Assessing and Mapping LD and SLM to Directly Support the Planning and Scaling Up of SLM Interventions to Combat Desertification

Hanspeter Liniger[1], Godert Van Lynden[2], Riccardo Biancalani[3], Lehman Lindeque[4], Déthié Soumaré Ndiaye[5] Gudrun Schwilch[6]

[1]Centre for Development and Environment (CDE) / WOCAT / University of Bern, Bern, Switzerland. E-mail: hanspeter.liniger@cde.unibe.ch

[2]ISRIC – World Soil Information, Wageningen, The Netherlands. E-mail: Godert.vanlynden@wur.nl

[3]Food and Agriculture Organisation (FAO), Rome, Italy. E-mail: Riccardo.Biancalani@fao.org

[4]Department of Agriculture, Forestry and Fisheries, Pretoria, South Africa. E-mail: LehmanL@daff.gov.za

[5]Centre de Suivi Ecologique, Dakar, Sénégal Email: dethie.ndiaye@cse.sn

[6]Centre for Development and Environment (CDE) / WOCAT / University of Bern, Bern, Switzerland. E-mail: Gudrun.schwilch@cde.unibe.ch

ABSTRACT: Global investment in Sustainable Land Management (SLM) has been substantial, but knowledge gaps remain. Overviews of where land degradation (LD) is taking place and how land users are addressing the problem using SLM are still lacking for most individual countries and regions. Relevant maps focus more on LD than SLM, and they have been compiled using different methods. This makes it impossible to compare the benefits of SLM interventions and prevents informed decision-making on how best to invest in land. To fill this knowledge gap, a standardised mapping method has been collaboratively developed by the World Overview of Conservation Approaches and Technologies (WOCAT), FAO's Land Degradation Assessment in Drylands (LADA) project, and the EU's Mitigating Desertification and Remediating Degraded Land (DESIRE) project. The method generates information on the distribution and characteristics of LD and SLM activities and can be applied at the village, national, or regional level. It is based on participatory expert assessment, documents, and surveys. These data sources are spatially displayed across a land-use systems base map. By enabling mapping of the DPSIR framework (Driving Forces-Pressures-State-Impacts-Responses) for degradation and conservation, the method provides key information for decision-making. It may also be used to monitor LD and conservation following project implementation. This contribution explains the mapping method, highlighting findings made at different levels (national and local) in South Africa and the Mediterranean region.

Keywords: Mapping, Decision Support, Land Degradation, Sustainable Land Management, Ecosystem Services, Participatory Expert Assessment

1. INTRODUCTION

Despite progress towards the Millennium Development Goals, there remains widespread hunger, poverty, and food insecurity, and the key ecosystems that provide our natural resource base continue to be depleted and degraded. These development challenges and the threat to our natural resource base are recognised as a global issue that concerns everyone. In 1992, at the request of UNEP and in collaboration with various international institutions and experts worldwide, ISRIC produced a world map (GLASOD) showing the status, global extent, and severity of human-induced soil degradation (Oldeman et al., 1991). Over the last two decades, researchers have focussed on assessing and mapping degradation using Geographical Information System (GIS) and remote sensing (Bai et al., 2008; Hill et al., 2008; Prince et al., 2009; Buenemann et al., 2011; Verstraete et al., 2011) and some have attempted to support decision making by assessing land potentials, land suitability and land health (Herrick et al., 2006; Bestelmeyer et al., 2009: Bojórquez et al., 2001; Ochala and Kerkides, 2004).

In 1992, the World Overview of Conservation Approaches and Technologies (WOCAT) programme was launched to find ways of preventing, mitigating, and rehabilitating degradation (Liniger et al., 2013). WOCAT takes a positive, solution-oriented approach rather than focussing solely on measuring degradation. Finding ways of sustainably managing our natural resource base is a fundamental challenge that the international community must effectively address in the coming decades (Liniger and Critchley, 2007; Liniger et al., 2011; Liniger et al., 2013; Van Lynden and Mantel, 2001).

In recent years, substantial global investments have been made in implementing Sustainable Land Management (SLM) in the context of development and environmental programmes (GEF, 2009). Nevertheless, overviews of where land degradation (LD) is taking place and how land users are addressing the problem using SLM are still lacking for most individual countries and regions. Relevant maps focus more on LD than SLM, and they have been compiled using different methods. This makes it impossible to compare the benefits of SLM interventions and prevents informed decision-making on how best to invest in land.

To fill this knowledge gap, WOCAT began developing a standardised mapping methodology. This generally applicable mapping method was further refined in collaboration with the FAO's Land Degradation Assessment in Drylands project (LADA) and, at a later stage, the EU's Desertification Mitigation and Remediation of Land (DESIRE) project. The method is an integral part of a comprehensive approach to LD and SLM that includes local-level case studies and decision support (Liniger et al., 2013). The method generates information on the distribution and characteristics of LD and SLM activities and can be applied at the village, national, or regional level. It relies on participatory expert assessment, documents, and surveys. Collected data are spatially displayed across a land-use systems base map. The method enables collection and mapping of information according to the five aspects of the DPSIR framework (Drivers, Pressure, State, Impact and Response). The resulting "spatialised" knowledge on degradation and conservation directly facilitates informed decision-making (Schwilch et al., 2011). Finally, the mapping method may also be used to monitor LD and conservation following project implementation.

In the following, the mapping method is described and examples of its use in planning interventions are shown. The examples stem from findings made at different levels (national and local) in South Africa and the Mediterranean region. Based on these case studies, policy oriented recommendations are formulated.

2. THE WOCAT-LADA-DESIRE MAPPING METHOD

The main goal of this mapping method is to obtain a picture of the distribution and characteristics of LD and conservation/SLM activities at the local, regional, national, or global level. Application of the method ultimately produces maps of existing LD, its causes and impacts as well as, conversely, maps of existing conservation efforts and their impacts on major land-use systems in the area. To facilitate compilation and organisation of the necessary data, a detailed mapping questionnaire and GIS-related database were developed (www.wocat.net). Data drawn from a variety of sources are compiled and harmonised by a team of experts, consisting of land degradation and conservation specialists working in consultation with land users from various backgrounds. Ideally, the expert teams include those (national) institutional and individual stakeholders who possess the country-specific knowledge of LD and SLM needed to compile the relevant questionnaire data and other information. This information covers all types of land use and land management employed on cropland, grazing land, forests, and other forms of land in the area being mapped. The specialists' and land users' knowledge is combined with existing datasets and documents (maps, GIS layers, high-resolution satellite images, etc.) in workshops that are designed to build consensus regarding the variables used to assess LD and SLM. This process is also referred to as participatory expert assessment (PEA) or consensus mapping.

The different steps may be summarised as follows:

Step 1: Contributing specialists and stakeholders: Data collection, harmonisation, and quality assurance should be performed by a team of specialists and stakeholders. National specialists involved in this step should possess relevant, country-specific knowledge of LD, land management, land use, soil and water conservation, and other related aspects. The contributing specialists are selected by means of detailed stakeholder analysis; they are charged with data collection, quality assurance, and entering all data in the database.

Step 2: Land use systems and the base map: The basic unit of evaluation is the land use system (LUS) (Nachtergaele et al, 2008). A global LUS map is available, but this map needs refinement and adjustments at the national, regional, and local level to delineate appropriate baseline mapping units. In any case, as a primary driver of degradation and conservation, land use represents the starting point for mapping them. It provides the basis for identifying the subsequent units that are used to compile information on LD and conservation. The mapping process begins with identification of the main land use type, e.g., "Cropland", "Grazing land", "Forest/woodland", "Mixed", or "Other". Depending on the mapping scale, further subdivision may be needed; for example, "Cropland" can be divided into "annual" and "perennial cropping" while "grazing" can be divided into "extensive" and "intensive grazing". Additional subdivisions may be made according to physiographic or geomorphologic criteria, administrative units, or socio-economic criteria, depending on the particular site and mapping scale. Next, for each mapping unit, the team of specialists makes an initial estimation of the "area trend" over the previous decade, indicating whether the land use area is rapidly increasing (+2), remaining stable (0), or rapidly decreasing (-2). Similarly, the team estimates the "intensity trend" of land use systems for each mapping unit, indicating whether there is a major increase (+2) (e.g. from manual labour to mechanization), no change (0), or a major decrease in land use intensity (-2).

Step 3: Land degradation per land use system (LUS): For each land use mapping unit, seven indicators of land degradation are compiled:

(a) The major types of LD currently occurring under each LUS are then identified and indicated as follows with individual letter codes:
(W): Soil erosion by water (e.g., loss of topsoil, gully erosion, mass movements, riverbank erosion, coastal erosion, offsite degradation effects); (E): Soil erosion by wind (e.g., loss of topsoil, deflation and deposition, offsite degradation effects); (C): Chemical deterioration (e.g., fertility decline and reduced organic matter, acidification, soil pollution, salinization /alkalinisation); (P) Physical deterioration (e.g., compaction, sealing and crusting, waterlogging, subsidence of organic soils, loss of bio-productive function due to other activities); (H) Water degradation (e.g., aridification, change of quantity of surface water or groundwater level, decline of surface water or groundwater quality, reduction of buffering capacity of wetlands); and, (B) Biological degradation (e.g., reduction of vegetation cover, loss of habitats,

quantity/biomass decline, detrimental effects of fires, decline in quality of species composition, loss of soil life, increase in pests and diseases.

(b) Next, the current extent of the identified LD types is assessed as a percentage of the LUS area: for each LD type identified, the extent should be given as percentage of the LUS affected by that degradation type (e.g., soil erosion by water affects 25% of the cropland).

(c) The current extent of LD identified is then defined as the intensity of LD taking place. This is coded from (1) light (damage that can be restored with minor efforts) to (4) extreme (degradation beyond restoration).

(d) Next, the rate of LD over the past 10 years is estimated, from rapidly increasing (+3) to rapidly decreasing (-3)

(e) Direct causes of LD are also indicated, including: soil management, crop and rangeland management, deforestation and removal of natural vegetation, overexploitation of vegetation for domestic use, overgrazing, industrial activities and mining, urbanisation and infrastructure development, release of airborne pollutants, disturbance of the water cycle, excessive abstraction of water, natural causes.

(f) Indirect causes of LD are indicated as well, including: population pressure, consumption patterns and individual demand, land tenure, poverty, labour availability, inputs and infrastructure, education/awareness, war and conflict, governance and politics.

(g) Finally, for each degradation type identified, the following possible impacts on ecosystem services are distinguished: productive services (e.g., production decline), ecological services (e.g., organic matter status; regulation of excessive water), socio-cultural services (e.g., spiritual, aesthetic, health benefits). For each type, a letter code and level of impact from (1) to (-3) are indicated (e.g., high negative impact on production)

Step 4: Land conservation (Sustainable Land Management): Similar to the previous step, those areas under SLM, displaying reduced LD, or even showing improvement are identified and assessed for each land use mapping unit:

(a) The names of the most prevalent SLM technologies (individual or combinations) are identified for each mapping unit.

(b) Each SLM technology identified under (a) is assigned to a letter-coded “Conservation group” including: (CA) Conservation agriculture; (NM) Manuring/Composting; (RO) Rotational system; (VS) Vegetative strips/cover; (AF) Agroforestry; (AP) Afforestation; (RH) Gully control; (TR) Terraces; (GR) Grazing land management; (WH) Water harvesting; (SA) Groundwater/salinity regulation/water use efficiency; (WQ) Water quality improvement; (SD) Sand dune stabilisation; (CB) Coastal bank protection; (PR) Protection against natural hazards; (SC) Storm water control; (WM) Waste management; (CO) Conservation of natural biodiversity; and (OT) Other.

(c) Each technology is then categorised according to the type of conservation measures, including: agronomic, vegetative, structural, management, and combinations thereof.

(d) For each technology, indication is made as to whether it was implemented for the purpose of prevention, mitigation and/or rehabilitation of LD.

(e) The extent of each SLM technology is then indicated as a percentage of the LUS area: For each type of land conservation identified, the extent should be given as percentage of the LUS affected by that degradation type (e.g., soil erosion by water affects 25% of the cropland).

(f) Next, the degradation that is addressed by each technology is indicated.

(g) Afterwards, the "effectiveness" class of the technologies identified for each LUS unit are indicated, ranging from (+4) very high to (+1) low effectiveness.

(h) Any trends towards higher or lower effectiveness of conservation are indicated as follows: increase (+1), no change (0), decrease in effectiveness (-1).

(i) Next, the SLM technologies’ impact – type and level – on ecosystem services is indicated (just as the impact of LD).

(j) Further, the year in which each technology was implemented is indicated.

(k) Finally, references are provided to one or more WOCAT questionnaires on SLM technologies (QT) that describe the technologies listed under (a). If no QT is available for a given technology, some concise details about the technology are recorded under “Remarks” in the database.

The assessment variables for LD and conservation are basically mirror images of one another, or two sides of the same coin. One set of variables assesses LD, describing its seriousness, causes, and impacts; the other set of variables assesses the current response to LD, describing the individual conservation measures, their effectiveness, and impacts. This enables direct comparison of degradation and conservation measures for a specific area, providing a spatial overview of the seriousness of the problem (degradation) and the effectiveness/impacts of current responses (conservation). This in turn allows decision-makers to identify priority areas for intervention and investment. Knowing the “where” of degradation enables them to consider more specific questions of policy: Should they address those areas with the biggest degradation problems and the least conservation measures in place? Or should they direct their attention to areas where degradation is moderate but increasing, and threatens highly productive systems? Or should investments be directed to areas where good management practices are already in place and could be expanded to neighbouring areas? To help answer such questions, the contributing specialists and stakeholders use the maps to derive recommendations in Step 5.

Step 5: Expert recommendations: For each mapping unit, expert recommendations are provided regarding interventions that could be used to address degradation through adaptation, prevention, mitigation, or rehabilitation.

3. APPLICATION OF THE MAPPING METHOD AT DIFFERENT SCALES AND IN DIFFERENT CONTEXTS

The following example (Fig. 1) illustrates the use of the methodology at the national level like in South Africa:

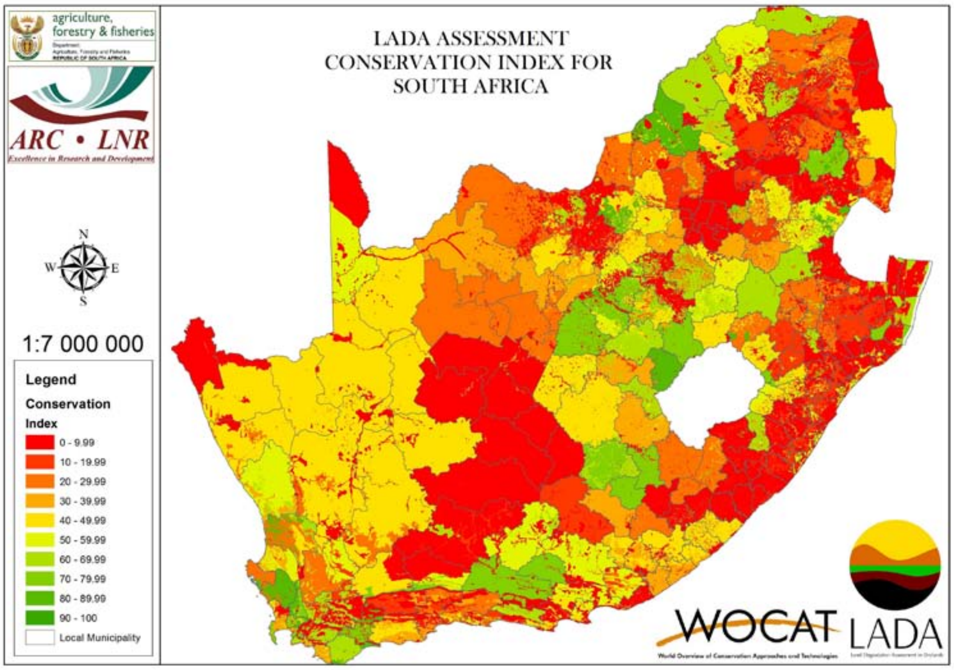

Fig. 1: Assessment of Conservation Index for South Africa (Lindeque and Avenant, 2012)

To create a Degradation Index map, the assessment results for each variable and each mapping unit were combined in a simple mathematical equation; the variables used in calculation covered the extent of degradation, its degree, rate, and level of impact on ecosystem services. To generate a Conservation Index map, the extent of conservation measures, their level of implementation, effectiveness trend, and level of impact on ecosystem services were calculated. The resulting maps have supplied national- and regional-level South African authorities, planners and decision-makers with a highly valuable overview and summary of the current state of land degradation and SLM (conservation) in their country. This national overview enables them to see what is happening and where in terms of land management and its impacts. The maps are very useful in identifying priority and focus areas for future restoration activities.

To maximise the potential of the maps and corresponding data, however, everything must be considered taking into account the variables that explain the “why” of degradation and SLM. These variables include changes in land use (area and intensity trend), direct and indirect causes of degradation and, of course, the reasons behind the changes in degradation rates and the effectiveness trends of conservation measures. Taken together, the knowledge of the experts and stakeholders involved in the mapping process, and the expert recommendations generated in Step, 5 provide a solid basis for informed decision-making, development of action plans, and national strategies.

In the DESIRE project, the WOCAT-LADA-DESIRE mapping tool was applied at subnational levels, e.g., the watershed level, for 17 dryland sites. Analysis of the many maps produced in the project has generated a wealth of useful information (Schwilch et al., 2012; van Lynden et al., in prep.). For example, SLM measures appeared to be most effective on cultivated land; in these areas, 20% of SLM measures displayed high to very high effectiveness. By contrast, only 4% of SLM measures displayed high or very high effectiveness on land under forest and grazing. In the DESIRE project, the maps have mainly served to establish baseline information for selecting, testing, and comparing SLM practices.

Application of the mapping method in six LADA pilot countries, 17 DESIRE study sites, and other projects elsewhere (e.g., Mongolia and the region of Central Asia) has revealed its strengths and weaknesses. Its advantages include relatively fast and easy compilation of specialists’ and land users’ knowledge and perception of LD and SLM and the ability to combine it in a mapping database. The process of data compilation consolidates previously fragmented knowledge, helps build consensus among stakeholders, and enables identification of knowledge gaps and the need for more surveys or research. Weaknesses of the methodology include possible distortions due to perceptual biases among team members (experts and land users) as well as difficulties in combining maps from one area or region with those of neighbouring areas created by different teams. The national map of South Africa, for example, required over 30 meetings with various groups from different administrative units. In some cases, the groups assessed and rated land degradation and conservation in different ways. Additional steps are required to harmonise such differences and overcome regional “biases” in order to produce reliable national maps. Nevertheless, such harmonisation requires platforms for exchange between stakeholders – those involved in compiling the data and those who will use it – and facilitation of such platforms is an overall strength of this method. The introduction of more dialogue enables further insights, better understanding, and establishes the basis for a stronger commitment to SLM. These are only a couple of examples of applying the mapping method at the national and regional level. More detailed results will be shared in presentation at the conference.

4. POLICY ORIENTED RECOMMENDATIONS

The methodology presented here is designed to provide decision-makers at each level with information on the status and causes of LD as well as current or potential conservation measures that may be used to counter it. In particular, the methodology enables observers to link data on LD and conservation with the actual land use and farming systems in place in a given area. Since the methodology is based on the DPSIR framework, it enables assessment of the actual situation on the ground (state) as well as the direction of trends, whether negative (degradation) or positive (improvement/sustainability). This kind of assessment is much more operationally useful than assessments based solely on theoretical evaluations of risk. However, if risk assessments are also present, they can complement the methodology and enable even better projections for decision-makers.

This methodology leads to synergy by bringing the stratified environmental and administrative knowledge of maps, inventories, and reports together with the local hands-on knowledge of land users, practitioners, and scientists. This synergy, emerging from a participatory approach that may be adapted to fit different levels, contributes to a shared understanding of the situation and supports less-contentious implementation of policy responses. The collaboration required to implement the methodology promotes establishment of stronger links between the diverse stakeholders and institutions involved, which in turn reinforces the institutional setup and the overall knowledge management capacity of the country in question.

Moreover, the data compiled provides a useful baseline against which to monitor changes in natural resources over time. The methodology is relatively quick and inexpensive to implement at each level of a given scale, and it may be repeated every five to 10 years to identify and analyse trends and major changes.

Further, the database is capable of supplying data on secondary indicators, including some of those proposed/adopted by the UNCCD to be used as a base for reporting to the Convention in the coming years.

The level at which degradation and SLM are assessed often influences the messages that may be taken from the resulting maps as well as their potential use for reporting and decision support. However, the level at which assessment is most feasible and logical may not always match what is required for reporting and decision-making. A nested approach is required – one in which methods and results are spatially explicit regarding degradation processes, SLM interventions, and ecosystem services. A unified methodological approach should be promoted and sustained – for example by the UNCCD – to enable harmonised reporting (see also Schwilch et al., 2011).

The mapping of LD *and* conservation is a must for effective regional and national planning and the establishment of intervention priorities. It enables policymakers to see where their money goes, has gone, or should go, in addition to its impact. It supplies an initial "quick" inventory of degradation and what is being done about it. The next step is to show how it can be optimally used for planning.

5. CONCLUSIONS

Application of the WOCAT-LADA-DESIRE mapping methodology successfully provides a spatial overview of what is going on in a given area in terms of degradation and SLM. When setting new policy, decision-makers often fail to assess what has already been implemented to combat desertification and LD. This should be fully taken into account before deciding about future land management interventions.

The mapping methodology's standardised cross-scale categorisation of land use systems, degradation types, SLM and its impacts on ecosystem services has proven very effective when working across scales. It enables comparison of local watershed-level assessments with national maps, providing a useful tool for local and national decision-making.

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