SOTER Report 2

International Society of Soil Science (ISSS)
Association Internationale de la Science du Sol (AISS)
Internationale Bodenkundliche Gesellschaft (IBG)

Proceedings
of the
Second International Workshop
on a
Global Soils and Terrain Digital Database

18-22 May 1987
at
United Nations Environment Programme
Headquarters
Nairobi, Kenya

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R.F. van de Weg, editor

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Proceedings of the Second International Workshop on a Global Soils and Terrain Digital Database

GLOBAL ASSESSMENT OF SOIL DEGRADATION

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1.0 INTRODUCTORY STATEMENT

1.1 INTRODUCTION TO THE WORLD SOILS & TERRAIN DIGITAL DATABASE

by Marion F. Baumgardner

Introduction

First, let me welcome all participants in this meeting to consider the feasibility and methodology of global soil degradation assessment. I wish to commend and thank UNEP for making it possible for us to convene here in Nairobi for these discussions and for this opportunity to interact and exchange ideas with members of the UNEP staff who are concerned with environmental monitoring.

During the latter half of this century there has been a growing concern over the Earth's carrying capacity, dwindling resources, and environmental deterioration. This same period has witnessed dramatic technical advances in our ability to acquire, handle, analyze and disseminate data about Earth surface features. Current and future sensor systems, computational facilities, georeferenced digital data management systems, and related technologies are literally revolutionizing the ways we perceive the Earth environment, from the local habitat to the global scene.

We have come together here to focus attention on specific components and processes of the Earth system, the degradation of the Earth's soil resources. In this context it is appropriate to describe a project proposal which has come to be referred to as the SOTER Project.

Background of the SOTER Project

In October 1984 Dr. W.G. Sombroek prepared and distributed for review a working paper entitled "Toward a Global Soil Resources Inventory at Scale 1:1M". Incorporating ideas from the reviewers, Dr. Sombroek prepared a revision which he entitled "Establishment of an International Soil and Land Resources Information Base". This paper was used as the basic study document for an International Workshop on the Structure of a Digital International Soil Resources Map Annex Database which was held from 20 to 24 January 1986 at the International Soil Reference and Information Centre, Wageningen, The Netherlands. Thirty-nine scientists from around the world participated in this workshop.

Conclusions from the Workshop were that it is feasible and desirable to begin planning for a project to prepare a world soils & terrain digital database at a scale of 1:1M. During the three months following the Workshop, the proceedings of the meeting were edited and published and a draft proposal was prepared setting forth an approach for the development of a world soils & terrain digital database. The draft proposal was distributed to all Workshop participants for review.

The group of soil scientists who met in Wageningen for the Workshop as an ad hoc working group of the International Society of Soil Science met again during the International Soil Congress in Hamburg in August 1986. The main agenda item was consideration of the draft proposal. The proposal concept was endorsed officially by the ISSS, and the ad hoc group became an official Working Group on a World Soil & Terrain Digital Database (SOTER) under Commission V of ISSS.

SOTER Proposal Summary

The project is designed to utilize current and emerging information technology to produce a world soils & terrain digital database (map and attribute data) with the following characteristics: 1) average scale of 1:1M; 2) compatible with databases of other environmental resources; 3) amenable to updating and purging of obsolete and/or irrelevant data; 4) accessible to a broad array of international, regional and national decision-makers and policy-makers responsible for the development, management and conservation of environmental resources; and 5) transferable to developing countries for national database development in greater detail.

The technical proposal describes the technical approach, divided sequentially into three phases and utilizing the most effective information technology (hardware and software) for developing, testing and implementing the following tasks: 1) creation of a "universal" legend for a world soils & terrain survey at 1:1M; 2) definition of soils & terrain parameters for entry into the database; 3) selection, prioritization and scheduling of land areas to be added sequentially to the database; 4) acquisition and input of all data essential for inclusion in the database; 5) implementation of updating capability and the capability to overlay with other global environmental data sets; 6) development of capability to extract from the database a broad range of interpretive maps and tabular information for use in the management of land resources; and 7) transfer of the technology to the user community.

It is well recognized by all members of the SOTER Working Group that this is an ambitious project which will take many years to complete. However, it was agreed that the critical need for a world soils & terrain database and the availability of the technical capabilities to implement the project provide the rationale to proceed with the project as rapidly as possible.

SOTER and Soil Degradation Assessment

One of the many possible applications of a soils & terrain digital database is to assess the condition or quality of the soil resources of a specific area. This particular application is in keeping with one of the primary concerns of UNEP in its environmental monitoring activities.

With this in mind the SOTER proposal was sent to UNEP with the request that UNEP consider initial funding of the project for the purpose of demonstrating the use in specified pilot areas of the SOTER database for the assessment of soil degradation. After some discussions and exchange of correspondence, UNEP agreed to invite the group here assembled at the UNEP facility in Nairobi to consider how the SOTER objectives and UNEP environmental monitoring objectives can be combined and implemented simultaneously and in support of each other.

We have the week ahead of us. During this time together may we take full advantage of this opportunity to examine our common objectives and develop innovative plans for implementing a global soil degradation assessment and a world soils & terrain digital database!

2.0 PLENARY SESSION REPORTS

2.1 WELCOME AND OBJECTIVES OF THE MEETING

by Genady N. Golubev

Mr. Chairman, members of the working group, ladies and gentlemen. On behalf of the Executive Director of UNEP, Dr. M.K. Tolba, I am greatly pleased to welcome you here at UNEP and to convey to you his greetings and best wishes. As you were informed last March by Prof. R. Olembo, the topic of this Expert Group Meeting is a constructive technical discussion on the Feasibility of producing a Global Soil Degradation Assessment, and if it is thought to be feasible, on the approaches and methods to be used.

There is no need to tell you, experts in the field, how complex is the process of soil degradation and how difficult it is to make a right approach to its assessment on a global scale.

We at UNEP feel, however, that the problem of the world soils degradation is one of the most serious environmental problems mankind faces now and that the public awareness to this issue does not correspond yet to the magnitude of the problem. Therefore, we consider this meeting extremely important.

UNEP has long had an interest in soil degradation and associated soil problems. Witness to this are World Soils Policy (1982), Guidelines for the Formulation of National Soil Policies (1983), and Guidelines for the Control of Soil Degradation UNEP/FAO (1983) etc.

In 1975 UNEP, FAO and Unesco initiated a project to develop a methodology for assessing soil degradation, and to begin to assess soil degradation on a global scale. This project resulted in the publication of 1:5,000,000 maps showing the current state and the risks of soil degradation for Africa north of the Equator and the near and middle East. Degradation shown on these maps was based on the compilation of existing data and on the interpretation of environmental factors influencing the extent and intensity of soil degradation.

Mr. Chairman, can a better assessment be made now, or in the near future? Or must it be a long-term study of over 15-20 years? Assuming it is the latter, are there ways for making a "quick look" assessment of the global picture in 1-3 years using methods such as, for example, satellite remote sensing, or else, through systems analysis of the factors of soil degradation? Or does it need to be done on a pilot study approach in a few countries world-wide and build from there? What methods are available now, and what new approaches need to be developed in the field, laboratory, remote sensing, data handling... etc?

There is usually a conflict between scientists who feel they don't know yet enough about the subject in question and therefore want to make more studies, and decision makers and the public at large who want to get recommendations from scientists now. This is the case in point for this meeting. Having had personal experience from both sides I am appealing to you that you consider a possibility to produce, on a basis of incomplete knowledge, a scientifically credible global assessment in the shortest possible time. Politically it is important to have an assessment of good quality now instead of having an assessment of very good quality in 15 or 20 years.

This meeting has come about basically because we could not agree in-house on the approach to be used for obtaining a global soil assessment. Therefore, we seek expert advice on how to obtain answers to questions raised earlier. We do recognise the complexity of the subject and its interrelation with other areas. Also we recognise need for cooperative approach so that we work closely with organizations with long experience in this area.

The result is this Expert Group Meeting, and we expect from it:

a) Suggestions to UNEP on feasibility and implementation of updated Global Soil Degradation Assessment.
b) Appraisal of available methods, for soil degradation assessment and what new approaches need to be developed.
c) Presentation of a plan of action on soil degradation assessment.

With this brief introduction I would like to express the firm belief of UNEP that this Expert Group Meeting will be a very successful one and will further promote the criteria and methodology of a global soil degradation assessment. Again, on behalf of the Executive Director of UNEP, I thank you all for attending the Meeting and express my best wishes for more progress in this field. Thank you.

2.2 REVIEW OF ISSS ACTIVITIES AND REPORT ON STATUS OF WORLD SOIL DATABASE

Wim G. Sombroek

ISSS is an international association of professionals in soil science, founded already in 1924. Its aim is "to foster all branches of soil science and its applications", and in that sense it is a "learned society".

Membership is open to all persons and institutions engaged in the study or application of soil science, and these days there are about 7000 individual members from nearly all countries of the world, 65 affiliated national societies, and about 250 institutional members. The only funds of the society are the membership fees ($ 8 per year for individual members), which allows the payment of correspondence, the printing of a six-monthly information bulletin and of a Membership List, and occasional travel support. All officers serve on a honorary basis, including the Secretary-general, his deputy and the Treasurer, hence the necessity for such persons to be attached to an institution which aims are in the same sphere such as FAO and, at present, ISRIC.

ISSS is an associate member of the International Council of Scientific Union (ICSU) since 1972, and takes part in the work of several of its commissions such as SCOPE and CASAFA. One of its own and most prominent standing scientific Commission is no V, the one on soil genesis, soil classification and soil cartography. Already well before 1940 it was active in stimulating the preparation of national and regional soil and land capability maps. This was much strengthened in the fifties when the availability of aerial photography gave much impetus to soil cartography in the tropics and subtropics, often related to specific development projects of UNEP, World Bank, etc.

ISSS wholeheartedly supported the FAO/Unesco project in the fifties and sixties to prepare an overall soil map of the world at 1:5M scale, and was instrumental in the creation of the International Soil Museum, now ISRIC, under the umbrella of Unesco.

Since the publication of the 1:5M map and its legend new techniques of soil data collection, processing and application were introduced. ISSS stimulated this through the creation of Working Groups on Remote Sensing, on Soil Information Systems, on Land Evaluation, on the preparation of and International Reference Base for soil classification and recently on the production of a Digital International Soils and Terrain Database.

The latter two merit special attention in the context of the present meeting, because of the links with UNEP.
First IRB:
The publication of the final sheets of the 1:5M Soil Map of the World of FAO/Unesco further stimulated soil inventory work in many countries, where gaps in the knowledge of soil geography and characterization were very apparent. The Legend Terminology of FAO was used by a number of countries as the basis for their material classification system. At about the same time, several major countries developed, or further refined, their own detailed soil classification system, each with different guiding principles and criteria, and several of them with an intended international application. The data of the FAO/Unesco map were used as base material for several applications at continental scale by UN and other agencies, such as the preparation of agroecological zonification maps, maps on population carrying capacities, maps on soil degradation, on desertification hazards etc.

In view of all this, it was soon realised that the 1:5M map and its Legend was not to remain a one-time effort. In 1978 FAO and ISRIC started cooperating on the systematic collection of new map material as produced by individual countries, to be used for the eventual updating of the 1:5M map. Funds for such an updating did however not materialize at the time. Updating of the Legend (definitions; detailing) would however seem to be within the limited financial means of the UN system. Therefore, with the financial support of UNEP, Unesco, FAO and ISSS, three meetings were held in Sofia (1980, 1981, 1983) with representatives of major national soil survey and classification organizations. The agreed intention was to create an International Reference Base for soil classification to which everybody could adhere, and it was decided to take the FAO Legend as starting point. UNEP, in the framework of its World Soils Policy, was to take the lion's share of the required funding, and FAO was to carry out most of the work. When the UNEP funds appeared to be less substantial than hoped for originally, FAO could not undertake the work, and ISSS tried to continue through the creation of its own working group for the purpose (1982). It functionned under the chairmanship of Prof. Schlichting of FRG, a past Commission V chairman, and a dozen "convenors" from all parts of the world were to work out details for major natural soil groups. Towards 1986, however, it became apparent that no UNEP money at all would be available for the purpose, and also that the chosen structure of cooperation on the subject within ISSS was rather unwieldy.

Since early this year, the IRB effort is continuing by a small core group directly under Commission V with Prof. Dudal - erstwhile principal executive officer of the FAO/Unesco soil map project - as its secretary. It is now realised that the obtainance of complete agreement on such a reference base for soil classification will take several more years. As an intermediate step, and at the urging of many countries - especially African ones, FAO and ISRIC have undertaken to revise and elaborate the original Legend of the FAO/Unesco soil map.

Now SOTER:
While the machinery for IRB and Legend adaptation was grinding on at an agonising slow pace, the need for updating and detailing of the original world soil map became even more urgent. It was realised that a substantially larger scale, viz. 1:1M, was needed to encompass all new data, and to make the result more useful for application on the one hand at world and continental level (for GEMS-GRID, for ICSU's-IGBP programme, for orientation of the research work of the CGIAR institutes etc.), and on the other hand at national and provincial/state level for all kinds of planning and assessment purposes.

The recent advance of cartographic digitizing techniques, computer storage and reproduction facilities, software programmes and modelling work, and the availability of high-quality satellite imagery, now make an effort for the development of a geographic soil database at 1:1M level and its continual updating, a realistic proposition. Hence the creation by ISSS, late 1985, of a provisional Working Group for the purpose, which had its first meeting in January 1986 at ISRIC in Wageningen, the Netherlands. The Proceedings of that meeting, and the ensuing project proposal for a World Soils and Terrain Digital Data Base at an average scale of 1:1M (acronymed SOTER) have led to the present UNEP sponsored meeting - for which we are most grateful.

The aim of the project goes beyond that of soil classification and mapping on the classical sense - although the development of adapted computer programmes will allow the "back translating" from the database into any soil classification system of one's own preference.

One has gradually become to realize that the many demands made upon application of soil science can never be completely served through one soil classification system, how detailed it may be. The efforts to combine scientific-process criteria with utilitarian ones in a detailed system for world-wide application turn out to be less than satisfactory.

It is the intention to encompass many more data, in a standardized quantitative form (on terrain features, on soil surface and topsoil factors, on substratum features etc.), and with the capacity to have it complemented with geographic information on climate, on vegetation, present land use, hydrology etc. This would allow much wider application of the data base, for instance the comprehensive assessment of the hazards of various forms of land degradation.

To further develop the methodology to be applied for the soil and terrain database itself; to examine the feasibility of quantitative assessment of land degradation; and to identify some priority/pilot areas, are the purposes of this week's meeting.

2.3 LEGEND CONCEPTS FOR A WORLD SOILS AND TERRAIN DIGITAL DATABASE

Jack A. Shields

The following discussion on legend concepts is outlined as follows:

1. Review of Generalized Soil Landscape Map (GSLM) Project in Canada
2. Summary of conceptual decisions documented at the Wageningen Workshop, 1986
3. Decisions required from the Soil Degradation Working Group which impact on Legend Development
4. Tasks that the Legend Development Working Group must address this week.

1. Current progress status of Canadian GSLM:

1.1 Procedures manual has been compiled
1.2 Maps at scale of 1:1 million have been completed for the agricultural region
1.3 Maps are digitized in the CanSIS system and will subsequently be transferred to ARC/INFO
1.4 Extended legends were completed and input to Personal Computer installed with Database III
1.5 First map (Province of Alberta) was published in full colour as displayed at this meeting.
The map is coloured by soil development and shaded by soil texture. Each map symbol provides information on the dominant soil for the differentiating attributes as follows:

+ soil development
+ parent material (P.M) mode of deposition
+ parent material-soil texture
+ local surface form
+ slope gradient class
+ unique polygon number which provides a linkage to a computerized extended legend containing additional information on both the dominant and subdominant soils:
  - surface texture
  - soil drainage
  - calcareousness of parent material
  - depth to water table
  - regional surface form
  - kind and depth of compact layer
  - slope length
  - available water capacity
  - coarse fragments
  - rooting depth
  - permafrost
  - ice content
  - patterned ground
  - pH
  - organic carbon
  - nitrogen
  - humus layer kind
  - vegetative ground cover.

The GSLM publication package consists of
- a colour map as displayed
- descriptive report including the extended legend.

Because the differentiating attributes of the GSLM are permanent, natural properties, the resultant map polygons provide realistic boundary conditions for various interpretative maps which are currently in production:

- wind erosion risk, as displayed
- water erosion risk
- extent of salinity

2. Conceptual legend development concepts documented in the Wageningen Proceedings were reviewed:

- major legend items emphasized patterns of landform, origin of soil parent material and soil attribute information
- soil classification is not a major legend entry
- attribute classes were required to satisfy the following interprative requirements:
    - crop suitability
    - land degradation
    - forest production
    - watershed management
    - agricultural trafficability

The terrain and soil attribute files compiled during the Wageningen workshop were briefly reviewed.

3. Basic decisions required from the Soil Degradation Working Group that impact on legend development

3.1 Are interpretations to be based on an "Expert System" qualitative assessment or derived from quantitative based models?
3.2 Priority interpretation list
3.3 Attributes required to satisfy above interpretations

4. Priority Working Group Tasks:

4.1 Adhere to initial concepts that major legend entries emphasize:
- Patterns of regional and local land forms and origin of parent material
  i.e. Create terrain attribute file to describe units
- Soil information required for priority interpretations:
  i.e. Create soil attribute file to describe soil continuum to 150 cm within a max. of 4 layers
- review coding necessity rating assigned to each layer (mandatory, desirable, optional)
- discuss acceptance of value data instead of class data.

4.2 Document Correlation Procedures

4.3 Document methodology for compilation of generalized maps from source maps and where no maps exist.

2.4 UNEP's GLOBAL ENVIRONMENT MONITORING SYSTEM (GEMS) AND GLOBAL RESOURCES INFORMATION DATABASE (GRID)

Harvey Croze

GRID, the Global Resource Information Database, is a new system designed to provide information to people making decisions that affect the health of our planet. As part of the United Nations, GRID will be indispensible to planners in their job of managing the Earth's precious resources wisely and rationally.
Traditional access to environmental data, in shelves of reports and proceedings, fast ageing maps and charts, no longer meets the demands of planners faced with a world where the nature of environmental change is infinitely complex. With the development of computers that can handle and analyse the immense quantities of data that a worldwide brief dictates, a global database is now possible.
GRID is designed to make the wealth of available environmental data useful to planners. Each decision that affects our resources must be made with an eye on the future, an eye on the future generations who will inherit the legacy of today's environmental planning.

GRID is the brainchild of a group of scientists working within GEMS, the Global Environment Monitoring System. GRID is part of GEMS and its brief is to provide an environmental data management service throughout the United Nations. GEMS is controlled by a Programme Activity Centre within the United Nations Environment Programme. The GEMS Programme Activity Centre's aim is to describe the changes at work in our surroundings and to gather the facts necessary to understand the mechanisms responsible.

GEMS staff functions as a catalytic team, ensuring that data are collected across the broad environmental spectrum. Their main concerns are plugging gaps in the environmental monitoring network, preventing work from being duplicated and amalgamating existing programmes into the global framework. Considerable effort is devoted to improving monitoring techniques, thereby ensuring data quality. Funds are raised, and monies allocated to programmes that are contributing to the international monitoring network.

GEMS works through the other United Nations agencies by enlisting their support in the five key areas defined by the 1972 United Nations Stockholm Conference on the Human Environment: climate, long-range transport of air pollutants, renewable resources, the oceans, and human health. Programmes are carried out by agencies such as the United Nations Educational, Scientific and Cultural Organization, the Food and Agriculture Organization and the World Health Organization. Inter-governmental groups such as the International Union for the Conservation of Nature also work to provide data. Agency expertise is a vital and integral part of GEMS.

Since its conception at the Stockholm Conference in 1972, and its birth in 1974, GEMS has established a key place in the world of international affairs as a co-ordinator of environmental monitoring. As a result, experts throughout the United Nations have become aware of the need for a global database to complement global data gathering.

The answer is GRID, a system for channelling key environmental data, from as many sources as possible, out to people who can use them. The users may be scientists trying to understand the functioning and behaviour of our global environment, or planners making important management decisions about the regions under their juridiction. GRID is an extension of the GEMS philosophy that prudent management of our environment is the only way to deal with an increasingly crowded planet.

GRID will enhance the relationship that already exists within the United Nations by effectively giving a wider audience access to vital databanks building up within the GEMS monitoring network. It will be a dispersed system, with facilities linked by telecommunications, eventually sending data to, and receiving data from, nodes throughout the world. This will help to build a useful picture of the state of the global environment and at the same time enable planners to manage environmental resources more effectively.

During the development phase, three main functions have been identified for GRID: bringing together existing environmental data sets; analysing existing information in order to pinpoint areas of environmental concern; and training people from both developing and developed countries in the use of GRID technology.

Providing the expertise

GRID will invest strongly in training. The technology of geographical information systems is well developed but has not, until now, been widely available through international and national outlets. As a result, there is a shortage of personnel qualified to operate the technology. In co-operation with GRID, national governments and major donors will provide studentships allowing young professionals to be trained in geographical information system technology. The trainees will work at a GRID facility on their own national data sets.

It would be ironic if the countries most likely to benefit from GRID were unable to obtain the help that the technology promises. For that reason, special attention has been paid to their needs. Most countries contribute to GEMS activities, and from this network some will be chosen to participate in the pilot phase of GRID. Participation will include personnel training and, as the programme advances, the provision of hardware and software.

Functions and tasks of GRID

Functions	Tasks
Assessment	Data supply Inventory management Status reporting Monitoring change
Analysis	Research support Forecasting Improved management Policy development Aid allocation Project evaluation

The Ultimate Goal

environmental data

↓

GRID

↙ ↘

national institutions — international agencies

↘ ↙

environmental managers

↓

A BETTER ENVIRONMENT

2.5 FAO's INTEREST IN A GLOBAL SOILS AND TERRAIN DIGITAL DATABASE

By Maurice F. Purnell

FAO has worked for many years on the development of global databases and on soil degradation assessment and control. Support to the proposed 1:1M soils & terrains database (SOTER) has been given from the beginning although it cannot be included as a priority activity for financing by FAO. Technical interest concentrates on the value of SOTER for improving prediction of future environmental response to changing conditions; in the short term as for crop forecasting; the medium term as for investment analysis; and in the long term as for prediction of potential population supporting capacity. Prediction of environmental degradation and its consequences is of increasing importance.

FAO activities related to SOTER includes the updating of the Soil Map of the World (which is a separate and non-competing activity). Assistance to development of the International Reference Base for Soils has been provided. The Agro-ecological zones used to link physical to socio-economic conditions for planning. FAO is installing a GIS (using Arc-Info and ERDAS), and can provide useful experience to SOTER.

With regard to soil degradation FAO has worked on studies of soil degradation and desertification with UNEP. Methods for field use have been developed and applied. Recently emphasis has been given to determinations of the cost of degradation in terms of lost productivity and increased costs.

The 1:1M soils/terrain map would have a general value for agro-technology transfer. FAO would buy it if it were commercially available. It would have specific uses for studies of potential population supporting capacities, crop production suitability, irrigation potential and others which are too complex to be tackled using manual methods.

It is essential that the map and legend should be related to the requirements of potential users. Therefore an interdisciplinary effort and integration of sectoral specialisms must be promoted by appropriate publicity. A huge effort will be required: FAO experience is that computerising and digitising usually takes a longer time than is anticipated. A problem to be avoided is the perfectionist approach which constantly introduces improvements and therefore never finalizes the output, the power of the computer to handle vast amounts of data encourages this tendency. Continued FAO interest is assured both in the development of SOTER and its use for global land degradation assessment and management planning.

2.6 CRITERIA AND FEASIBILITY FOR SELECTION OF PILOT AREAS

Roel F. van de Weg

When starting an ambitious undertaking as a World Soils and Terrain Digital Database, it is clear that the methodology proposed should be tested and worked out in certain priority areas. "pilot areas".
It is important that the areas selected represent a range of environmental conditions and soils/terrain diversity so that the legend, correlation guidelines, and initially defined minimum set can be thoroughly tested.

During the workshop held at ISRIC in January 1986 one of the tasks of working subgroup I was to come forward with a list of priority areas (page 102-106 of Proceedings and enclosed map).

The identification of the "candidate areas" (national and regional) was based on a number of criteria for the selection of these pilot/demonstration areas. On basis of these criteria tentative priority areas have been defined and indicated on a map of the world (ref table page 105 of Proceedings).

It should be stressed that by the selection strong emphasis was put on the fact that 1:1 million topographic maps of the world do exist: the ONC (Operational Navigation Charts) produced by the US Defence Mapping Agency (in total appr. 275 sheets). This was also supported by the fact that plans do exist for a World Digital Database for Environmental Resources (WDDES), under the aegis of the IGU (International Geographic Union) and ICA (International Carthographic Association). A 4th International Workshop on this topic was held recently (April 1987). Phase I of this plan is concerned with digitizing and structuring the existing ONC maps, to be followed by improving the ONCs.

In total 21 areas (sheets) were indicated during the Wageningen 1986 meeting as tentative priority areas, and a kind of rating was worked out indicating the level of priority. (The size of an average pilot area is 160,000 sq.km., 4x4 degree).

Criteria used in this rating were:
- Availability of 1:1 M maps, in particular maps on soil resources, eg. natural resources in general
- Interest of donor countries/agencies (A particular donor may be interested in a particular region. This may influence the (final) choice).
- political feasibility
- interest of users (in the region)
- multinational aspects: sheets covering different countries. In view of developing and testing the legend cq. validation of proposed legend construction etc.
- regional distribution (continent-wise)

The high priority areas are indicated by * asterisks. The high priority areas "with potential early funding" (mid.86 judgement) are indicated by ** in table 6.1.2 of Proceedings. Some examples of pilot areas are:
Area 1 Western Africa: Benin, Burkina Faso, Ghana, Niger, Nigeria, Togo.**
- regional situation
- many data (national soils maps) available
- multinational setting
- interest by ORSTOM

Area 3 Southern Africa: Malawi, Mozambique, Tanzania, Uganda, Zambia, Zimbabwe**
- regional situation
- interest shown by SADCC-RIARB
  SADCC: Food Security Programme, Harare, Zimbabwe
  RIARB: Regional Inventory of Agricultural Resource Base Project

Area 5 Iraq/Jordan/Saudi Arabia/Lebanon/Syria:
- ACSAD interest

Area 10 Indonesia, Malaysia, Singapore**
- regional (continental) setting
- extended area in view with link-up with GEBCO (oceanographic mapping, Bathymetry)
- availability of basis data

Area 14 Southern America: Argentina, Brazil, Uruguay.**
- availability of data
- interest by IICA
- Soil Resources Inventories available

Area 2 Uganda, Kenya, Ethiopia; at present also be considered as a high priority area in view of the following criteria:
- many data available, incl. soil map on 1:1M scale
- interest shown in Kenya
- on going desertification pilot study in Kenya: Desertification Assessment and Mapping National Pilot Study
- GRID (UNEP, Nairobi) facilities
- GRID, Kenyan Case Study.

Ref. Proceedings of an International Workshop on the Structure of a Digital International Soil Resources Map annex Data Base, Workshop held on 20-24 January, 1986, ISSS/ISRIC, Wageningen, the Netherlands.

3.0 FINAL REPORT OF EXPERT MEETING ON FEASIBILITY AND METHODOLOGY OF GLOBAL SOIL DEGRADATION ASSESSMENT

The final report of the expert meeting on the feasibility and methodology of global soil degradation assessment, held from 18-22 May 1987 at UNEP, Nairobi, was prepared and distributed by UNEP. It is included in these proceedings unabridged with the approval of UNEP.

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FINAL REPORT

OF

EXPERT MEETING ON FEASIBILITY AND METHODOLOGY

OF GLOBAL SOIL DEGRADATION ASSESSMENT

18 – 22 MAY 1987

UNEP, NAIROBI

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1.0 Introduction

1.1 Background: In January 1986 a group of approximately thirty scientists (soil science and related disciplines) from around the world assembled at the International Soil Reference and Information Centre (ISRIC) in Wageningen, the Netherlands under the sponsorship of the International Society of Soil Science (ISSS). The meeting was designed as a workshop to consider the feasibility and desirability of developing a global soils and terrain digital database at an average scale of 1:1,000,000. The proceedings of the one-week workshop were published by ISSS, and from the Workshop recommendations, a proposal was written for the development of a "World Soils and Terrain (SOTER) Digital Database at a Scale of 1:1M". Soil scientists who participated in this Workshop became a provisional Working Group of ISSS which was later formalized at the ISSS Congress.

The SOTER proposal was endorsed at the ISSS International Soils Congress in Hamburg, West Germany, in August 1986. Even before the Congress contacts were made with UN agencies and other international development organizations to explore their interest, their possible use of such a database, and their potential participation in such a project, either as a direct participant and/ or as a funding contributor.

One of the UN agencies represented in the January 1986 ISSS Workshop was UNEP. In succeeding conversations and correspondence with UNEP officials, ISSS/SOTER representatives have explored the concepts of a) collaborating with UNEP in developing the SOTER database as a component of Global Environment Monitoring System (GEMS) and b) using such a database for preparing soil degradation assessment maps.

In December 1986, Prof. Marion Baumgardner, Chairman, and Drs. Roel van de Weg, Secretary, of the ISSS Working Group on SOTER, met in UNEP Nairobi with Prof. Genady Golubev and several GEMS representatives to discuss the SOTER proposal and possible UNEP participation. As a result of those discussions, it was agreed that UNEP would sponsor ten to fifteen expert soil scientists for a meeting in Nairobi with UNEP representatives to consider more specifically the possibilities of collaboration. Invitations were distributed to fourteen soil scientists to participate in the Expert Meeting set for 18 to 22 May 1987.

1.2 Purpose of the Meeting: The purpose of the meeting was to consider a) UNEP's commitment to/and responsibility for mapping and monitoring global soil degradation, b) ISSS's commitment to/and responsibility for improvement of acquisition, analysis, interpretation and dissemination of accurate, timely and useful information about global soil resources, and c) collaboration between UNEP and ISSS in improving capabilities for soil degradation assessment.

1.3 Summary of conclusions and recommendations. In summary, the major conclusions of the meeting were that the objectives of UNEP and ISSS with regard to soil degradation are compatible and that both UNEP and ISSS can benefit in both the short and long terms by collaboration in an assessment of global soil degradation.

The major recommendations were that a) a global soil degradation status map with complementary data be prepared at a scale of 1:10M and be completed within three years, and b) status and risk assessment maps of soil degradation (wind erosion, water erosion, salinization, alkalization, and chemicals nutrient decline) and complementary attribute data be produced for five pilot areas in developing countries. Soils and terrain data for pilot areas will be entered into the SOTER/GEMS database.

The recommendations and Plan of Action are prepared for a period of 2.5 to 3 years in the context of a longer range objective as projected in Figure 1.

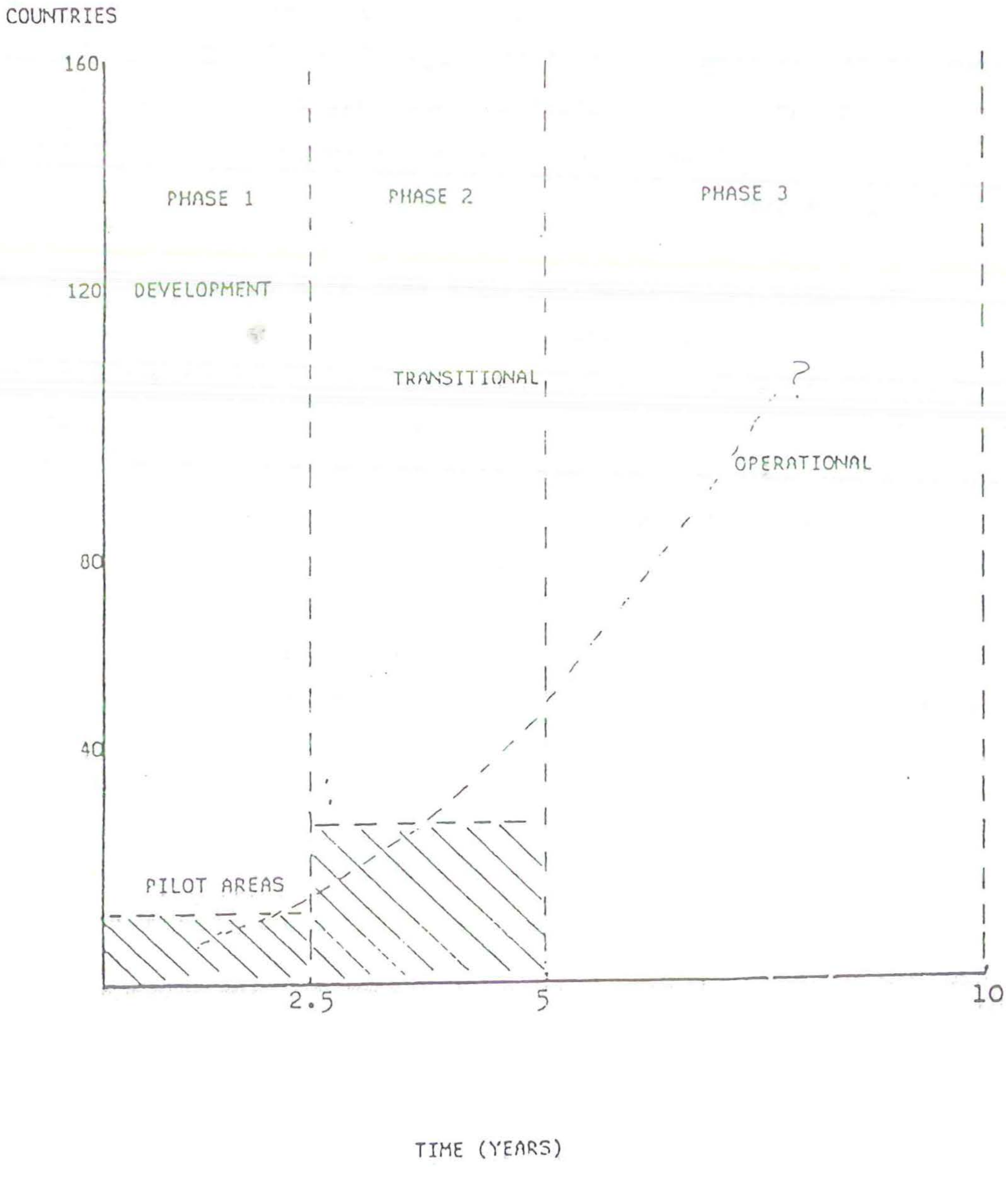

FIGURE 1. POSSIBLE SCENARIO FOR MOVE TOWARD OPERATIONAL GLOBAL SOILS AND TERRAIN DIGITAL DATABASE AS A COMPONENT OF GEMS

2.0 REPORT OF WORKING GROUPS

2.1 Legend (structure of an "universal" legend for a world soils and terrain digital database at a scale of 1:1M).

Participants:

A. Ayoub
P. Brabant
T. Cochrane
M. Ilaiwi
J. Sehgal
J. Shields (Chair)
W. Sombroek
R.F. van Weg (recorder)

The working group was charged with the task to develop guidelines for a World Soils and Terrain Digital Database at 1:1 million, to come forward with general legend concepts and definitions, to prepare an attribute file structure with attribute classes, and to come forward with an outline or first draft of a Procedures Manual. Preparatory work for this task was carried out by the "working group subcommittee on legend" which was established at the Wageningen meeting in 1986.

The group met for two consecutive days and the outline for a Procedures Manual, including a very tentative final draft was prepared (see appendix 6.1).

The general concepts and definitions of the soils and terrain database can be summarized as follows:

1. Major legend entries on the map emphasize patterns of regional and local landforms and parent rock/material.

2. Soil classification systems are not a required major legend entry.

3. Map deliniations ("polygons") that have the same components (as regards landform, parent material and soil) constitute a mapping unit. Each polygon will be assigned a unique number and a map symbol, or a first number referring to the mapping unit and a second, smaller number referring to the serial number in the mapping unit.

4. Major differentiating map unit attributes include:

- land/surface forms	Mandatory
- parent rock/material	"
- texture of parent material	"
- slope gradaient class	"
- general soil descriptive entry/ major soil forming process	Optional

These attributes are also shown in the map symbol and described on the map legend.

5. Each polygon may include a maximum, of three terrain components, in which a terrain component is defined as a segment of the overall landform of a polygon with comparable surface forms and/or soil patterns.

6. For each terrain component at least one soil is characterized; a maximum of three soils may be characterized for each polygon.

7. Each soil may have a maximum of 4 "layers" in a continum to a depth of 150cm.

8. Each "layer" attribute has a necessity requirement designation of mandatory, desirable or optional.

9. The minimum size area of a polygon should be about 1 x 1 cm.

10. Additional attribute information is documented in computerized files consisting of (1) Polygon file
(2) Terrain component file
(3) Soil attribute file.

11. Additional information required for interpretation, such as climate, vegeration, etc. will be assessed from other disciplines with compatible files.

During the working group sessions the extended legend polygon, terrain component and soil attribute files were established and classes indicated for each attribute. An outline for the Procedures Manual was drawn up and a first (incomplete) draft of the Procedures Manual was prepared as an example (see appendix).

The subject of the acceptance of value data instead of class data in the attribute files was discussed briefly but no conclusion was reached on this topic.

The first priority now is the development of the Procedures Manual, including guidelines for the map compilation and the correlation procedures. This task should be delegated to one or two persons and may take about 1m/month.

The legend settings and format design can then be tried and tested in a test area/sheet.

2.2 Soil Degradation Assessment.

Participants in the soil degradation assessment work group included the following:

George Varallyay, Chair
M.F. Baumgardner, recorder
Ivan Garbouchev

Maurice Purnell
M.G. Abdel Raziq

2.2.1 Definition of soil degradation. Consideration was given to the definition of the term "soil degradation". It was agreed that the definition in the FAO document on Soil Degradation Methodology would be used. In short, soil degradation is usually human-induced and results in the reduction in the quality of soils.

2.2.2 Processes of soil degradation. The working group considered the processes of human-induced soil degradation. The following processes were listed (alphabetical order), with no indication of importance or priority.

Acidification (acid rain, fertilizer-induced, leaching)
Alkalization
Biological degradation
Chemical degradation
Desertification (development of extreme moisture regime)
Nutrient decline
Physical degradation (compaction, puddling, crusting)
Pollution of heavy metals and toxicity
Reduction of buffering capacity
Salinization
Subsidence
Water Erosion
Waterlogging
Wind erosion

2.3.3 Priority processes of soil degradation. Five processes of soil degradation were selected as those which would be included in the development of a global soil degradation map at 1:10M, and pilot area maps and attribute data at 1:1M. The processes selected were:

Wind erosion
Water erosion
Salinization
Alkalization
Chemical/nutrient decline (emphasis on tropics)

2.2.4 Kinds of soil degradation maps. After much discussion on how to illustrate and document soil degradation, the work group recommended that soil degradation be assessed in terms of present condition or status, and risk or hazard.

2.2.5 Data requirements for assessment of soil degradation. For each of the processes of soil degradation the work group listed the kinds of data needed for degradation assessment for both status and risk. Each item listed was assigned a symbol indicating the necessity of having the data, e.g. M = mandatory; D = desirable; O = optional. For each of the processes, it is recommended that the methodology used should separate the severity of degradation into four levels: none, slight, moderate, severe. Data requirements to assess soil degradation are as follows:

Status of wind erosion	Other important data:
M description of surface patterns (takyr)	wind velocity
D surface cover (stones, litter)	wind direction
M microrelief particularly related to wind erosion (moving sand, wind ripples, wind scour)	
D moving dunes	

Status of water erosion:

M	description of surface patterns	rainfall erosivity
D	surface cover (litter, vegetated)	
M	microrelief (gullies, rills, deposition)	
D	macrorelief (slope length, gradient, aspect)	
O	erodibility index of topsoil	

Status of salinization/alkalization:

M	EC	rainfall distribution
M	ESP	potential evapotranspiration
D	pH	
D	depth of salt accumulation	soil moisture regime
D	depth of water table	
D	ground water salinity	

Status of chemical/nutrient decline:

M	pH	rainfall
M	topsoil nutrient status	temperature
		type of land use
		CEC of topsoil

Risk assessment of wind erosion

D	macrorelief	wind velocity
M	land cover and use	wind direction
M	texture	rainfall distribution
D	surface structure	

Risk assessment of water erosion

D	parent material	rainfall erosivity
M	land use and cover	rainfall distribution

M texture

D structure

O erodibility index

D microrelief

M macrorelief

D description of surface patterns/features

Risk assessment of salinization/alkalization: Other important data

D	EC	potential evapo-transpiration
D	ESP	soil moisture regime
D	pH	
D	CEC by horizon	elemental composition of primary minerals
M	texture by horizon	
M	depth of salt accumulation	
D	depth of fluctuation of water table (hydromorphic features)	
D	groundwater salinity	
D	substrata salinity	
M	drainage characteristics	

Risk assessmennt of chemical/nutrient decline

M	annual percolation (mm/year)	type of land use
D	pH profile	CEC of the topsoil
D	topsoil nutrient status.	

2.3 Pilot areas.

As a follow up to the pilot areas suggested in the SOTER proposal and the proceedings of the ISSS Workshop on World Soils and Terrain Digital Database at 1:1M scale (Wageningen, January 1986), further consideration was given to the criteria for and selection of pilot areas. The main emphasis was placed on the use of the soils and terrain data (map and attribute file) for assessment of soil degradation at a scale of 1:1M. It was determimed that representative pilot areas of approximately 250,000 square kilometers each would be designated as examples of the five major processes of human-induced soil degradation in developing countries. These five major processes are defined in section 2.2. Other criteria considered in the selection of these pilot areas include: a) multiple countries within a pilot area in order to develop and test correlations across international boundaries and among different soil classification systems, b) availability and completeness of soils and terrain data essential for development of a database (map and attribute data) at a scale of 1:1M, and c) interest of relevant scientists and agencies of countries within proposed pilot areas.

The pilot areas are listed below according to the predominant soil degradation process:

Wind erosion:

Priority	:	West Africa
Alternate	:	Sudan

Water erosion:

Priority	:	Northern Argentina, S. Brazil, Uruguay
Alternate	:	Northern Kenya, Southern Ethiopia
2nd Alternate	:	SADDC countries in Africa
3rd Alternate	:	Central India

Salinization:

Priority : Mesopotamian Plain (Iraq, Syria)

Alkalization:

Priority : Indo-Gangetic Plain (India)

Chemical/Nutrient decline:

Priority : North Sumatra, Malaysia

Alternate : Northern Bolivia, Southeast Peru, Western Brazilian Amazon

3.0 RECOMMENDATIONS

3.1 Considerations. The meeting considered UNEP's need to have within a few years (2-5) a global map of the status of soil degradation (wind erosion, water erosion; salinization/alkalinization; nutrient decline). Three alternatives emerged.

3.1.1 Use of the existing FAO/UNESCO soil map of the world at 1:5M as base material and apply the FAO/UNEP/UNESCO "Provisional Methodology for soil degradation assessment" (1979). This would require funds over $1M. Consensus emerged that the methodology could serve well, with only minor modifications. The database itself is, however, considered to be incomplete and out-of-date for many parts of the world (field data mainly pre-1965).

3.1.2 Prepare a global map on soil degradation at 1:1M or 1:5M based on the contributions, through subcontracts, of experts in all countries, using a unified legend. This would require funds in the order of $2M. The meeting agreed that it would be very difficult to get the data within a reasonable time and have them compiled and presented in a systematic and illustrative way. Moreover, it would lack a systematic soil and terrain database for future monitoring.

3.1.3 Produce a global map, at say 1:10M scale ("awareness map" on global soil degradation), to be accompanied by several "windows" at 1:1M scale where the soil degradation status and risk are faily well quantified on the basis of a systematic soil and terrain database as proposed in the SOTER project of ISSS. The meeting considered this altenative the most useful and realistic, emphasising that the 1:1M scale global map will of necessity be a first and quick approximation, for guidance only, based on local knowledge and estimates rather than a systematic scientific study.

3.2 Specific recommendations

3.2.1 It is recommended that the long term objective be the establishment and implementation of an operational global soils and terrain digital database (SOTER). This database will be a component of the Global Environment Monitoring System (GEMS) and will serve as a comprehensive and objective basis for soil resource and soil loss monitoring and assessment, and rational management. Funding for such a database should be broad based and sought from multiple sources.

3.2.2 It is recommended that a general map and complementary database of soil degradation (status of wind erosion, water erosion, salinization, alkalization, and chemical/nutrient decline be prepared at a working scale of 1:10M.

3.2.3 It is recommended that, linked to the general map, a soil degradation assessment (status and risk) map and complementary database at a scale of 1:1M be prepared for five pilot areas, each consisting of approximately 250,000 square kilometers.

Processes of degradation to be included are wind erosion, water erosion, salinization, alkalization, and chemical/nutrient decline.

3.2.4 It is recommended that data from the five pilot areas be entered into the soil and terrain digital database (SOTER) and that the system be tested for information extraction for soil degradation and other purposes.

3.2.5 It is recommended that regional training workshops be organized and implemented to bring together representative soil scientists of the countries in the pilot areas (and other appropriate soil scientists in the region) for briefing on the objectives of the project, discussion of the methodology to be followed, and development of an implementation plan for production of a digital soil and terrain database and soil degradation map at a scale of 1:1M. In preparation for these workshops, it is recommended that basic training metarials be developed to support the project.

3.2.6 It is recommended that a detailed provisional Procedures Manual be prepared for development and use of the global soil and terrain digital database, including soil degradation assessment.

3.2.7 It is recommended that UN agencies and ISSS stimulate and encourage national soil survey entities to include soil degradation interpretive maps as an integral part of their soil survey activities.

3.2.8 It is recommended that serious consideration be given to the designation of time(s) 0 (zero) to serve as a benchmark for all future monitoring of global environmental status, including soil degradation.

4.0 PLAN OF ACTION

The Plan of Action covers Phase 1, the developmental and testing phase (Figure.1). The Plan is designed to be completed within two or three years if sufficient financial resources are made available.

4.1 Generalized global soil degradation map

4.1.1 Objective. The objective is to produce as a component of Phase 1 (2-3 years) a global map and complementary data showing the status of soil degradation (wind erosion, water erosion, salinization, alkalization, chemical/nutrient decline) at a scale of 1:10M.

4.1.2 Guidelines. One of the first tasks which must be completed before undertaking this objective is preparation of a set of guidelines to serve as an operations manual for the many participants in the description and global mapping of soil degradation. This is essential to assure uniformity of reporting and compatibility in compiling and joining adjacent map sheets.

4.1.3 Execution of this component of the project.

Task 1. Coordination and administration. An institution will be designated and a specialist selected and named to administer and coordinate all activities related to the accomplishment of the objective defined in 4.1.1.

Task 2. Prepartion of regional maps. Institutions and/or qualified individual specialists will be designated and contracted to prepare regional or continental soil degradation status maps and complementary data sets at a working scale of 1:10M. Uniform procedures in the Guidelines (Section 4.1.2) will be followed by all contractees. The following groupings of countries are suggested as specific regions for which contracts will be let for the preparation of soil degradation status maps:

Africa, South of Sahara (East, West)
Australia, New Zealand, Pacific Islands
Central & South America, Caribbean, Mexico
Eastern Europe, USSR
Middle East and North Africa, including Afghanistan and Iran
North America, excluding Mexico
Northeast Asia (China, Japan, Koreas, Mongolia)
South Asia (Bangladesh, India, Pakistan, Sri Lanka)
Southeast Asia
Western Europe

Task 3. Correlation and compilation of a global soil degradation map. The administration institution (4.1.3 Task 1) will have the responsibility for performing the correlation and compilation function or of sub-contracting this function to a qualified institution. This task will provide a product ready for publication.

Task 4. Publication. A subcontraction will be let to a qualified map publisher to print a designated number of maps at scale of 1:10M (4-6 sheets) and a designated number of maps at a scale of 1:25M (1 sheet);

Task 5. Documentation and final report. In a final report the coordinator will provide appropriate documentation on methodologies used, particular problems encountered, recommendations for future global soil degradation assessment, and a cost accounting for various components of this operation.

4.2 SOILS AND TERRAIN (SOTER) DIGITAL DATABASE FOR FIVE PILOT AREAS

4.2.1 Objective. The objective is to produce within a period of two to three years a soil degradation map and complementary data for each of five pilot areas at a scale of 1:1M. In order to accomplish this objective, it will be necessary to use experts to interpret existing soil maps and to extract information essential for the preparation of maps of soil degradation (status and risk assessment) caused by wind erosion, water erosion, salinization, alkalization, chemical/nutrient decline. An important component of this objective is to enter all pertinent data (map and attribute) into the SOTER database.

This objective is an important first step in achieving the long term objective of developing and testing methodologies and installing software which will allow objective extraction of soil degradation information from the SOTER database.

4.2.2 Pilot areas. Five priority sites have been identified to serve as pilot areas for Phase 1 (Figure 1). Each pilot area covers approximately 250,000 square kilometers. A pilot area (PA) has been selected to represent each of the five processes of soil degradation named in the objective. They are as follows: .

PA1	Wind and water erosion:	West Africa (northern parts of Benin, Burkina Faso, Ghana, Nigeria, Togo; Niger)
PA2	Water erosion:	Nothern Argentina, Southern Brazil, Uruguay
PA3	Salinization:	Mesopotamian Plain (Iraq, Syria)
PA4	Alkalization:	Indo-Gangetic Plian (India)
PA5	Chemical/nutrient decline:	Sumatra, Malaysia

It is important that some of the test areas include multiple countries so that the uniform legend and correlation methods can be more clearly defined and tested across national boundaries and among different systems and levels of soil classification.

4.2.3 Regional workshops. Regional workshops will be organized and conducted as early as possible in each of the Pilot Areas. The purpose of the workshops is to assemble representative soil scientists from each participating country and surrounding countries of each pilot area for briefing on the project objectives, discussion of methodologies to be followed, and preparation of an implementation plan.

4.2.4 Execution of the project in each pilot area

Task 1. Administration. An existing institution will be selected and contracted to administer and provide technical coordination of the project. A qualified individual will be named to administer the project. The administering institution may subcontract with individuals and/or institutions to carry out specific tasks of the project.

Task 2. Procedures Manual. The administrative unit will have the responsibility for the development and publication of a detailed Procedures Manual (this may be subcontracted). It is essential that uniform methods and descriptors be used to minimize problems of correlation and entry of data into the SOTER database.

Task 3. Cooperators. As soon as possible, contacts will be made to establish cooperative working arrangements with soil scientists in each of the potential participating countries. The success of the project will be greatly dependent upon the interests of and contributions from participating countries.

Task 4. Workshops. The purpoe of the workshops has been stated in 4.2.3. These workshops should be organized and scheduled as early as possible in the project schedule. The following dates and places are suggested as candidates for workshops:

November 1987	Montevideo	(PA 2)*
January 1988	Niamey	(PA 1)
June 1988	Bogor	(PA 5)

September 1988	Damascus	(PA 3)
October 1988	Nagpur	(PA 4)
December 1988	Kampala	
–	Harare	

*Refers to Pilot Areas listed in 4.2.3.

Task 5. Assembly of data. Within each pilot area and each participating country, all pertinent soil surveys maps, reports and other relevant data, including satellite imagery, will be assembled for use in the generation of soil degradation (status and risk) maps and for input of data into the SOTER database at a scale of 1:1M. This task will be elaborated more fully in the Implementation Plan to be developed at each regional workshop.

Task 6. Generation of new data. Where possible the generation of new data will be avoided because of the expenditure of time and funds. However, where there are serious gaps in country data sets, satellite imagery will be used as a basis for expanding soils and terrain data sets into these areas. The methodology for accomplishing this task will be elaborated more fully in the Implementation Plan to be developed at each regional workshop.

Task 7. Correlation. One of the most challenging task will be that of correlating data across international boundaries and among different classification systems. Although this issue has been addressed already by the Legend Sub-committee of SOTER, a small Correlation Sub-committee will be assigned to develop, test and document the methodology to be used to accomplish the correlation task.

Task 8. Draft map for each pilot area. Each participating country will be responsible for the production of a draft map of soil degradation and assembly of data for the SOTER database at a scale of 1:1M. This task will be conducted according to the Procedures Manual and guidelines set forth in the Implementation Plan. Technical coordination will be available from the project administration.

Task 9. Final soil degradation maps of pilot areas. The final assembly and correlation of country maps into a draft soil degradation map and data set for each pilot area will be done within each pilot area with the collaboration of scientists from each participating country.

Task 10. Final map editing and publishing. The project administration will have the responsibility for coordinating and subcontracting this activity.

Task 11. Entry of data into SOTER database. Each of the pilot area maps will be digitized and entered into the SOTER database. All attribute data, defined by the SOTER legend, will also be entered into the attribute file of the SOTER database. It is possible that the digitization of the 1:1M soil degradation maps can be provided at no cost to the project. It is also understood that the GEMS facility will be available for use in the development of the SOTER database.

Task 12. Testing of the SOTER database. By the end of Phase 1 preliminary tests will be made on the SOTER database. Tests will be conducted to assess the use of the system in producing interpretive maps on items such as forms of soil degradation (status and hazard), potential productivity, land use capability, and others.

Task 13. Documentation and reporting. In a final report the project coordinator will provide a) documentation on methodologies used, b) particular problems encountered, c) recommendations for further development and operation of the SOTER database and the use of SOTER for producing soil degradation assessment maps, and other interpretive information and d) at a cost accounting for various components and task of the project.

5.0 BUDGET (preliminary draft)

The budget estimates presented herein are the best estimates resulting from the discussions, limited time, and limited reference materials available to the participants during the meeting. The emphasis in the preparation of the estimates has been on the costing of the tasks outlined in 4.1.3 and 4.2.4.

It has been assumed that the digitizing of maps can be provided at no cost to the project and that the soils and terrain (SOTER) database can be installed and tested in the GEMS facility. It is further assumed that there will be a "cost-sharing" by participating countries through their provision of data and basic services.

Budget estimate for Task under 4.1.3
(Global Soil Degradation Map at 1:10M)

Budget Item	Cost Estimates
Guidelines	5,000
Sub-continent contracts (10 contracts at $25,000)	250,000
Global correlation, compilation, preparation for publication	25,000
Publication	30,000
Total	$310,000

Budget estimate for Task under 4.2.4(Soil degradation map and attribute data at 1:1M for five pilot areas)

Budget Item	Cost estimate per pilot area
Workshop	25,000
Execution of project	250,000*
Total per pilot area	$275,000

Budget estimate for preparation of Procedures Manual for use in all Pilot Areas, and the future:

Procedures Manual	$25,000

*This may vary considerably depending on complexity of area, number of participating countries, completeness of available data.

Appendix I

6.0 LEGEND DESCRIPTORS

6.1 FILE 1. Summary SOTER POLYGON Attributes

VERSION 4 (revised 21.5.87)

01	Country Code
02	State/Province Code
03	Base Map Code
04	Report Number Ref Code
05	Polygon Number (unique)
06	General landform
07	General relief (difference between highest/lowest)
08	Elevation, Average
09	General surface lithology
10	Surface hydrology including drainage pattern
11	General vegeration/land use
12	Climate (refer to "separate file")

6.2 FILE 2. Summary SOTER/TERRAIN COMPONENT Attributes/(VERSION 4)

01	Country Code
02	State/Province Code
03	Base Map Code
04	Report Number Ref Code
05	Polygon Number (unique)
06	Proportion on Polygon to which following attributes apply, nearest 5%
07	Terrain Component Number
08	Surface Form
09	Parent material or Parent rock
10	Slope Gradient, %
11	Slope Length, m
12	Surface stoniness/Rockiness
13	Ground Water Depth,cm
14	Ground Water Quality, mhv
15	Effective unrestricted Rooting Depth (or zone), cm
16	Ground (or plant) cover
17	Surface Flooding/Submergence
18	Surface Crusting or Sealing Risk or surface cracking
19	Soil Drainage
20	Overwash with Water Erosion Products
21	Overblow with Wind Erosion Products
22	Surface Texture
23	Water Erosion, status
24	Wind Erosion, status
(25)	Permafrost Distribution
(26)	Ice Content of Materials
27	Soil Variability

6.3 FILE 3: Summary SOTER Soil Attributes (From Extended Legend) VERSION 4 (revised 21.5.87)

01	Country Code				
02	State of Province Code				
03	Base Map Code				
04	Report Number Code				
05	Polygon Number				
06	Degree of complexity				
07	Slope Position				
08	Internal Drainage				
09	Proportion of Polygon to which following attributes apply; nearest 5%				
10	Soil Number (coding)				
11	Layer or Soil Horizon Depth				
12	Abruptness of Horizon/Layer Boundary to Underlying Horizon	M	M	O	O
13	Soil Disturbance	M	M	O	O
14	Moist Munsell Color Hue, Nearest Chart	M	M	O	O
15	Moist Munsell Color Value, Nearest Unit	M	M	O	O
16	Moist Munsell Color Chroma, Nearest Unit	M	M	O	O
17	Dry Munsell Hue, Nearest Chart	M	M	O	O
18	Dry Munsell Value, Nearest Unit	M	O	O	O
19	Dry Munsell Chroma, Nearest Unit	M	O	O	O
20	Organic Carbon, %	M	D	O	O
21	Total Nitrogen	M	O	O	O
22	CEC, me/100g soil	M	M	M	O
(23)	CEC Clay, me/100g clay	M	M	M	O
24	ECEC (Effective) me/100 g soil; at pH-soil	O	O	O	O
25	Anion Exchange Capacity me/100g soil; at pH-soil	O	O	O	O
26	Exchangeable Ca	M	M	M	O
27	Exchangeable Mg	M	M	M	O
28	Exchangeable Na	M	M	M	O
29	Exchangeable k	M	M	M	O
30	Exchangeable Al	M	M	M	O

(31)	Ca/Mg ratio	D	D	D	D
(32)	Ca/K ratio	D	D	D	D
(33)	Mg/K ratio	D	D	D	D
(34)	Al Saturation %	M	M	M	M
35	Available P	M	M	O	O
36	Available S	D	D	D	D
37	Trace Element Deficiency	D	D	D	D
38	Toxicity/Potential Toxicity	D	D	D	D
(39)	Base Saturation, %	M	M	M	O
40	pH in Water, one decimal	M	M	M	M
41	pH in KCl, one decimal	M	M	M	M
42	Electrical Conductivity, ds/m (mmhos/cm)	M	M	M	M
(43)	ESP	M	M	M	M
44	Total $CaCO_3$ equivalent, %, primary, secondary incl. nodules	O	O	O	O
45-a	Gypsum $CaSO_4$ 2H2O	M	M	M	M
45-b	(Free Fe_2O_3	M	M	M	M
46	Clay Mineralogy	O	O	O	O
47	Texture, USDA	M	M	M	M
48	Coarse Fragments, Nearest %	M	M	O	O
49	Sand, Total, %	O	O	O	O
50	Fine Sand, Nearest %	O	O	O	O
51	Silt, Total %	O	O	O	O
52	Clay, Total %	O	O	O	O
53	Available Water Capacity, upper limit (i.e. Field Capacity)/definition KPA	M	M	M	M
54	Available Water Capacity, lower limit (i.e. Wilting Point), definition KPA	M	M	M	M
55	Bulk Density, kg/m^3 (g/cm^3)	M	M	M	M
(56)	Available Water Capacity, upper limit, volume %	M	M	M	M
(57)	Available Water Capacity, lower limit, volume %	M	M	M	M
58	Infiltration/Percolation	M	O	O	O
59	Saturated Hydraulic Conductivity, cm/h	O	O	O	O
60	Structure	M	M	M	M

61	Soil Aggregate Stability	D	D	D	O
62	Decomposition Degree of organic material	M	M	M	M
63	Biological activity	D	D	D	D
64	Contrasting Layer	M	M	M	M
65	Diagnostic Horizon/Features	M	M	M	O
66	Diagnostic Horizon Defined Source	M	M	M	M
67	Reference Pedon	M	M	M	M

(..) derived data; could be computer calculated from the primary data

4.0 ANNEXES

4.1 AGENDA
MEETING OF EXPERT GROUP ON THE
FEASIBILITY AND METHODOLOGY OF
GLOBAL SOIL DEGRADATION ASSESSMENT

Place of Meeting UNEP, Nairobi
Dates of Meeting 18 to 22 May 1987

Monday, 18 May 1987

9.30 General Session
 Marion F. Baumgardner presiding
 Welcome and Objectives of this Meeting
 Genady N. Golubev, UNEP
 Introduction of Participants
 Introduction to World Soils & Terrain Digital Database (SOTER)
 Marion F. Baumgardner, Purdue University USA

11.00 Report on Progress in the Preparation of an International Reference Base for Soil Classification
 Wim G. Sombroek, ISSS, Wageningen, the Netherlands
 Legend Concepts for a World Soils & Terrain Digital Database
 Jack A. Shields, Agriculture Canada, Ottawa

14.00 UNEP's Global Environment Monitoring System (GEMS) and Global Resources Information Database (GRID)
 Harvey Croze
 FAO's Interest in a Global Soil & Terrain Digital Database
 Maurice F. Purnell, FAO, Rome

16.00 Criteria and Feasibility for Selection of Pilot Areas
 Roel F. van de Weg, Stiboka, Wageningen

17.30 Reception

Tuesday, 19 May 1987

9.00 Working Group Sessions:
1. Legend (structure of a "universal" legend for a world soils and terrain digital database)
 Participants: J.A. Shields (chair), P. Brabant, T.T. Cochrane, J.L. Sehgal, W.G. Sombroek, R.F. van de Weg (recorder), A. Ayoub, M. Ilaiwi.
2. Degradation Assessment (Criteria and methodology for a digital database for soil degradation assessment)
 Participants: G. Varallyay (chair), M.F. Baumgardner (recorder), M.F. Purnell, I.P. Garbouchev, M.G.A. Raziq.

14.00 Working Groups continue

Wednesday, 20 May 1987

9.00 The two working groups (Legend and Degradation Assessment) continue with their deliberations.

ANNEX 1 (cont.)

14.00 General Session, W.G. Sombroek presiding
1) Legend: J.A. Shields, R.F. van de Weg
2) Degradation Assessment: G. Varallyay, M.F. Baumgardner
3) Suggestions to UNEP on feasibility and implementation of Global Soil Degradation Assessment

16.00 Discussion on pilot areas

Thursday, 21 May 1987

9.00 Work on preparation of report and a draft Plan of Action

14.00 Working Groups continue

Friday, 22 May 1987

9.00 General Session, W.G. Sombroek presiding
Presentation of report and adoption of Plan of Action

12.00 Closing Remarks
R.J. Olembo

13.00 Discussion on national soil policies (A. Ayoub, M.F. Purnell, W.G. Sombroek, I. Garbouchev)

4.2 LIST OF PARTICIPANTS

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