators and methods, including remote sensing, which has became a popular and more powerful method since images became more accurate and affordable over the last decade. It is possible to directly map some land degradation features from remote sensing images, using high resolution data (Bai *et al*., 2008; Verstraete *et al*., 2011). The WOCAT/LADA/DESIRE method presented below attempts to map SLM, using participatory approaches backed up by quantitative data and by using cross-scale categorization of land use systems, degradation types, SLM and their impacts on ecosystem

 

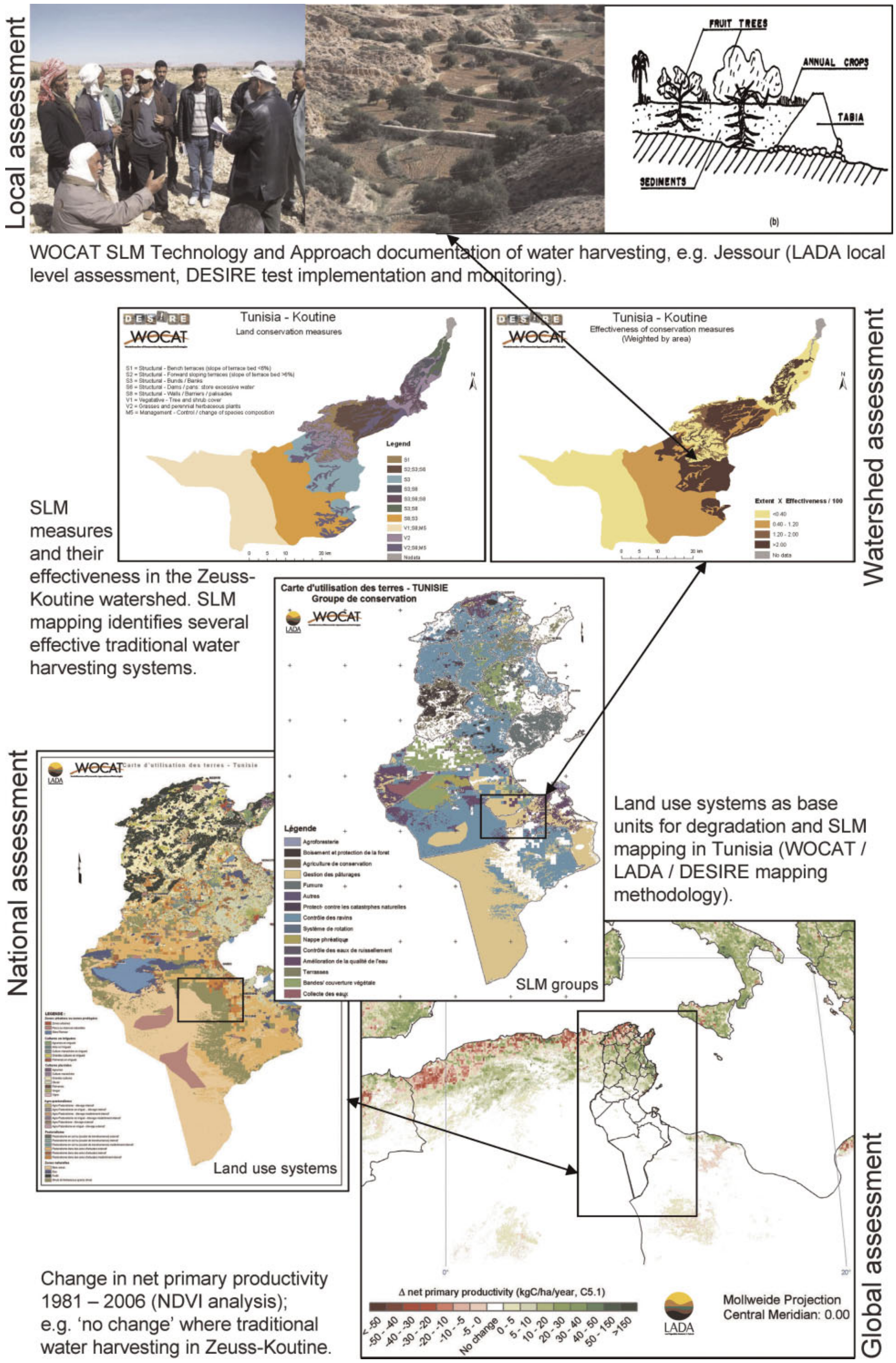


Figure 2. WOCAT/LADA/DESIRE methods applied across different spatial scales (example Tunisia. Sources: DESIRE-Tunisia, LADA-Tunisia, GLADA).

services, respectively. Other innovative geospatial methods and approaches are discussed in Buenemann *et al.* (2011).

For the development of a standardized mapping methodology, WOCAT, LADA and DESIRE joined forces in 2007. The principle of the WOCAT/LADA/DESIRE mapping methodology is that degradation and SLM are mapped on predefined units (described below). This does not mean that the exact spatial location of, for example, water harvesting technologies is delineated on a map, but that rather the extent is indicated as a percentage of a specific map unit. The map units are defined according to the biophysical and socio-economic variables influencing degradation and SLM, respectively, which can be land potential ('ecological sites' as introduced above) or land use. Within the methodology presented here, the mapping units are land use systems within local administrative areas (e.g. districts, municipalities, etc.). National land use systems are defined according to the principles presented in the Global Land Use Systems Map developed by LADA (Nachtergaele and Petri, 2008) and refined by countries at national level. These principles require that, besides biophysical attributes of land use, key socio-economic attributes, such as population density and poverty, are also reflected. This land use system procedure has in-built flexibility to permit more detailed local, provincial or catchment mapping where no land use system map is available at the appropriate scale, as for the DESIRE sites. The mapping methodology is, therefore, applicable at various scales, from village level to national or even regional level (see Figure 2). It is the number and size of mapping units which defines the level of detail and focus, and hence the relevant use of the results for decision-making.

The mapping questionnaire is filled out by local experts (extension officers, agronomists, soil and water specialists, etc.) familiar with the area, in consultation with land users, further drawing on various secondary data sources (e.g. maps, statistics). Information is collected on land use (trend in area and in intensity) and on a number of items related to degradation and to SLM. These items cover the same topics for degradation as for SLM; that is they are 'mirrored' as illustrated in the schematic Table I. The hierarchical nesting of observations across locations is illustrated by steps (a), (b), (c) and (d) in Table I (right column). Local-scale technology observations, such as bunds, low dams or bare fallow, nest hierarchically together in the SLM group 'Water Harvesting'. The hierarchical nesting approach allows the accommodation of broad local diversity while providing meaningful aggregation to higher scale levels. These aggregated observations have already passed through a 'quality assurance' filter through the judgments of the locally-experienced assessment teams, bringing together a large and diverse group of experts. Though originally derived from the GLASOD method, it assesses much smaller land areas with which the experts are familiar, and in more detail, thus improving the quality and accuracy of assessments. The expert consultations are carried out in a systematic and standardized way, in combination with scientific evidence such as analysis on land cover change derived from satellite imagery, normalized difference vegetation index (NDVI) and soil, water and vegetation analysis. Nevertheless, it remains a challenge for research to make optimum use of remote sensing information and incorporate it into this system, notably to calibrate spectral signals with various land degradation and SLM practices, and to assess ecosystem services. The surveys also attempt to diagnose some of the drivers of degradation such as human population and livestock density, consumption patterns, land tenure, poverty, labour availability, market access or civil conflicts.

This WOCAT/LADA/DESIRE mapping and reporting approach for the national and sub-national level would benefit from integrating more existing data sources. The Australian Collaborative Rangelands Information System (ACRIS; www.environment.gov.au/land/rangelands/acris/), for example, was developed to deal with the challenge of

Table I. Degradation and SLM information gathered through the mapping questionnaire

| Degradation within given land use system<br>*(a)–(g) indicating the questionnaire steps* | SLM practice within given land use system<br>*(a)–(k) indicating the questionnaire steps* |
|---|---|
| (a) Type(s) of degradation (incl. overlaps) | (a) Name of technology |
| | (b) SLM Group |
| | (c) Type of measure (agronomic, vegetative, structural, management) |
| | (d) Intention: prevention, mitigation, rehabilitation |
| (b) Extent (area percentage) | (e) Extent (area percentage) |
| (c) Degree | (g) Effectiveness |
| (d) Rate (over past 10 years) | (h) Effectiveness trends |
| (g) Impact on ecosystem services (type and level) | (i) Impact on ecosystem services (type and level) |
| (e) Direct causes | |
| (f) Indirect causes | (f) Degradation addressed |
| | (j) When was technology installed |
| | (k) Reference to documented technology in QT or concise details |

 

integrating large amounts of existing data from disparate sources. Meta-analysis techniques are used to synthesise information from different pastoral monitoring systems plus other monitoring datasets (e.g. climate variability, fire extent and frequency, livestock and kangaroo densities indicating grazing pressure, census and socio-economic survey data). The meta-analysis approaches utilized by ACRIS were successful in producing standardised interpretations from a body of heterogeneous data (Bastin *et al*., 2009). Such meta-analytical treatments could be used to provide additional quantitative support for the evaluations of the effectiveness of SLM technologies and mapped information derived from expert interviews.

National assessments and monitoring could eventually be based on more detailed quantitative programmes at varying levels of intensity. The United States National Resource Inventory (NRI), for example, is a statistically-based inventory of land cover and land use, based on photo-interpretation, field observations and measurements. Each plot is assessed relative to its ecological potential using 17 indicators of three attributes: soil and site stability, hydrological function and biotic integrity (Herrick *et al*., 2006). National maps of current status based on over 10 000 plots assessed since 2003 are being generated with the primary objective of informing national policy; however, the results are also applied regionally, and the methods are used at scales as fine as individual pastures.

Overall, the WOCAT/LADA/DESIRE methodology provides a reasonably cost-effective tool to assess land degradation, SLM, and—as much as possible—their impacts on ecosystem services at the present time. The LADA experience shows that the mapping (including land use systems classification and technical expertise) can be implemented for approximately US$250 000 in a country the size of South Africa. The assessment can be periodically updated at much lower costs to review progress. These approaches can be complemented by data-driven assessments and monitoring in the future, as resources become available.

### *Global Level Indicators and Knowledge Management*

At the global level the main interest groups in SLM comprise international organizations and conventions, donor agency programs and international policy makers. These include the UNCCD and the GEF Land Degradation Focal Area. In order to sustain support, one of the UNCCD's key interests is to demonstrate its success by assessing and monitoring progress towards impacts given in the 10-Year Strategic Plan of the Convention (UNCCD, 2008). Consequently, a set of 11 impact indicators was adopted at its last Conference of the Parties (COP-9) for this purpose. Out of those, a sub-set of two impact indicators (the proportion of the population in affected areas living above the poverty line and land cover status) are considered to be the minimum requirement for reporting by affected countries—starting in 2012. The others are considered optional. The methodologies for measuring these indicators are still being developed. The indicator selection process of the UNCCD so far lacks a clear framework.

GEF has invested considerably in a new global and systematic strategy for SLM (Stocking, 2009). To strengthen the management of its investments in its Land Degradation Focal Area, GEF initiated the long-term program termed KM:Land which is executed by the United Nations University—Institute for Water, Environment and Health (UNU-INWEH). A hybrid SLM framework (see Figure 1) has been used to formulate indicators at global and at project levels. At the global level, five biophysical and socio-economic core indicators (land cover, land productivity, water stress, rural poverty and income distribution) were chosen for the purpose of guiding decisions on resource allocation. The indicators are measured from available global datasets and existing methodologies such as those emerging from the global component of LADA (see also Schuster *et al*., in press). Consistent with the global indicators, project-level indicators are assessed at the (sub-) national level, and are then rolled up to evaluate the aggregate environmental and livelihood impact of investments of the GEF Land Degradation Focal Area. The added value of the KM:Land indicator system is that it provides a convenient linkage between the more context-specific local level indicators with the necessary aggregated indicators to provide information for larger scale comparisons. Thus, this indicator system is designed to support and guide decision-making at the global level, which is directly relevant to UNCCD. Since 2010 all GEF-funded SLM projects have been required to report on these indicators.

While the selected indicators need to simplify the complexity of SLM successes, their changes are influenced by many factors which are outside the project influence (e.g. market, policy, climate, etc). Tying changes in these indicators to GEF-funded SLM interventions alone is, therefore, problematic. In order to address the problem of attribution and facilitate upscaling of project-level information, it is suggested that the GEF-funded SLM projects apply an approach entailing the following steps:

(1) Collect data in a defined project impact area, or for a defined target population,
(2) Compare observed changes with control/reference areas,
(3) Monitor and assess additional external factors (e.g. rainfall, extreme natural events, human conflict, prices for agricultural products, etc) in order to evaluate the effects of these drivers,

(4) Monitor and assess the progress towards creating an enabling policy environment, enhanced institutional capacity at different levels, financial mechanisms for SLM and improved knowledge management to implement SLM and
(5) Context-specific interpretation of the data together with national/sub-national stakeholders.

A remaining challenge is making the knowledge gained through M&A available to those who need it most, in order to initiate change: these parties may be local land users and/or decision-makers at various scales. Knowledge management for decision support at the local level has been implemented using the tools presented in this paper within the DESIRE project (Schwilch *et al*., 2009) and is currently being integrated into a methodological framework (Reed *et al*., 2011).

Whatever is assessed at the local or (sub-) national level, the link to the global level must be made through common indicators, either aggregated or standardized. WOCAT, LADA, DESIRE and KM:Land have tried to streamline their language and ways of assessing and monitoring SLM in order to develop such common indicators for the global level, while keeping in mind the flexibility required for lower levels. A large number of indicators have been described by the predecessor to DESIRE, the DESERTLINKS project: http://www.kcl.ac.uk/projects/desertlinks/. DESIRE has supplemented these indicators and is measuring them in 16 study sites. In addition, the DESERTLINKS indicators have now been reviewed and systematized within a database in collaboration with LADA and the University of Sassari (http://nrd.uniss.it/nrd/dis/index.php). The database enables countries to enter their own indicators and assessment methods and to exchange experiences. In order to achieve comparability between countries, the five KM:Land global core indicators given above would ideally become the heart of this database, and be applied and monitored regularly (e.g. every year).

UNCCD and GEF can both play key roles in sharing knowledge about SLM through their reporting mechanisms on a common and accessible global platform and in translating it into the various UN languages.

## LESSONS AND FUTURE DIRECTIONS

The approaches and methods presented in this paper yield a number of lessons that inform the continued development of a global, unified approach to the M&A of SLM. Table II provides an overview of these methods, their strengths and shortcomings, as well as a suggested pathway towards a common framework.

Below, we summarize some of the core concepts that we believe are essential elements of an integrated M&A approach, for the UNCCD and others, including various UN environmental conventions or financing mechanisms like GEF:

(1) *Common conceptual framework*: The conceptual framework is the foundation to developing a common methodological framework. The hybrid SLM framework of GEF presented in this paper is likely to be broadly acceptable to the UNCCD community because it is simple and based on widely-known, pre-existing frameworks. It integrates the underlying interrelationships of biophysical processes and human activities as well as the causal chain from driving forces to responses and impacts on ecosystems and human wellbeing.
(2) *Common methodological framework*: The WOCAT, LADA, DESIRE and KM:Land approaches presented in this paper have made progress towards a common and practical methodological framework, which needs to be further developed and promoted to reflect the complexity of interlinkages between human actions and biophysical processes over time and space. It should include common and standardized tools and methods, facilitating the M&A of SLM, while allowing flexibility and context-specific adaptation of the methods employed. It further requires consistent reporting processes and coordinated knowledge management.
(3) *Nested scales*: Multiple and hierarchical scales of assessment are required, while possibly distinguishing the scales needed for assessment from those used for reporting. Spatial explicitness at scales (extents) where it is possible should be envisaged (see Figure 2). This requires stratification according to both biophysical and socio-economic variables. The concepts of eco-regions, land use systems and, at a finer scale, ecological sites are useful stratification procedures.
(4) *Common indicators and varieties of data sources*: Indicators are essential tools for the evaluation of SLM interventions and should be hierarchical and nested over scales (i.e. reflect processes operating at different scales) and involve consistent methodologies. Preferably, at all scales, a core set of indicators should be applied to assess the state of degradation and the impact and effectiveness of SLM. Reference areas are needed to clearly attribute changes in the environment and livelihoods to SLM interventions. A variety of data sources should be used to measure and identify these indicators. Ideally a linkage of remotely-sensed data with ground-based scientific measurements, as well as local knowledge, should be envisaged.
(5) *Participation and interdisciplinarity*: M&A of SLM requires participatory approaches to assess and interpret data, involving a range of stakeholders from land users to SLM specialists, planners and decision makers, as well as scientists from various disciplines. Participation ensures that the results are agreed upon and used by stakeholders for improving land management and adapting to change. There is growing recognition given to stakeholder

Table II. Overview of current methodological approaches, their strengths, shortcomings and suggested future pathways

| Spatial level | Approach/method/tool | Major strengths | Shortcomings | Suggested pathway towards a common framework |
|---|---|---|---|---|
| Local level | WOCAT technologies/ approaches (questionnaires + global database) | Participative and comprehensive (self-) assessment, including biophysical and socio-economic issues; allows knowledge sharing between land users and experts worldwide | Time-consuming; difficult to assess data on cost and benefit and impacts of SLM, one-time assessment | Complement with elements from the ecological sites and state-and-transition models; address global issues more comprehensively |
| | DESIRE stakeholder workshops | Step-by-step procedure for local stakeholder groups to identify, assess and select SLM for implementation and monitoring; link to regional level through policy integration and modelling for upscaling | Professional facilitation of process required | Strengthen link to regional level with tools listed below; streamline methodological framework (see Reed *et al*., 2011) |
| | LADA local level assessment of land degradation | Broad variety of tools; extensive guidelines on all tools as well as implementation and reporting procedure; robust, participatory | Time-consuming, complexity requires expert knowledge | Simplify complexity; put stronger focus on SLM and harmonize with WOCAT; make truly participative (integrate DESIRE methods) |
| | Best practices and success stories (UNEP, FAO, IWMI and others) | Rapid assessment, many case studies | Linked to short-term projects; not standardized | Standardize documentation and evaluation, e.g. through WOCAT |
| | US Ecological sites and state-and-transition models | Fully explores ecological land potential and mechanisms; assesses likelihood of SLM success | Focus on ecological mechanisms; time-consuming | Integrate into WOCAT/ LADA methods where resources and know-how are available |
| Sub-national to national level | WOCAT/LADA/ DESIRE mapping methodology | Cost-effective; participatory; backed up by quantitative data; uses cross-scale categorization of LUS, degradation types, SLM and their impacts on ecosystem services; direct link to WOCAT local case studies | Mainly assessment and not yet a monitoring tool | Better integration of remote sensing data as well as existing data sources |
| | ACRIS | Integrates large amounts of monitoring data from disparate sources | Highly scientific; requires expert know-how | Add as module to WOCAT/ LADA/DESIRE method to make better use of existing data sources |
| | US NRI | Statistically based; true monitoring tool over longer time periods | Can be costly depending on level of intensity | Use as possible supplement to methods above, if resources are available |
| Global level | GEF KM:Land | Direct link between project-level indicators and global indicators | Limited to 5 global core indicators and GEF projects | Open up for use outside GEF and harmonise with UNCCD core indicators |
| | DESERTLINKS/LADA indicators | Allows comparison between countries | Open list of indicators and methods; not very practical or easy-to apply | Assess the 5 GEF global indicators annually and make them the heart of a broader indicator database |

involvement, but 'true' participation integrating all stakeholders on an equal footing is not easy to achieve. Nevertheless, while it is necessary and important, it should not lead to a disregard of conventional scientific methods or the neglect of the physical limitations of the land determining the different types of use.

(6) *Knowledge management from local to international scales*: Knowledge management for effective decision support is a key element of a common framework, but remains a challenge. UNCCD, as a global convention, has to play a key role in supporting global efforts in compiling, managing and disseminating information from M&A of SLM. Standardization of methodologies as advocated in points 2, 3, 4 above enables effective knowledge management.

The methodological approaches from WOCAT, LADA, DESIRE, KM:Land and selected national institutions presented here address most of the elements mentioned above. Further ongoing refinement is needed but is restricted by project duration and collaborative processes among the lead agencies. Continued tests of their usefulness, accuracy and practicability will undoubtedly assist in their refinement. Finance remains a major constraint to progress, especially over the long term. Although it is often stated that M&A of SLM is required for regular reporting to UNCCD, both donors and governments are hesitant to make the required commitments and provide the necessary funds and resources. Investment in implementation activities is often more attractive than long term M&A. Greater global support is, therefore, urgently required, for example, through UNCCD or GEF reporting obligations, while the scientific community needs to be prepared to explain the benefits of scientifically-based approaches described here. These have been demonstrated to be economic, practicable and consistent, supporting comparison across localities and nations and enabling global aggregation, while still allowing flexibility in serving the interests of various stakeholders. Another constraint is that research, limited in time, space and thematic scope—and often driven by the urge to develop new methods and findings rather than applying standardized methods—is reluctant to provide the scientific support required. It needs genuine inter- and trans-disciplinary research for the continued development and testing of a global, unified approach to the assessment and monitoring of SLM.

## CONCLUSIONS

A number of projects and researchers have invested in developing methods to monitor and assess the complex issue of SLM over the past 10–20 years. Some global level initiatives have been presented and discussed in this paper; others may remain unknown and thus unacknowledged. We hope to stimulate the debate on monitoring and assessing SLM that began with the preparations for the first UNCCD Scientific Conference at COP-9. We have described the extensive experience and key lessons from global SLM monitoring initiatives, to ensure that this knowledge is applied and used, with the ultimate goal of supporting the implementation of the UNCCD. WOCAT, LADA, DESIRE and other methods provide important tools and lessons that can be used to address UNCCD monitoring needs at the local and (sub-) national level, while the global SLM indicator system of KM:Land can support global level M&A needs. In order to reduce the burden of reporting and data collection and increase comparability, it is important to move towards harmonized monitoring systems at the global level. The collaboration among many of the initiatives mentioned in this paper is already an important step in this respect, but further efforts are required. Effective M&A of SLM requires accessibility to tools and methods through free access and through training and workshops for a range of stakeholder and researcher groups at various levels. The latter remains a challenge unless a global process, such as the UNCCD, clearly supports a methodological framework including the potential elements outlined here. This would provide far greater insight into the processes and outcomes of efforts to combat land degradation and desertification underway today by both public agencies and by land users themselves. In turn, it would help the UNCCD to monitor progress towards its goals.


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