Soil Conservation and Sustainable Use

Soil Monitoring for Comparable Data, Index on Sustainable Use of Soils

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draft

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by L.R. Oldeman[2]

1 Soils as a Central Life Supporting System

The proposal for a "Convention on Sustainable Use of Soils" can be seen as a direct response to the initiative of the International Food Policy Research Institute (IFPRI), known as "A 2020 Vision for Food, Agriculture and the Environment". As argued by Scherr and Yadav (1966) one of the most hotly debated elements to facilitate an international consensus on the directions that policy should take to ensure sufficient food for growing populations is the extent and effect of land degradation. While some argue that the deterioration of the land is considered as a threat to global food supplies (Pimentel *et.al.*, 1995; Eger *et.al.*, 1996; Oldeman, 1998) others consider that land degradation is overestimated and relatively unimportant to global food supplies (Crosson, 1998).

In a report of a panel of senior scientists prepared for the World Bank, Borlaug (1995) argued that although advances in science during this century have increased world food supplies more rapidly than population and have in general become more reliable, "we must acknowledge that in many of the most productive areas – especially irrigated areas located in warm climates – there are problems of declining soil and water quality that, if left unchecked, can lead to permanent loss of prime agricultural land. Low profits (mainly in developing countries) have kept farmers from adequately investing in resource conservation, while excessive subsidies (mainly in industrial countries) have caused over-use of agricultural chemicals, with consequent environmental damage".

Since the soil is of vital importance to mankind, is not renewable in the short time and very expensive to reclaim or to improve once it is eroded by water or wind, physically degraded or chemically depleted, it is our common duty to maintain it for the future, while at the same time obtaining the best benefit from its use now (Stoops and Cheverry, 1992).

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While there is widespread evidence that soil losses resulting from erosion are far in excess of the natural rate of soil formation science faces the challenge of assessing the impact of soil erosion on soil productivity. Economic estimates only focussing on production however can be misleading because the underlying problem of soil degradation, and its long term irreversible consequences on soil productivity and the urgent need for action are under-estimated (Hurni, 1996).

As a consequence of increased population and the scarcity of unreclaimed land, physically and socio-economically suitable for cultivation, there will be increasing pressure on all sectors of society to utilize the existing cultivated areas as efficiently as possible and on a sustainable basis.

In his plea for feeding humanity, Pinstrup-Andersen (1995) urged for action to meet the food needs of a growing world population, while preventing or containing environmental degradation.

2 Soil Monitoring for Comparable Data

While there is sufficient evidence that the global land surface (and the composition of the atmosphere) has been altered by the human species, it is unknown how much change can be tolerated to meet our basic needs now and in the future. According to an international working group, who coordinated an initiative of ICSU, UNEP, FAO, Unesco, and WMO for a Global Terrestrial Observing System (GTOS) (1995), there is a lack in globally comprehensive environmental monitoring systems to provide data essential for sound policy formulation and planning. A fundamental principle for monitoring is the provision of a baseline against which future changes can be assessed.

The World Resources Institute (WRI) and the California Institute of Technology at Pasadena developed a proposal for "Global Environmental Monitoring: Pathways to Responsible Planetary Management" (1992). In order to manage our planet rationally there is a need 1) for a sound understanding of Earth's systems processes; 2) an accurate measure of baseline conditions of the Earth's resources; and 3) an efficient system of monitoring and reporting of changes in the resource conditions or quality.

According to these institutions research into Earth's processes is well-funded, but efforts to collect baseline data on the conditions of global natural resources, or to analyze, monitor and report on changes in those conditions are few and impoverished.

The demand for accurate, up-to-date and readily accessible data on natural resources is repeatedly expressed and is reflected in various recently formulated international research and development initiatives (such as GTOS; the Soil, Water and Nutrient Management programme (Greenland *et.al.*, 1994); the FAO Strategy for Planning for Sustainable Use of Land Resources: Towards a New Approach (Sombroek and Sims, 1994); the Land Quality Indicators initiative of the World Bank (Pieri *et al.*, 1995).

Primary data on soil and terrain resources as well as on other environmental factors form the baseline for the development of land qualities and for monitoring changes in land degradation. While there is much concern that land quality is changing, there is not much formal monitoring of what is changing, in what direction and at what rate. Benites (1997) states that a systematic assessment of sustainability of current and planned land uses is hampered by 1) too many detailed data that are difficult to interpret; 2) no baseline from which to compare change, and 3) data that are inconsistent over time or between geographic areas.

Lack of adequate information for land use planners and decision makers at all level may lead to inaction. Unreliable data can result in poor decisions. Based on a wealth of papers, articles and policy documents, cited above, the necessary monitoring must be based on 1) agreement on priority of information needs; 2) appropriate technologies to collect, store, analyze and disseminate that information; and 3) a network of linked institutions, appropriately funded, motivated to and capable of collecting, analyzing, and disseminating primary and derived information in a suitable, accessible format (WRI, 1992).

3 Baseline Information on Soils

IFPRI developed policy recommendations to protec and improve agricultural lands (Scherr and Yadav, 1996). The first recommendation deals with the improvement of information systems for land management. "A high priority is to develop geographically referenced, computerized information systems that can collect, store, and analyze data on natural and socio-economic resources and that can disseminate, in "user-friendly" format, information about the range of available options and techniques for different types of soils, climates and farming systems". In a footnote they indicate the development of such information on soils and terrain through the Global and National Soil and Terrain Digital Database program, called SOTER. Eger *et. al.* (1996), reviewing the results from the 9th International Soil Conservation Conference in Bonn, Germany, stated also the urgent need to develop or improve national systems of georeferenced information on natural resources and socio-economic conditions, in order to monitor changes in land quality over time. They recommend that national institutions apply adapted forms of internationally used methodologies such as SOTER, GLASOD (Global Assessment of Soil Degradation), and WOCAT (World Overview of Conservation Approaches and Technologies) to facilitate regional and global cooperation, e.g. exchange of data.

The earlier cited proposal for Global Environmental Monitoring: Pathways to Responsible Planetary Management (1992) mentions SOTER as an activity to use properly structured ground assessments to create a baseline geo-referenced database on soil, soil degradation and terrain over the next 10-15 years ... if funding become available. "These data would be invaluable to local and national planners and to those seeking to set priorities for global action and environmental assistance". However, they questioned whether there is any global institution that would then monitor soil changes subsequent to SOTER.

The three international organizations that closely cooperated in developing the methodologies for SOTER (Van Engelen and Wen, 1995) – the International Soil Reference and Information Centre (ISRIC); the Food and Agriculture Organization of the United Nations (FAO); and the United Nations Environment programme (UNEP) – and the Working Group DM: "Land Resources Information System for Assessment and Monitoring (SOTER)" of the International Union of Soil Sciences have agreed that the SOTER approach at scale 1:5 Million would be the official strategy to replace the FAO-Unesco Soil Map of the World. At this moment the segment for Latin America and the Caribbean has been finalized and will soon become available as CD-Rom (Oldeman, 1998).

More importantly for soil conservation and sustainable land use are the SOTER databases, developed at national level. Baseline data on soils and terrain have been developed or are under development for a number of countries in Latin America, Africa, Central and Eastern Europe, West Asia and Southeast Asia. (In the SOTER approach, mapping units are described as a unique combination and pattern of terrain units, terrain components and soil components. The soil and terrain attributes are linked to a Geographical Information System (GIS) permitting spatial analysis. Additional climatic and land use/land cover data are linked to SOTER as separate files.)

While SOTER consists of files of quantitative soils and terrain attributes, GLASOD data are mainly qualitative and are therefore by nature subjective to expert judgment. Despite criticism on this aspect of subjectivity it forms the only global database on the status of human-induced soil degradation (Oldeman *et. al.*, 1991). The United States Agency for International Development (USAID), aware that soil degradation is an increasing problem in world food security, recently questioned whether there exists an organization that is tracking (read: monitoring) soil degradation globally on an annual basis (written communication). Not being ware of such an organization the United Nations Environment Programme (UNEP) replied: "Soil degradation is one of those subjects where the world believes monitoring data are available at an international harmonized link, while in fact this is not the case". As a sequel to GLASOD, a more detailed assessment of the Status of Human-induced Soil Degradation was prepared for 17 countries in South and Southeast Asia (ASSOD).

ASSOD (Van Lynden and Oldeman 1997) uses the same qualitative approach as GLASOD, but the mapping units were defined in an objective way using the SOTER methodology and more emphasis was placed on the impact of soil degradation on the production function of the soil. Results obtained from the ASSOD database have been extensively reported in the second edition of the World Atlas of Desertification (UNEP, 1997). It should be remarked that it is unfortunate that only the dryland areas have been considered. Human-induced soil degradation is of equal importance in the humid regions of the world (see Table 1A), while in South and Southeast Asia soil degradation in the humid regions is far more important compared to the drylands (Table 1B).

Table 1A Human-induced Soil Degradation in the susceptible drylands and in the susceptible humid regions of the world (expressed in Million Hectares) (data from GLASOD)

	Dry lands				Humid regions			
Degradation types	Light	Moderate	Strong + Extreme	Total	Light	Moderate	Strong + Extreme	Total
Water erosion	175	208	84	467	168	319	140	627
Wind erosion	197	215	20	432	72	39	6	117
Chemical deterioration	44	31	25	101	49	72	18	138
Physical deterioration	11	15	9	35	33	12	3	48
Total	427	469	138	1035	322	442	167	930

Table 1B Human-induced soil degradation in the drylands and humid areas of South and Southeast Asia ,expressed in Million Hectares (data from ASSOD)

	Dry lands				Humid regions			
	Light	Moderate	Strong + Extreme	Total	Light	Moderate	Strong + Extreme	Total
Water erosion	68	23	6	198	186	82	42	330
Wind erosion	46	14	45	105	37	15	22	74
Chemical deterioration	78	18	3	99	93	42	2	137
(salinization	*18*	*12*	*3*	*33*	*8*	*2*	*0*	*10)*
(nutrient decline	*59*	*7*	*1*	*67*	*77*	*38*	*2*	*117)*
Physical deterioration	236	59	58	353	361	154	69	584

This information forms a supporting argument to expand the Convention on Desertification into a Comprehensive Soil Convention for the sustainable use of soils in all eco-regions of the world. Similar in nature, but even more comprehensive, is the WOCAT approach. The goal of WOCAT is to contribute to the sustainable use of soil and water through the collection, analysis, presentation and dissemination of soil and water technologies and approaches worldwide, to promote decision-making and land management (Liniger *et al.*, 1997). While in its initial stages WOCAT used the mapping units of GLASOD for its inventories on soil and eater conservation, it now plans to use SOTER mapping units, delineated on more objective criteria.

In future projects to establish integrated land resources information systems at national scale an amalgamation of technologies developed under SOTER, ASSOD and WOCAT is proposed.

4 Indicators of Sustainable Use of the Land

Indicators are statistics or measured values that relate to a condition, change of quality, or change in the state of something valued (Dumanski, 1997). In the proposed Soil Convention on Sustainable Use of the Land, article 7 suggests an index of sustainable use of soils by constantly assessing and comparing rates of soil formation and of soil degradation in appropriate spatial units and thus comparing different periods and areas.

The rate of changes of soil characteristics as a result of natural soil formation processes is highly variable. Varallyay (1990) developed time changeability classes of various soil characteristics. The weathering of the initial solid-phase lithosphere structure into a newly formed pedosphere solid-phase structure is highly dependent on the prevailing climatic conditions and topographic relief.

Processes of soil formation may occur *in situ* (transformation processes) or by translocation, migration of products of transformation (transport processes).

The soil and terrain databases described in previous sections form the baseline conditions of the present or near-present conditions of the land. They can be used to estimate land qualities such as moisture availability, nutrient availability, oxygen availability, available foothold for roots, conditions for germination, workability of the land, salinity conditions, soil toxicity, etc. They can also be used to estimate soil erosion hazard, nutrient decline, salinization hazard, etc.

These soil related land qualities indicate the inherent biotic, chemical and physical state conditions of the land. As a result of human intervention, depending on the type of land use and land management the state of these soil qualities may change. These changes may be negative when the land is poorly managed or positive under good management. Society in turn may respond (or not) as a consequence of the impact of the changing state of land qualities.

The decline in nutrient availability and/or the loss of organic matter in traditional low external input agriculture (e.g. slash and burn systems) result in reduced yields. Farmers will abandon the fields and over time the natural fertility may be restored. Loss of nutrients may also occur as a result of top-soil erosion when arable crops are cultivated on sloping land. Farmers may adopt soil conservation technologies to prevent further erosion.

Salinization can be defined as an increase of the salinity status of the soil, which usually occurs in the arid and semi-arid irrigated lands. Farmers must adopt proper water management techniques to rehabilitate the land.

As a result of human, industrial and social activities certain chemical toxic substances can accumulate in soils to the extent that in some cases concentrations have reached thresholds above which they become an environmental hazard. Certain soils are capable of absorbing, retaining and recycling contaminating substances better than others. Identification of those soils more at risk from contamination and their geographical distribution would be most valuable information to have available (ISRIC, 1991).

These are only a few examples to illustrate the need for indicators of sustainable use of the land. These indicators should be related to the many functions of the land (e.g. Sombroek, 1997). The

Land Quality Indicators programme for Sustainable Resource Management (FAO, 1997) – a joint initiative of the World Bank, FAO, UNEP, UNDP, and the United Nations Commission for Sustainable Development — is an initiative that is practical and directly related to the issues of sustainable use of the land to contribute to the challenge of providing sufficient food for the growing world population, while preserving the biophysical potential of natural resources and minimizing environmental degradation. This programme can be considered as implementation activities of the proposed Convention on Sustainable use of the Land.

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