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GLOBAL AND REGIONAL DATABASES FOR DEVELOPMENT OF STATE LAND QUALITY INDICATORS

The SOTER and GLASOD Approach

L.R. Oldeman

Discussion Note Prepared for FAO Workshop on Land Quality Indicators for Sustainable Land Resources Management, 25-26 January, 1996

ISRIC

INTERNATIONAL SOIL REFERENCE AND INFORMATION CENTRE

Discussion Note
on
Global and Regional Databases for Development of State land Quality Indicators

The SOTER and GLASOD Approach[1]

L.R. Oldeman[2]

1. INTRODUCTION

As a consequence of ISRIC's mandate:

> *"to collect and disseminate scientific knowledge about soils for the purpose of a better understanding of their formation, characterization, classification, distribution, and capability for sustained land utilization at local, national and global scales",*

ISRIC has since its establishment in 1966 prepared national, continental and global soil profile databases and spatially georeferenced soil and terrain databases.

These databases are known under the following acronyms:
ISIS: ISRIC Soil Information System
WISE: World Inventory of Soil Emission Potentials
SOTER: World Soils and Terrain Digital Database

Within the framework of the United Nations Environment Programme (UNEP) and in close cooperation with the Food and Agriculture Organization of the United Nations (FAO), ISRIC has coordinated the development of a global soil degradation status database and is presently preparing a regional soil degradation status database for South and Southeast Asia.

These databases are know under the following acronyms:
GLASOD: Global Assessment of the Status of Human-induced Soil Degradation
ASSOD: Regional Assessment of the Status of Human-induced Soil Degradation in South and Southeast Asia

These databases can be used as baseline for the development of State Land Quality Indicators. The preamble for a series of workshops (1992) initiated by the World Resources Institute and the California Institute of Technology (Global Environmental Monitoring: Pathways to Responsible Planetary Management) states: *"In order to manage our planet's environment rationally, we must understand Earth system processes, obtain a measure of the baseline conditions of Earth Resources, and monitor and report on changes in Earth resources and environmental quality. The SOTER activity of UNEP, FAO and ISRIC plans to use properly structured ground assessments to create a baseline geo-reference database on soils, soil degradation, and terrain over the next 10-15 years if funds 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".*

Benites (1995) 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 over geographic area. In the following section a brief overview is given of the baseline databases prepared or coordinated by ISRIC.

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2. BASELINE DATA ON SOILS, TERRAIN AND SOIL DEGRADATION STATUS

2.1 *ISIS*

Since ISRIC's establishment in 1966 as the International Soil Museum, soil profiles were assembled, standard analytical procedures developed, soil samples analyzed and associated information collected to illustrate the units of the FAO-Unesco Soil Map of the World. To facilitate the storage and management of the soil and environmental data collected and analyzed, a computerized database management system was developed (ISIS), which has been operational since 1986. Out of a total of some 950 reference profiles around 650 are now stored in ISIS (see Table 1). It is envisaged that by 1997 the ISIS database will be completed. The uniqueness of this database is that all stored information on soil attributes is analyzed in a standardized way. The dissemination of the information in ISIS is in the form of hard-copy Country Reports, while selections of the database can be requested in electronic format. Appendix 1 gives an example of the stored information.

2.2 *WISE*

Development of a global soils database, linked through a G.I.S. to the only viable global soil map available (the FAO-Unesco Soil Map of the World), now available in digital format with errors corrected and boundary changes included. This database (see Table 2) is composed of international datasets held by the Natural Resources Conservation Service of the USA, by the FAO, and by ISRIC (*i.c.* ISIS) and complemented with regional and national databases where and when available. Also included are resources of the ISRIC library collection. Software is developed to (mechanically) transfer data held by the major data holders from one database to another. Currently the WISE database contains 4353 profiles (Africa - 1799; South, West, North Asia - 522; China, India, Philippines - 553; Australia and Pacific Islands - 122; Europe - 492; N. America - 266; S. America + Caribbean - 599).

The cartographic database of WISE has been built up mechanically, by identifying soil associations occurring in each 5'x5' grid-cell of the digital version of the World Soil Map; computing the percentage area of each soil unit present in the 36 cells which make up the ½°x½° grid-cell (Nachtergaele, 1994) using FAO's standard composition rules; aggregation of information to generate soil geographic area data relevant to each terrestrial ½°x½° grid-cell. Each of these grid-cells consists of up to 10 different soil units (see Figure 1).

2.3 *SOTER*

The World Soils and Terrain Digital Database (SOTER) programme provides an orderly arrangement of natural resource data in such a way that these data can be readily accessed, combined and analyzed from the point of view of potential use, in relation to food requirements, environmental impact and conservation. Basic in the SOTER approach is the mapping of areas (SOTER units) with a distinctive, often repetitive pattern of landform, surface form, slope, parent material and soils. Each SOTER unit is linked through a Geographic Information System with a computerized database containing all available attributes on topography, land form and terrain, soils, climate, vegetation and land use. In this way each type of information or each combination of attributes can be displayed as a separate layer or overlay or in tabular form.

SOTER is an initiative of the ISSS and the approach was adopted at the 13th World Congress of Soil Science in 1986. Under a UNEP project the SOTER methodology was developed in close cooperation with the Land Resources Research Centre of Canada, FAO, and ISSS. After initial testing in three areas, involving five countries (Argentina, Brazil, Uruguay, USA, Canada) the methodology was endorsed by the ISSS Working Group on World Soils and Terrain Digital Database (DM), further refined and in 1993 the Procedures Manual for Global and National Soils and Terrain Digital Databases was jointly published by UNEP, ISSS, FAO and ISRIC, thus obtaining international recognition. The Procedures Manual is available in English, French, and Spanish.

The SOTER concept was developed for application at a 1:1 Million scale. However, the methodology is more or less scale independent. At larger scales subdivisions into smaller sub-units will be necessary. At smaller scales, reduction of the number of attributes is proposed.

In 1992 an international panel to evaluate SOTER was convened by UNEP. The panel recommended not only SOTER activities at national level using scales ranging from 1:500,000 to 1:1 Million, but also the development of small-scale continental SOTER databases. In 1993 a joint action plan was formulated and jointly financed by UNEP, FAO, and ISRIC to compile a 1:5M SOTER database for Latin America. The SOTER approach applied at scale 1:5M is seen by FAO, UNEP and ISRIC as the formal strategy to replace the Soil Map of the World in the near future (in 2002 at the latest).

SOTER databases completed or currently under construction:

1:5 Million:
- Argentina, (partly) Brazil, Cuba, Ecuador, Mexico, Uruguay, Venezuela: completed
- All other Latin American countries: under construction
- Russia, China and Mongolia, in the framework of the Land Use and Cover Change activities of IIASA (under construction)
- South and Southeast Asia, as follow-up of the ASSOD activities (see 2.5), under discussion

1:1 Million:
- Argentina (16%), Uruguay, Kenya: completed
- Syria, Jordan: under construction

1:500,000:
- Hungary: completed

1:100,000:
- Pilot areas in Argentina, Uruguay: completed

The SOTER methodology is also being used in Bolivia, Ethiopia, Europe, USA and in North Asia outside the direct involvement of ISRIC. SOTER project proposals have been submitted for funding for China, for Central and Eastern Europe, and for high mountain areas under the CGIAR's Initiative for Global Sustainable Mountain Development. For further information on the SOTER methodology reference is made to Van Engelen and Wen (1995) and Appendix 2.

2.4 *GLASOD*

In view of UNEP's urgent need to have a scientifically credible global assessment of the status of human-induced soil degradation, ISRIC prepared under a financial arrangement with UNEP and in close cooperation with over 250 soil scientists worldwide, a World map of the Status of Human-induced Soil Degradation at scale 1:15 Million at the equator (Mercator Projection). Regional cooperators were asked to delineate on a standard topographic basemap (derived from the world map of the Institut Geographique National) map units showing a certain homogeneity of physiography, climate, vegetation, geology, soils and land use. Within each delineated map unit, soil degradation types occurring in these units were identified and interpreted for the degree of degradation, its relative extent within the unit and for the type of human intervention that has resulted in soil degradation during the post-war period. The regional results were then generalized and compiled as World map.

As a follow-up activity the GLASOD map was digitized and through a GIS linked to a soil degradation database with attributes derived from its legend. Single value maps on various types of soil degradation and its severity were prepared by UNEP for inclusion in the World Atlas of Desertification. The tabular statistics on extent, degree and causative factors has attracted worldwide attention. They were published in the World Resources Report 1992-1993 of the World Resources Institute and are used in IFPRI's 2020 Vision papers. Although GLASOD data are based on qualitative expert estimates and provide only a first approximation of the worldwide status of soil degradation, the GLASOD study is according to IFPRI (1995) "one of the most cited studies in recent literature on the extent of global soil degradation". More details on GLASOD can be found in Greenland and Szabolcs (1994). See also Appendix 3.

At the request of the Steering Committee for the Conservation and Management of the Environment and Natural Habitats of the Council of Europe an updated version of the European section of GLASOD was prepared (Van Lynden, 1995).

2.5 *ASSOD*

The third meeting of the Expert Consultation of the Asian Network on Problem Soils (October, 1993) was devoted to the collection and analysis of land degradation data. The consultation recommended to adopt the GLASOD methodology and recognized the need to adopt a physiographic approach in conformity with the SOTER methodology in order to develop national and regional geo-referenced databases to be utilized not only in monitoring soil degradation status but also in estimating key sustainable development factors (FAO, 1994). Under an agreement with FAO a physiographic map and database at 1:5M scale was prepared. The guidelines for soil degradation status assessment was adapted and late 1994 a project document was formulated by UNEP for the Assessment of the Status of Human-induced Soil Degradation in South and Southeast Asia, to be implemented by ISRIC in close coordination with national institutions in 16 participating countries and FAO. In ASSOD more emphasis is placed on the assessment of the degree of soil degradation (Van Lynden, 1995).

Table 3 illustrates how national institutions are asked to relate the degree of soil degradation to the impact on productivity (increase/decrease) and the level of management inputs (e.g. if we find no increase in production despite a major level of management input the area is considered to have a moderate degree of soil degradation). The results of ASSOD will be finalized by mid 1996. During a recent workshop of the Expert Consultation in Manila (November, 1995) members expressed the need to prepare more detailed national assessments, to develop a 1:5M SOTER database for the region, and national SOTER databases at larger scales.

3. THE STATE OF LAND QUALITY

The databases described in the previous sections form the baseline conditions for the identification of the present or near-present conditions of the land. They can be used to estimate land qualities such as moisture availability, nutrient availability, erosion hazard, flooding hazard, available foothold for roots, conditions for germination, conditions for mechanisation, availability of oxygen for root growth, excess of salts, soil toxicities.

In a Pressure-State-Response Framework a solid baseline information on the conditions of the land is a prerequisite. This will indicate the "inherent" chemical and physical conditions of the land. These conditions are influenced by outside pressures, which are the normal pressures exerted by natural (climatic) events or those exerted by human activities, in dependence of the type of land use and land management. As a result the state of the land conditions may change. This change may be negative (degradation of the state conditions) or positive (amelioration of the state conditions). If the natural resource base is sufficiently stable (or is stabilized) and if the pressures exerted on the conditions is balanced by land management inputs the state of the land conditions may not change at all (sustained utilization of the land). The impact of these changes may lead to a Response to halt further degradation or to rehabilitate the degraded land conditions to its initial conditions. In the absence of any response further pressure may lead to further deterioration of the land conditions, eventually leading to a situation, in which the land has no further productive capacity. Then the land will be deserted.

At ISRIC several procedures have been developed to determine the state of the condition of the land. An ISIS-based procedure has been developed for a qualitative evaluation of the land conditions. This procedure uses the Automated Land Evaluation System (ALES) and is acronymed STRESS (Mantel and Kauffman, 1995). Its aim is to provide an indication of the potential physical suitability of reference soils for low input, arable farming thereby indicating major limitations, and to enable the comparison of soils from different parts of the world.

A SOTER-based, automated procedure for qualitative land evaluation is developed (created in ALES). The objective of this procedure, acronymed SOTAL (Mantel, 1995), is to design a methodology that allows for a quick separation of the potentially suitable SOTER units from those non suitable for an intended land use, thereby indicating constraints for different kinds of land use. SOTAL case studies have been executed in Kenya and Uruguay. The procedure is a useful tool in land use planning, because constraints for different kinds of land use can be determined quickly. Areas indicated as potentially suitable have no major physical limitations for a proposed land use. For more specific statements, like for instance the potentially attainable yield, a quantified land evaluation is needed, using dynamic crop growth simulation models. The attractive feature of the procedure following the pathway of a qualitative land evaluation in SOTAL, preceding a quantified land evaluation is that non-suitable areas can be neglected in the quantified land evaluation, which demands more data and time.

A SOTER-based programme is developed for the assessment of water erosion hazard (Van den Berg and Tempel, 1995). In this programme, acronymed SWEAP, two alternative erosion assessment models, based on SLEMSA (Soil Loss Estimation Model for Southern Africa, developed by Elwell and Stocking, 1982) or USLE (Universal Soil Loss Equation, developed by Wischmeyer and Smith, 1978) can be selected. Modifications were introduced in order to adjust the programme to SOTER's facilities and limitations. The aim of SWEAP was to optimize the balance between refinement of the equations and the available information. Results obtained by using SWEAP must be interpreted in terms of abstract "erosion hazard units", rather than as quantified estimates of potential soil loss. SWEAP has been tested in a SOTER pilot area in Canada, in pilot areas in Uruguay and is now being applied in Kenya within the framework of UNEP's programme: National Land Degradation Assessment and Mapping in Kenya".

The earlier discussed GLASOD and ASSOD activities provide a qualitative assessment of the status of soil degradation. The approach, used in these studies provides indicators for soil degradation state. For each type of soil degradation its estimated impact on productivity and the "recent past" rate of degradation over the past 5 to 10 years is indicated. Although changes in soil and terrain properties may reflect the occurrence and intensity of soil degradation processes, it does not necessarily reflect the seriousness of its impact on overall soil productivity (removal of a 5 cm layer of topsoil has a greater impact on a poor shallow soil than on a deep fertile soil). It would be better to measure the degree of soil degradation by the relative changes of soil properties: the percentage of the topsoil lost, the percentage of total nutrients and organic matter lost; the relative decrease in soil moisture holding capacity, etc.

Declining productivity as an indicator for soil degradation is also hazardous because yield declines may be caused by a variety of factors such as soil degradation, improper management, drought or waterlogging, quality of inputs, pest and diseases. It is therefore important to consider a medium to long term period (10-15 years) to level out large aberrations resulting from fluctuation in weather patterns or pest and disease occurrence. On the other hand, soil degradation can be more or less hidden by the effects of various management measures such as soil conservation techniques, improved varieties, increased levels of fertilisation, increased land management, etc. Part of these inputs is used to compensate for productivity losses caused by soil degradation.

In order to indicate the change in degree of soil degradation over time, a qualitative estimate of the trend of soil degradation is given in ASSOD. It is important to know whether a severely degraded area is at present quite stable, or whether an area that has now only a slight degree of degradation has a high rate, indicating a trend towards rapid further deterioration. At the same time, the ASSOD map will also indicate areas where the situation is improving (for example through soil conservation measures). In this context the WOCAT project (World Overview of Conservation Approaches and Technologies) is worth mentioning.

4. CONCLUSIONS

Soil and terrain databases form the basis for the assessment of state land qualities. Soil degradation databases provide useful indicators of the conditions of the land. Baseline information on the state land qualities are essential to monitor changes in land conditions over time. It would be worthwhile to consider resampling of soil profiles of reference soils in ISRIC's soil reference collections to determine changes over time. Most of the sites are well-documented and provide a unique opportunity to study land condition changes as a result of exerted pressures. Another possibility to compare changes over time would be to compare land conditions between areas under natural cover and areas with similar soils but used for agricultural production. In order to asses the effect of a relative change of soil properties on food productivity an assessment can be made of the potential biological productivity of reference soils with and without assumed losses of topsoil or with removal (mining) of nutrients by crops with and without fertilizer inputs.

REFERENCES

Benites, J., 1995. Land Conditions Change Indicators for Sustainable Land Research Management. Working Paper, rpts. 6, FAO, Rome, 20 p.

Berg, M. van den, and P. Tempel, 1995. SWEAP: A Computer Program for Water Erosion Assessment applied to SOTER. SOTER Report no. 7. UNEP, Nairobi and ISRIC, Wageningen, 50 p.

Elwell, H.A., and M.A. Stocking, 1982. Developing a Simple, yet Practical Method of Soil-loss Estimation. Trop. Agric. 59:43-48.

Engelen, V.W.P. van, and T.T. Wen, 1995. Global and National Soil and Terrain Digital Databases (SOTER). Procedures Manual (revised ed.). UNEP, Nairobi; ISSS, Vienna; FAO, Rome; ISRIC, Wageningen, 125 p.

FAO, 1994. The collection and Analysis of Land Degradation Data: Report of the Expert Consultation of the Asian Network on Problem Soils, Oct. 1993. RAPA Publ. 1994/3. FAO, Bangkok, 259 p.

Lynden, G.W.J. van, 1995. Guidelines for the Assessment of the Status of Human-induced Soil Degradation in South and Southeast Asia. Working Paper and Preprint 95/02, ISRIC, Wageningen, 20 p.

Lynden, G.W.J. van, 1995. European Soil Resources. Current Status of Soil Degradation, Causes, Impacts and Need for Action. Nature and Environment, no. 71. Council of Europe Press, Strasbourg, 99 p.

Mantel, S., 1995. The Automated Land Evaluation System applied to SOTER with an Example from West Kenya. Working Paper and Preprint 95/03. ISRIC, Wageningen, 39 p.

Mantel S., and J.H. Kauffman, 1995. Agricultural Suitability of Reference Soils. The Automated Land Evaluation System applied to ISRIC Soil Information System. Working Paper and Preprint 95/13. ISRIC, Wageningen, 27 p.

Oldeman, L.R., 1994. The Global Extent of Soil Degradation. In: Soil Resilience and Sustainable Land use, ed. D.J. Greenland and I. Szabolcs, CAB International, Wallingford, p 99-119.

Wischmeyer, W.H., and D.D. Smith, 1978. Predicting Rainfall Erosion Losses. A Guide to Conservation Planning. US Dept. of Agric., Agric. handbook no. 537, 58 p.

WRI, Cal. Tech., 1992. Global Environmental Monitoring: Pathways to Responsible Planetary Management. Pasadena, Cal., Washington DC., 17 p.

Yadav, S., and S. Scherr, 1995. Land Degradation in the Developing World: Is it a Threat for Food Production to the year 2020? (Draft paper for workshop on: Land Degradation in the Developing World: Implications for Food, Agriculture and Environment to the Year 2020, April 4-6, Annapolis, IFPRI, 190 p).

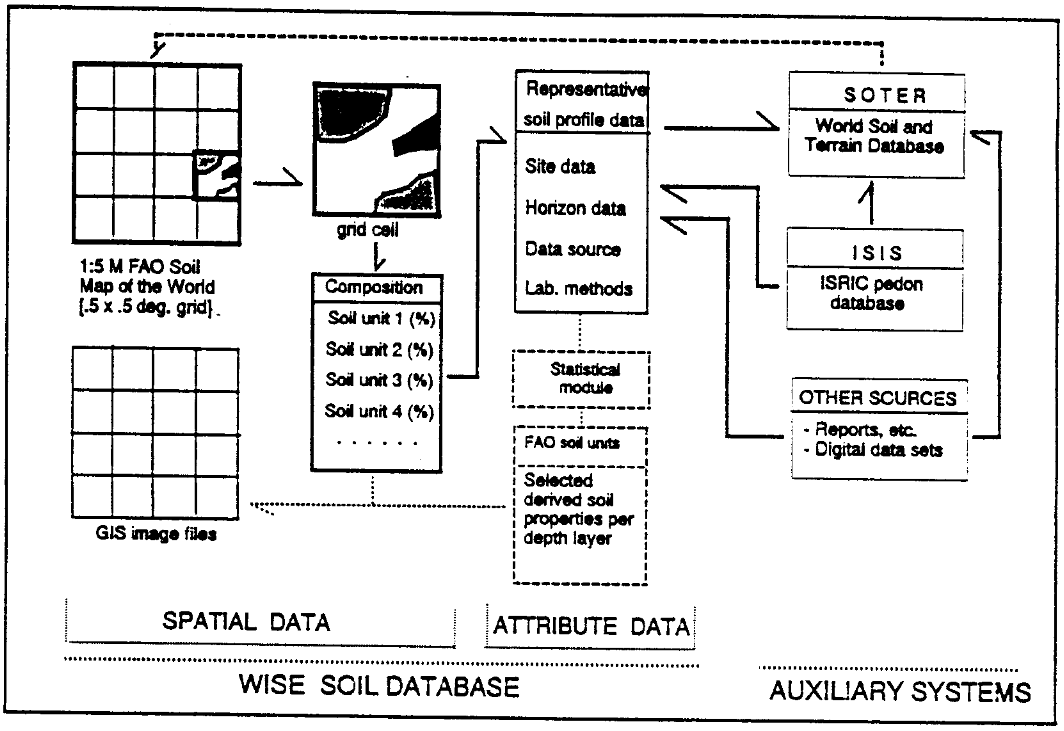

Fig. 1 Generation of spatial products using the WISE database

Table 1 Database status of reference profiles stored in ISIS (December 1994)

Country	ISIS	Archive
Australia	3	36
Belgium		4
Botswana	7	
Brazil	28	1
Cameroon	1	
Canada		21
China	51	
Colombia	18	1
Costa Rica	12	
Côte d'Ivoire	7	
Cuba	22	
Czech Republic		8
Denmark		8
Ecuador	20	
Finland		5
France	11	1
Gabon	6	
Germany	14	3
Ghana	1	5
Greece	15	
Greenland	1	
Hungary	3	16
India	12	18
Indonesia	46	
Ireland	3	7
Italy	17	
Jamaica	4	
Japan	4	
Kenya	68	3
Malaysia	18	
Malawi	1	
Mali	8	1
Mozambique	9	
Namibia	3	6
New Zealand		5
Nicaragua	11	
Nigeria	28	
Norway	2	1
Oman	4	
Pakistan	6	
Peru	21	
Poland	14	8
Philippines	6	
Romania	11	
Rwanda	10	
South Africa	12	9
Spain	19	
Sri Lanka	4	
Sweden	5	14
Switzerland		1
Syria		4
Thailand	13	
Turkey	16	
United Kingdom		11
Uruguay	10	
USA	4	21
former USSR	2	60
Venezuela	1	
West Samoa	5	
Yugoslavia		3
Zambia	11	
Zimbabwe	13	
TOTAL (1994)	652	296
total (1992)	*375*	*440*

Table 2 Global Pedon Database

Broad geographic region	in WISE	In homogenized database (Int. set)			
		FAO	NRCS	ISIS	Total
Africa	1799	93	204	18	315
S.,W. and Northern Asia	522	24	44	0	68
China,India, Indonesia, Philippines	553	45	129	106	280
Australia and Pacific Islands	122	28	27	0	55
Europe	492	5	2	0	7
North America	266	14	144	0	158
Latin America + Caribean	599	41	114	86	241
	4353	250	664	210	1124

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Table 3 Impact of soil degradation on productivity

Level of production increase/decrease	Level of Input/Management improvements		
	A) Major	*B) Minor*	*C) Traditional*
1) Large increase	No significant impacts (stable)	No significant impacts (stable)	No significant impacts (stable)
2) Small increase	Light	No significant impacts (stable)	No significant impacts (stable)
3) No increase	Moderate	Light	No significant impacts (stable)
4) Small decrease	Strong	Moderate	Light
5) Large decrease	Extreme	Strong	Moderate
6) Unproductive	Extreme	Extreme	Strong to Extreme

ISIS 4.0 data sheet of monolith BR015 Country : BRAZIL Print date (dd/mm/yy) : 19/05/94

FAO/UNESCO (1988) : Geric Ferralsol
(1974) : Acric Ferralsol, cerrado phase
USDA/SCS SOIL TAXONOMY (1992) : Humic Acrustox, fine clayey, isohyperthermic (1975 : typic haplustox)
LOCAL CLASSIFICATION : Latossolo LVA

DIAGNOSTIC CRITERIA
FAO (1988) : Diagnostic horizons : ferralic B
: Diagnostic properties : geric properties
USDA/SCS (1992) : Diagnostic horizons : oxic horizon
: Soil moisture regime : ustic

LOCATION : Distrito Federal, Planaltina,CPAC research station,top plateau
Latitude : 15°36'30'' S Longitude : 47°45' 5'' W Altitude : 1170 (m.a.s.l.)
AUTHOR(S) : Kauffman, J.H. Date (mm.yy) : 4.86

GENERAL LANDFORM : plateau Topography : flat or almost flat
PHYSIOGRAPHIC UNIT : "chapada"=nearly flat plateau
SLOPE Gradient : 1% Aspect : Form : straight
POSITION OF SITE : flat
MICRO RELIEF Kind :
SURFACE CHAR. Rock outcrop : nil Stoniness : nil
Cracking : nil Slaking/crusting : nil
Salt : nil Alkali : nil
SLOPE PROCESSES Soil erosion : slight sheet Aggradation : nil
Slope stability : stable

PARENT MATERIAL 1 : colluvium derived from : highly weathered material
Texture : clayey
Weathering degree : high Resistance :
Remarks :

EFFECTIVE SOIL DEPTH(cm) : 300

WATER TABLE Depth(cm) : 320 Kind : groundwater table
DRAINAGE : well
PERMEABILITY : high No slow permeable layer(s) cm
FLOODING Frequency : nil Run off : rapid
MOISTURE CONDITIONS PROFILE : 0 - 120 cm dry 120 - 300 cm moist 300 - 470 cm wet

LAND USE : high level arable farming; Crops : soya bean; seasonal irrigated; Rotation : crop rotation continuous
VEGETATION Type : deciduous woodland
Landuse/vegetation remarks : Cerrado = brazilian wooded savanna

ADDITIONAL REMARKS :
Brief field description:
Very deep, well drained, yellowish brown clay derived from extremely weathered parent material.
Soil has very high porosity in upper two horizons, more than 5/cm2.
The soil does not show any oxidation/reduction colours above and below the water table.
Additional information: Boletim tecnico no.53 SNLCS-EMBRAPA. (ISRIC-libr. LA-36). Detailed information on vegetation in field archive. U=windspeed is measured at 2m high.
Slides no 9781-9793.

CLIMATE : Köppen: Aw
Station: 15 35 S/ 47 42 W 1007 m a.s.l 5 km of site Relevance: very good
CPAC,MAIN STATION

		No. years of record	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
EA class A pan	mm	13	144	152	157	144	143	150	173	209	200	177	147	145	1942
relative humidity	%	13	75	73	73	72	70	66	61	58	60	67	72	74	68
precipitation	mm	13	321	196	267	102	28	5	5	15	42	171	181	234	1566
T max	°C	13	26.5	27.2	27.5	26.9	26.4	26.1	26.0	27.9	29.0	28.1	27.0	26.7	27.1
T min	°C	13	17.6	17.6	17.8	17.1	15.6	13.8	13.4	15.1	16.8	17.5	17.7	17.6	16.4
windspeed(at 2m)	m/s	13	1.3	1.2	1.0	1.2	1.2	1.3	1.5	1.5	1.5	1.3	1.2	1.2	1.3
bright sunshine	h/d	13	3.9	6.8	5.8	7.1	7.8	8.7	8.9	8.7	7.2	6.4	5.2	4.1	6.7

UNEP ISSS-AISS-IBG

SOTER

ISRIC FAO FIAT PANIS

World Soils and Terrain Digital Database

Appendix 2

OBJECTIVES

To make data on soil and terrain resources accessible to resource managers, policy-makers and the scientific community at large for:

- Assessments of the productive capacity of soils
- Better understanding about the risks of soil degradation
- Estimations of soil degradation and impacts on food production
- Improved quantification of global change processes

INITIATIVE

SOTER is a direct response to Agenda 21 (chapter 10, 11, 12, 13) of the United Nations Conference on Environment and Development, consisting of a strengthening of natural resources information systems at global and national levels.

SOTER has been initiated by:

- United Nations Environment Programme
- International Society of Soil Science
- Food and Agriculture Organization of the United Nations
- International Soil Reference and Information Centre

ISSS congress, Acapulco, Mexico, 1994

CHARACTERISTICS

SOTER provides an orderly arrangement of natural resource data through the creation of a computerized database containing available attributes on:

- Physiography
- Soils
- Vegetation and land use
- Climate

This database is linked to a geographic information system (GIS) which contains the digitized map units. The GIS and the database can generate cartographic and statistical information consisting of:

- Simple extraction of one or any combination of attributes
- Simple interpretations of attributes
- Complex models using and combining attributes from various sections of the database

Covers of SOTER manuals

SOTER MATERIALS

Since its inception in 1986, the methodology of SOTER has been refined and is now available in a Procedures Manual (in English, Spanish and French). Software for input of attribute data is available with the user manual.

For interpretation purposes a water erosion assessment programme (SWEAP) has been developed making direct use of the SOTER database.
A similar approach for wind erosion is now under development.
Other new applications include salinity risk assessments and land evaluation.
The latter approach makes use of the Automated Land Evaluation System (Rossiter, 1993).
An interface for data transfer between SOTER and ALES is available.

ACTIVITIES

SOTER databases are currently under construction or have been completed at scales ranging from 1:5 M towards 1:100,000 in:

- Argentina, Brazil, Cuba, Ecuador, Mexico, Venezuela, Uruguay (1:5 M)
- Argentina, Kenya and Uruguay (1:1 M)
- Hungary, Jordan and Syria (1:500,000)
- Detailed areas in Argentina and Uruguay (1:100,000)

The SOTER methodology is also being used in several other countries outside the direct responsibility of the project (e.g. Bolivia, USA).

TECHNICAL ASSISTANCE

ISRIC can provide:

- Project coordination
- On-the-spot training
- Technical assistance

FURTHER INFORMATION

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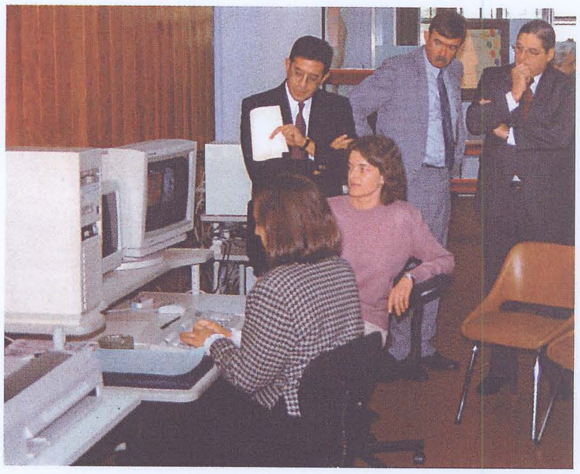
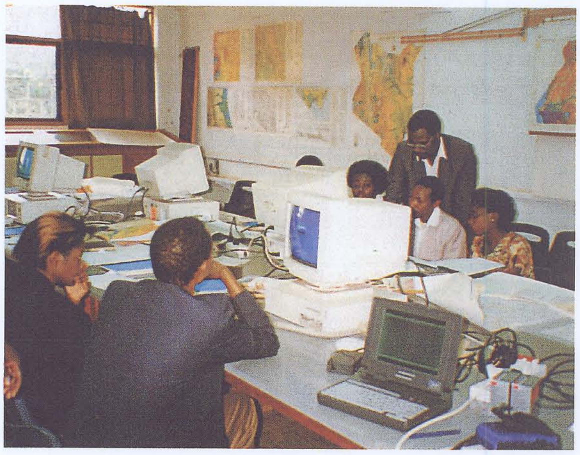


GIS-training in Argentina



Applications-training in Kenya

Design: Jacqueline Resink & Wouter Bomer

UNEP

Global Assessment of the Status of Human-Induced Soil Degradation (GLASOD)

ISRIC

BACKGROUND
The United Nations Environment Programme (UNEP) expressed the need to produce, on the basis of incomplete knowledge, a scientifically credible global assessment of soil degradation in the shortest possible time. On behalf of UNEP, a 1:10 Million World Map of the Status of Human-induced Soil Degradation (GLASOD) has been prepared by ISRIC (1988-1990) in close cooperation with over 250 soil scientists worldwide. The GLASOD map was presented at the XIVth International Congress of Soil Science in Kyoto, 1990, and at UNCED, Rio de Janeiro, 1992.

FOLLOW-UP
The map units of the GLASOD map were digitized and linked to a soil degradation database in which the attributes of soil degradation type, degree, frequency of occurrence, and causative factors of soil degradation are stored. It is now possible to estimate the global and continental extent of the various soil degradation types and their degree of impact. Single value maps of water erosion, wind erosion, chemical and physical degradation were prepared by UNEP/GRID and used in the production of the World Atlas of Desertification in 1992. Tabular data on the status of soil degradation were published in the World Resources Report 1992-1993 of the World Resources Institute. The results of GLASOD are also published by CAB International in the Proceedings of an International Symposium on "Soil Resilience and Sustainable Land Use", Budapest, 1992.

RESULTS
Human-induced soil degradation has affected almost 2000 million hectares (Mha) worldwide, or approximately 15% of the total land area. Water erosion is by far the most important type of soil degradation (56% of the total area affected by soil degradation). Wind erosion is of particular importance in the arid and semi-arid regions of Africa and Asia, while more than 50% of the land affected by nutrient depletion is in Latin America. Salinization is most dominant in Asia. Pollution as a result of industrial activities is of major concern in Europe.

Altogether more than 300 Mha of land is strongly degraded and has virtually lost its productive capacity. About 900 Mha is moderately degraded, characterized by a serious decline in productivity. However, this land can be restored if rehabilitation is implemented now.

Overgrazing, deforestation and mismanagement of the agricultural land, occurring on respectively 680 Mha, 580 Mha and 550 Mha are the major causes of human-induced soil degradation.

Global and Continental Extent of Human-induced Soil Degradation (in million hectares)

Degradation type	Africa	Asia	Latin America	North America	Europe	Oceania	World
Water Erosion	227	440	169	60	114	83	1093
Wind Erosion	187	222	47	35	42	16	549
Nutrient Depletion	45	14	72	-	3	+	134
Salinization	15	53	4	+	4	1	77
Pollution	+	2	+	-	19	-	22
Acidification	2	4	-	+	+	-	7
Compaction	18	10	4	1	33	2	68
Waterlogging	+	+	9	-	1	-	11
Subsidence Organic Soils	-	2	-	-	2	-	4
Total	495	748	305	97	218	102	1965
Land Area affected	17%	18%	15%	5%	23%	12%	15%

FUTURE ACTIVITIES

Frequent requests have been made for more detailed regional and national estimates of soil degradation. The World Resources Institute indicated "a critical need for further study to more accurately portray soil degradation problems at a national and local level and to link soil degradation with its social and economic consequences". There are now proposals tabled for Mapping of Soil and Terrain Vulnerability in Central and Easter Europe (see "SOVEUR"), and for a Soil Degradation Assessment for countries in South and Southeast Asia, as recommended by the Expert Consultation of the Asian Network of Problem Soils (Bangkok, October 1993).

ACKNOWLEDGEMENT

The catalytic and coordinating role of UNEP in bringing SOTER into reality is highly appreciated.

Name:	GLASOD
Agent:	UNEP project, implemented by ISRIC, in cooperation ISSS
Duration:	5 years (1988-1990; 1991-1993)
Status:	Completed
Future:	New proposals formulated
Contact:	L.R. Oldeman

INTERNATIONAL SOIL REFERENCE AND INFORMATION CENTRE

GENERAL AIM

The collection and dissemination of scientific knowledge about soils for the purpose of a better understanding of their formation, characterization, classification, distribution and capability for sustained land use at local, national, and global scales.

SPECIFIC AIMS

* To serve as a centre for documentation about the soils of the world as a natural resource. To assemble soil monoliths, reports, maps and other information with emphasis on soils of the developing countries.
* To contribute to an increased understanding about soils enabling their sustained utilization in a changing global environment.
* To improve the accessibility of soil and terrain information for the widest possible range of users through applied research, improvement of research methods, and advice on the establishment of soil laboratories, soil reference collections and databases.
* To contribute to developments in soil classification, soil mapping and land evaluation and in the development of geographically referenced soils and terrain digital databases.

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