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ORGANIZATION

Institutional Development

The reporting period 1991-1992 can be characterized as transition period at ISRIC. It commenced with an in-house review by the staff and its National Advisory Council which aimed at an assessment of the relative strengths and weaknesses of the centre in the international field of soil science and soil information dissemination, to evaluate the performance of ISRIC's specific programme during the eighties, and to identify constraints in ISRIC's achievements in the light of its operational mandate. These considerations were reported in a 'Position Paper' which formed the background for an external review of ISRIC.

A consultative panel was invited by the Board of ISRIC to review ISRIC's aims and its programme of work. It had as members Dr. W.E.H. Blum (Secretary General of the International Society of Soil Science), Dr. R. Dudal (Professor in soil science at the Catholic University of Leuven, Belgium), Dr. J.W.M. la Rivière (Secretary General of the International Council of Scientific Unions), and Dr. C. Valverde (Senior Scientific Officer of the International Service for National Agricultural Research, ISNAR). The consultation took place late May 1991. The panel indicated that the collection of soil information is the foundation of ISRIC's work:

> *"Although it may be less glamorous in the eyes of donor agencies it should be stressed that it is a capital to be maintained and enhanced without which no returns can be expected. The global scope of the material which ISRIC collects and the opportunity which it has to undertake comparative research should underlie the basis for international correlation and understanding".*

In the light of the recommendations reported by the consultative panel, ISRIC then developed a strategy for the future role of the centre. The centre took also note of the increasing demands from policy makers, resource managers and the scientific community (soil science and non-soil science researchers) for a ready access to natural resource databases in order to make assessments of the productive capacity of the soils, to have a better understanding about environmental degradation, and to further improve estimates of parameters related to global change.

By early 1993, ISRIC staff had developed a Strategy Paper, identifying ISRIC's role in the collection and dissemination of baseline information on soils of the world towards the year 2000.

The period 1991-1992 was also a period of transition in management. On 11 September 1991 ISRIC staff, board members and the soil science community in the Netherlands congregated at ISRIC to say farewell to Dr. Wim Sombroek, who served for a period of more than 12 years as Director of ISRIC. His energetic leadership and international reputation has ensured ISRIC's status as "a reputable institute, being qualified and punctual in accomplishing its tasks"; a statement made on behalf of the United Nations Environment Programme. Six months later the Board of ISRIC appointed Dr. Roel Oldeman as the new director of ISRIC. Until that time he was head of ISRIC's section on Projects and Programmes.

ISRIC's increasing workload, growing number of staff and the need for storage space in particular for soil samples and documentation, called for an expansion of its premises. In September 1991 ISRIC's annex was officially inaugurated. After interior reconstruction and refurbishing of an old building of the Wageningen Agricultural University, adjacent to ISRIC's main building, ISRIC acquired an additional 300 m^2 of working space. The ground floor is used for storage and preparation of soil

monoliths, while the upper floor provides working space for ISRIC's project staff. The space in the main building formerly occupied by these activities has been used to expand ISRIC's library facilities.

The period 1991-1992 was characterized by further strengthening of international contacts. As a follow-up of the project: Global Assessment of Soil Degradation (GLASOD), concluded in 1990, ISRIC signed a new agreement with the United Nations Environment Programme. This project: "Reinforcement of the Regional Capabilities for Assessment and Database Development on Soil Degradation/ Desertification" was a clear indication of the importance UNEP attached to the development of a World Soils and Terrain Digital Database (SOTER). It specifically called for the development of a SOTER Training Manual and for training soil scientists in the use of SOTER, to finalize the SOTER manual and to further publicise the results of GLASOD.

A SOTER training course was successfully conducted in Uruguay (March 1992). In February 1992 UNEP organized an ad-hoc expert meeting to evaluate the GLASOD map and the SOTER methodology. Based on the outcome of this meeting ISRIC prepared, in close cooperation with FAO, the finalized edition of the SOTER manual (a joint UNEP-ISRIC-FAO-ISSS publication). ISRIC participated in several meetings of UNEP's DC/PAC (Desertification Control/Programme Activity Centre) for the preparation of the World Atlas on Desertification which was published at the occasion of UNCED and featured global thematic maps of soil degradation based on GLASOD.

In June 1991 ISRIC organized a Press Conference to publicise GLASOD. This resulted in major articles in leading Dutch newspapers, often accompanied by coloured reproduction of segments of the GLASOD map. Also various scientific journals in the Netherlands and abroad reviewed the GLASOD map. The World Resources Institute devoted a full section to the results of the GLASOD survey in their World Resources Report 1992-1993 and prepared a special press release on soil degradation. Results of GLASOD also featured in UNEP's issue of The World Environment 1972-1992.

As a result of negotiations between the Kenya Agricultural Research Institute/Kenya Soil Survey, UNEP, and ISRIC a project was formulated in 1992 for the Compilation of Soil and Terrain Database in the Republic of Kenya, to commence in January 1993 with a duration of 26 months.

The long-standing cooperation between FAO's Land and Water Development Division, the ISSS and ISRIC has been further strengthened. FAO assigned two experts for a short period to work at ISRIC on the development of a physiographic base map at a scale of 1:5 Million for South America and Africa as part of a programme to update the 1:5 M Soil Map of the World. ISRIC staff have also participated in the working group of the World Reference Base for soil classification (WRB), which is being coordinated by ISRIC at the request of the Chairman of Commission V of the ISSS. The ultimate objective is to develop the current legend of the FAO-Unesco Soil Map of the World into a World Reference Base for Soil Classification. The working group decided (Silsoe, October 1992) to prepare a monograph for distribution at the ISSS Congress in Acapulco, Mexico (July, 1994). FAO indicated also a strong interest and provided some funding for the development of a Soil Laboratory Information Management System (SOILIMS). Finally, FAO's membership of a working group for Soil Pedon Databases, in which ISRIC, ORSTOM, the Soil Conservation Service of the U.S.A. and the Soil Survey Research Centre of the U.K. also participate, clearly underlines a common interest in developing a World Soil Reference Pedon Database. This working group was initiated by the Database Information System of the International Geosphere Biosphere Programme (IGBP-DIS) in October 1992.

International contacts were also established with several developing countries through ISRIC's National Soil Reference Collection and Database programme (NASREC). Under a financial agreement with the Dutch Directorate General for International Cooperation (DGIS), NASREC activities commenced in 1990 for a three-year period in Nigeria, Zimbabwe, Costa Rica, Peru and India. In close cooperation

with local soil survey organizations, universities and agricultural research institutions, on-the-spot assistance (and training in India) was provided to establish national soil monolith collections, soil pedon databases and to prepare scientific and more popular explanatory brochures demonstrating the importance of soils in land evaluation, food production and environmental degradation. Under a separate agreement, contacts were established also for NASREC activities in Cuba and China. The latter activity forms part of a project under the STD-2 programme of DG-XII of the CEC, coordinated by ISRIC and with active participation of Kiel and Justus-Liebig Universities in in Germany, ORSTOM in France, and Academia Sinica in China.

The NASREC programme provides major inputs for ISRIC's Soil Information System (ISIS). ISIS is a database management system for storage and handling of pedon data of ISRIC's own soil collection. Since 1986 data from the field and from ISRIC's laboratory have been stored in ISIS. The programme for the development of a World Soils Reference Pedon Database mentioned previously will rely heavily on ISIS data. This activity will be given the necessary attention and manpower it deserves.

ISRIC's soil analytical laboratory is conducting soil physical and chemical analyses for programmes like NASREC (and thus for ISIS) in addition to analytical work requested by outside bodies (e.g. ITC's soils division). The laboratory research programme has focused its attention over the reporting period mainly on the development of a framework for Good Laboratory Practice and a user-friendly software programme for a Soil Laboratory Information Management System (GLP/SOILIMS). This activity is a follow-up of ISRIC's Laboratory Exchange Programme (LABEX) which had as its objective the standardisation of laboratory practice and an improvement in the quality of soil analyses in developing countries through an exchange of reference sample material. LABEX, which had run for over a decade, regrettably had to be terminated due to lack of funding. The GLP/SOILIMS programme has attracted the attention of the International Institute for Tropical Agriculture (IITA) in Ibadan, Nigeria. IITA has developed a project for the establishment of the Soils and Plant Analyses Laboratory Network in Africa (SPALNA) and has asked ISRIC to install SOILIMS at its laboratory.

Environmental degradation and global change are key issues on the agenda of many organizations and institutions worldwide. The World Resources Institute organizes a series of workshops on Global Planetary Monitoring in which ISRIC has been invited to participate. In an executive summary the statement was made that in order to manage our planet's environment rationally, a sound understanding of the Earth's environmental processes, an accurate measurement of the baseline conditions of the Earth's resources, and an efficient system for monitoring and reporting on changes in resource conditions or quality is urgently needed.

In March 1991 an international workshop was organised by ISRIC on 'Mapping of Soil and Terrain Vulnerability to Specified Chemical Compounds in Europe' (SOVEUR). This workshop, organised on behalf of the Foundation for Eco-development ("Mondiaal Alternatief"), the Dutch Ministry of Housing, Physical Planning and Environment (VROM) and the International Institute for Applied System Analysis (IIASA) in the framework of the Chemical Time Bombs project, revealed a large amount of scientific interest and enthusiasm from participants of West, Central, and Eastern Europe to cooperate in the production of soil vulnerability maps at Pan-European and national scale.

Based on the results of GLASOD and on recommendations of SOVEUR, the Group of Soil Conservation Specialists of the Council of Europe and the Task Force of the European Environment of the E.C. (DG XI) have asked ISRIC to prepare chapters for a Handbook of Soil Conservation of Europe and for an update of the European section of the GLASOD map.

The International Conference on Soils and the Greenhouse Effect, which was organised by ISRIC in 1989 as a contribution to the Global Change Programme of IGBP, was followed in 1991 by a three-year

project for the development of a World Inventory of Soil Emission Potentials (WISE). This activity deals with a geographic quantification of soil factors and soil processes, that control fluxes of greenhouse gases. The project is carried out by ISRIC within the framework of the Netherlands National Research Programme on Global Air Pollution and Climate Change (NOP-MLK). An international workshop was convened at ISRIC in August 1992 after a comprehensive study was made of the currently known chemical, physical and biological factors controlling the gaseous exchanges involved. A close cooperation with the International Rice Research Institute in the Philippines and Nagoya University in Japan, was established to study methane formation and emission under wetland rice.

Information collection and dissemination does not only concern soil and terrain attribute data. It also includes the wealth of information on soil profiles (pedons) in published bibliographic and cartographic form. A major concern is the poor accessibility of information. In the framework of a French initiative: Observatoire du Sahel et du Sahara (OSS), ISRIC has been requested to develop a computerized cartographic and bibliographic system on soils and related resources for the OSS region. This project, with the acronym STRING, commenced in September 1992 for a one-year period. The database structure developed for STRING is likely to be used to store data on ISRIC's own cartographic collection.

ISRIC also collaborated with the Centre for Soil and Agroclimatic Research (CSAR) in Bogor, Indonesia; the Institute for Soil Fertility Research (IB-DLO) in Haren, Netherlands; and the Publication and Documentation Centre (PUDOC) in Wageningen in the preparation of an annotated Bibliography of Soil Science in Indonesia, period 1890-1963 (SOBIN). This compilation of published and unpublished literature with full English abstracts of publications mainly in Dutch was prepared by Mr. S.M. Chin A Tam under a financial arrangement with DGIS. The bibliography has been published in 1993.

With the financial support of the E.C., ISRIC is engaged in the preparation of a Handbook on Laterites, which will be published in 1993.

This overview of activities which took place during the reporting period illustrates the wide diversity of programmes and projects, all of which are directly or indirectly linked to ISRIC's mandate. They are coordinated and/or executed by a group of about 12 scientific and 13 support staff members with a core funding of around US$ 900,000 provided by the Dutch Directorate General for Development Cooperation of the Ministry of Foreign Affairs, and supplemented by an additional $ 250,000 annually from external sources for specific project activities.

The increasing concern for environmental change and sustainable development of the scarce land resources has led to an increasing pressure for improved, useful and accessible soil and terrain information. ISRIC's future strategy and revised organisational structure, as discussed in the next chapter will focus on these issues, while its role as an international centre for soil information and documentation must not be neglected. The continuing external support from various donor agencies is vital in order to secure an uninterrupted continuation of present activities and future developments, for which the Centre has a mandate.

ISRIC's organizational structure

In reviewing the mandate of ISRIC and developments during the 25 year existence of the Centre, the consultative panel, invited by the Board of ISRIC to conduct an evaluation of ISRIC's activities (see section on Institutional Development) stated that:

"ISRIC is a research based service centre with three major tasks:

To collect and disseminate scientific knowledge of the soils of the world, in particular through the establishment of an international collection of soil monoliths, soil maps and reports, and a soil database at its central location in Wageningen; and to provide support for the establishment of national and regional soil reference collections and databases in developing countries.

To conduct research on soil analysis with emphasis on the adequate characterization of soils, soil correlation and soil classification at the international level, and the mapping and interpretation of soil characteristics in terms of their suitability for different types of land use.

To apply, and assist in the application of, the information collected and the results of research towards the promotion of sustainable development and environmental protection".

In view also of the increasing international concern about global change and the deterioration of the environment, a diverse group of international organisations have expressed an urgent need for readily accessible, accurate and up-to-date basic information of the Earth's natural resources, including soils.

In order to have a better integration of the wide diversity of activities, in which ISRIC is engaged, the organisational structure of the Centre, as outlined in previous annual reports, underwent some basic changes. Since early 1993 ISRIC's activities are regrouped around four major themes or programmes, which reflects ISRIC's strategy for the future.

Theme I — The Development of a World Soils Reference Database

The long term objective of this theme is to ensure that all FAO-Unesco soil units are adequately represented in ISRIC's Soil Information System (ISIS), and to improve the accessibility of its reference soil pedon database. In close co-operation with the IGBP-DIS working group on soil databases efforts will be stimulated for the creation of a global geo-referenced soil pedon database through the transfer of data between holders of databases elsewhere.

The global soil pedon database should be linked to the World Soils and Terrain Digital Database (SOTER) at a scale of 1:1 Million. The operational approach will be to develop a standardized, uniform database and map for whole continents with the input of readily available soil and terrain information. These initial SOTER-shells will be supplemented and completed with the co-operation of national soil agencies. Necessary technical assistance will be provided by the SOTER management for national participants ensuring the necessary homogeneity of the prepared SOTER mosaics.

Theme II — Transfer of Technology for the Assessment of Soil and Terrain Resources in Developing Countries

Through on-the-spot training, the programme aims to strengthen the capacity of national land resources/soil survey institutions in developing countries to deliver accurate, timely and useful information on national soil and terrain resources in an format accessible to a wide spectrum of users. This information is a prerequisite for the achievement of sustainable land use. ISRIC has a long standing experience in its National Soil Reference and Database programme (NASREC), and has developed in close co-operation with UNEP, FAO, and ISSS the internationally accepted methodology for SOTER. Training programmes have been developed for both programmes. ISRIC's soil laboratory research programme has developed guidelines for Good Laboratory Practices (GLP) and a user-friendly software package for a Soil Laboratory Information Management System (SOILIMS). The fourth

activity in this theme is the introduction of ISRIC's computerized bibliographic and cartographic information system on soil and terrain resources (STRING). A package of technology, based on these four programmes can be offered to national land resource/soil survey institutions in developing countries.

Theme III — Use of Soil Databases through Applied Research
The objective of this programme is to adapt established models to make them interactive with the soil databases. ISRIC will not itself engage in model development.

The research community, interested in developing models for predicting aspects of global change, requires information about soils of the entire world. ISRIC is engaged in a number of research programmes which contribute to a better understanding and description of the interactive physical, chemical and biological processes that regulate the Earth's system. This theme builds upon the programme of theme I (Development of a World Soils Reference database). It applies the information on soils and terrain resources through a variety of projects, such as the Global Assessment of Soil Degradation (GLASOD); the World Inventory of Soil Emission Potentials (WISE); the proposed mapping of Soil Vulnerability for Europe (SOVEUR); and the preparation of a Handbook for Soil Conservation in Europe.

Research will also be geared towards the needs of national resource managers. Emphasis is placed on activities to estimate biomass from each land unit, to evaluate levels of production at different levels of input, to assess the status and risk of soil degradation, and to evaluate the environmental impact. The application modules will make use of existing models and databases developed under the NASREC and SOTER programmes, but also of other land resources databases (e.g. on climate, land use, vegetative cover). The objectives of this theme are being pursued in close collaboration with international organizations such as UNEP, FAO, IGBP, ISSS, Unesco, WRI, as well as with organizations in the Netherlands, such as SC-DLO, ILRI, ITC, RIVM.

Laboratory research activities will be needed in efforts to homogenize data from various database holders, while also a systematic analysis of soils data in the ISIS database is needed to see whether they fit in the data needs of different models including pedo transfer functions. Micromorphological research should also be geared towards requests coming from field observations, in particular those related to physical soil degradation.

Theme IV — Dissemination of Soils Information
The information and the results of various collection, training and application programmes derived from activities of themes I, II, and III should be disseminated to a much wider audience than the soil science community *per se*. Emphasis, which was previously placed on agricultural aspects of soil science, is now being widened to include environmental and ecological aspects. Exchange of information with the CGIAR institutes and with the multidisciplinary global change programmes and with ICSU will be encouraged.

It is generally recognized that basic soil and terrain information has little appeal by itself except for soil scientists who need soil data for the development of different models including pedo-transfer functions currently being used in global and regional studies. Through an effective dissemination of information generated by process-oriented projects, which focus on the characterization of dynamic soil behaviour in a rapidly changing global context, ISRIC can make itself more visible to the important group of policy makers and resource managers who are more interested in information derived from application programmes (such as GLASOD, WISE, etc.). The wealth of factual and derived information on soils and terrain already collected by ISRIC in the past and to be assembled through activities outlined in themes I, II, and III will be disseminated by various means:

- Through the display of selected soil monoliths in the exhibition hall, accompanied by fact sheets from the ISIS database and by illustrations (photographs, graphs, and diagrams). This exposition provides a unique opportunity to examine the wide variety of soils of the world, developed in different ecological environments, particularly if studied in combination with ISRIC's collection of reference materials (e.g. the bibliographic, cartographic, slides and thin section collection).
- Through the preparation and subsequent publication of research results, proceedings of workshops, background papers for conferences and invited papers for scientific meetings. Although the value of papers is judged primarily by their scientific content, the lay-out, quality of figures and illustrations also are of importance. ISRIC encourages the use of new computer-driven technologies for this purpose.
- Through Newsletters issued by ISRIC (e.g. NASREC, SOTER) and Annual Reports. Emphasis will also be placed to contribute articles in Newsletters issued by other international organizations.
- Through participating in poster sessions at international scientific gatherings.
- Through the distribution of ISRIC's brochure with up-to-date lists of its project activities to facilitate a wider use of ISRIC's information on soils.

General Support Services

The organizational structure of ISRIC can only function properly if supporting services are adequately performed. These general services include the secretariat, the purchase and financial divisions, the maintenance of ISRIC premises, the maintenance of equipment including computer hardware and software, and the graphical design and photography department. While there is a steady increase in scientific staff, the general support staff has not been growing with equal pace. To reduce the workload pressure of ISRIC's secretariat, staff members are now preparing drafts of their own correspondence, technical reports, etc., before submitting them to the secretariat for final editing. With nearly thirty stand-alone IBM (compatible) computers the level of automation at ISRIC can be regarded as adequate. Discussions are taking place about the installation of a network and possible link with the Wageningen network. There is a growing need for a full-time professional computer systems manager.

As in previous years, ISRIC produces the section on New Publications for the Bulletin of the ISSS while it also houses the office of the Deputy Secretary General of the Society.

With the increasing number of staff, documentation, soil monoliths and soil samples, ISRIC's office and other facilities were becoming too small. We were fortunate that the Wageningen University allowed ISRIC to hire a part of an adjacent building. After major adaptations and refurbishment "the Annex" was officially opened by ISRIC's outgoing director on 10 September 1991. With office space for about 10 persons, room for impregnation of soil profiles, and sample storage space, this annex is a very welcome addition. Through a reshuffle in the main building, ISRIC's library could be doubled in space. Still, about 200 m^2 space for storage is occupied in other buildings belonging to the Wageningen University. If the present trend to carry out more projects is continued, office space will soon become insufficient, while storage of ISRIC's growing map collection, including space for consulting these maps is inadequate.

The role of ISRIC in the Collection and Dissemination of Baseline Information on Soils of the World

Different international organizations, concerned with environmental changes, have expressed the need for baseline information on natural resources. The intense and increasing pressures on soil and water resources, leading to degradation and pollution, combined with a part or complete loss of biological productivity, calls for action that,

- strengthens the awareness of the dangers of inappropriate environmental management (at local, national and global level);
- enhances the capability of national soil/land resource institutions to produce and deliver reliable, up-to-date information in an accessible format to a broad spectrum of users;
- encourages the timely monitoring of changes in soil resources to identify, halt, and remedy deterioration of the land before irreparable damage occurs.

A key element of the Dutch Government's strategies for Development Cooperation stated in their note (*Een wereld van verschil: Nieuwe kaders voor Ontwikkelingssamenwerking in de jaren negentig*) stresses that the basis of economic growth in the developing countries is being undermined by the deterioration of the ecological environment. The note emphasizes that *"in order to reverse the vicious circle of poverty and environmental degradation, national institutes have to strengthen their efforts to control and rehabilitate the environment"*.

ISNAR's agricultural research priorities for the 90s (ISNAR, 1992) states that in addition to the traditional emphasis on stimulating agricultural productivity, many of the national and international agricultural research institutes (CGIAR) are being called upon to broaden their research and give greater attention to environmental degradation and resource management. Agricultural research must place greater emphasis on developing new farm technologies and land utilization that act to sustain or enhance the natural resource base for agriculture. Better information is required on the causes and effects of environmental damage. *"There is a serious lack of information on the most basic issues, on the actual degree of soil erosion and the full extent of groundwater pollution. A comprehensive information system must be developed to document these and other problems, as well as their effects on human population"*.

FAO's Land and Water Division indicated that an increased efficiency in the use of soil and water resources is a pre-requisite for the achievement of sustainable agriculture and rural development. However, improved resource management is only possible if the environmental factors are known and a (global) natural resource base is available. Much of this data – including soils, climate, vegetation and topography – is more widely available than is generally realized. The data is usually fragmented, of different scales and of varying reliability and is held in different places. *"With computers becoming more readily available and easy to use, it is now possible for any country to establish its own Geographic Information System (GIS) for the assembly, storage and processing of natural resource data"* (FAO, 1990).

UNEP has stressed that there have been substantial advances in our understanding of environmental processes, and many governments have already legislated for protection of the environment. Also, a consensus has emerged that all forms of development must be sustainable. Nevertheless, there are still important gaps in our knowledge of how to assess adequately the costs of repairing environmental damage and costs of non-action. *"The world's environmental database is incomplete and of variable quality"* (UNEP, 1992).

Land degradation in arid, semi-arid and dry sub-humid areas (desertification), results from a number of factors, including climatic variation and human activities. This has received special attention during the UNCED Conference in 1992, during which an awareness of the lack of reliable information pertinent to land degradation became manifest. A workshop, organized by the Africa Environment Division of the World Bank (Oslo, 1992) concluded that in the past, attention was focused mainly on the boundaries of deserts and how they expand or contract. *"It is more important to gain a better understanding of the more widespread land degradation processes, which are undermining agricultural and rangelands over vast parts of Africa. The post-UNCED emphasis on increasing national capacity building for policy and programming of the environment and sustainable development activities will focus more on relevant information systems"* (Christoffersen, 1992).

This opinion was also expressed during a meeting on Desertification, Land Degradation and the Global Environment Facility – GEF – (Nairobi, October 1992), where one of its central recommendations was: *"The collection and dissemination of environmental data and environmental monitoring is a major priority for effective action, yet is beyond the capability of many countries"* (UNSO/UNDP, UNEP, 1992).

The Directorate-General for Science, Research and Development, Life Science and Technology Development of the European Community (STD-3 programme) assembled a group of soil scientists from EC-countries and Developing Countries (Rennes, 1992) to discuss "New Challenges for Soil Research in Developing Countries: A Holistic Approach". Their conclusion was, that *"an improved assessment of land resources for the development of a sustained utilization of the land could be established through a package of technology, that consists of two elements:*

- *The establishment of a detailed information system on natural and human resources in such a way that this information can be immediately and easily accessed;*
- *The establishment of scientifically valid methods, that can analyze this land, water, climate, vegetation, land use and socio-economic information from the point of view of potential land use; both in relation to food and other human requirements and for assessing the environmental impact".* (Stoops and Cheverry, 1992.)

The World Resources Institute (Washington) and the California Institute of Technology (Pasadena) convened a workshop on Global Planetary Monitoring: Pathways to Responsible Planetary Management (Washington, December 1992). The executive summary of this workshop stressed that in order to manage our planet's environment rationally we need a sound understanding of environmental processes, an accurate measure of the baseline conditions of the Earth's natural resources, and an efficient system for monitoring and reporting changes in resource conditions or quality. *"At present research into Earth processes is well-funded, but efforts to collect baseline data on the conditions of global resources, or to analyze, monitor or report on changes in those conditions are few and impoverished. The World Soils and Terrain Digital Database (SOTER) activity of ISSS, UNEP, FAO, and ISRIC, which plans to use properly structured ground assessments to create a geo-referenced database on baseline soil and terrain conditions over the next 10-15 years – if funding becomes available – would be invaluable to local and national planners and to those seeking to set priorities for global action and environmental assistance"* (WRI, Cal Tech, 1992).

This opinion was also voiced by the Director of the Land and Water Development Division of FAO: *"The many international initiatives on the modelling of the effects of an environmental change in combination with population growths in the developing countries are in dire need of sound ground-truthed and up-to-date spatial databases on agroclimatic conditions; on basic landform-soil relationships; water resources and agro-hydrology; on present-day land cover and land use; on status and hazard of land degradation"* (Sombroek, 1992).

ISRIC can contribute to meeting the need expressed by policy makers, decision makers and the scientific community for ready access to soil and terrain resources through databases in order to enable assessments of the productive capacity of the soils, to have a better understanding about the risks and rate of soil degradation, and to better quantify processes of global change. ISRIC will endeavour to provide this baseline information in cooperation with national and international organizations. A concerted joint effort is a pre-requisite to attain these objectives.

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ACTIVITIES

Theme I *The Development of a World Soils Reference Database*

ISRIC Soil Information System (ISIS)

Background

When ISRIC was established as International Soil Museum in 1966 its main objective was to assemble soil profiles, soil samples and associated information to illustrate the units of the FAO-Unesco Soil Map of the World. At present, the world soil collection consists of over 800 monoliths from 60 countries. This is accompanied by soil and environmental data. In addition, the collection is supported by a soil map collection, soil report library and a slide collection. To facilitate the storage and management of the soil and environmental data a computerized database management system, called ISRIC Soil Information System (ISIS), has been operational since 1986.

The following data are stored in ISIS:
site data: about 60 attributes on location, geology, landform, soil surface properties, hydrology, land-use and vegetation;
climatic data: average monthly data of meteorological elements of one or more meteo-stations relevant to the site;
soil data:
- 11 attributes for soil classification in FAO-Unesco Soil Map of the World Legend, USDA Soil Taxonomy and a local system,
- soil profile description according to FAO guidelines;
- 103 physical, chemical and mineralogical attributes;

other: additional relevant information.

At the end of 1992 information about 375 profiles were stored in ISIS (see table below). In view of the large amount of information on soils studied before 1986, of which information is presently only available in archives, an ISIS up-date project is formulated with the following objectives:
- to make an orderly arrangement of soil data and relevant environmental data of all soils sampled for ISRIC's world collection,
- to improve the accessibility of the site and environmental information, including linkages to other information sources at ISRIC (map collection, soil report library and slide collection),
- to stimulate the use of the information in and outside ISRIC,
- to contribute to the transfer of data between different soil databases both inside and outside ISRIC.

Activities in 1991-1992
- Field information of about 120 soil profiles was coded, completed and stored in ISIS database. Part of this work has been accomplished with assistance of Messrs. R. Stork and J. Seemann who came to ISRIC for work-experience.
- Analytical data of about 250 soil profiles in the ISIS database was verified.
- NASREC projects and fieldwork part in the countries resulted in a further 50 profiles (see section on NASREC).
- Work on the revision of ISIS version 3 programme was initiated at the end of 1992.

Plan-of-work

- To complete and improve site and analytical data in the database through consistency and quality checks. In addition a substantial number of soil samples will be analyzed. This task is scheduled for the period 1994-1996.
- Expansion of the database by transferring information from manual archives to the ISIS database. Verification, completion, coding and inputting are main activities, for which cooperation will be sought with authors and national soil institutions involved in the past fieldwork. It is estimated that this task will be completed by 1996.
- Expansion of the database by acquiring new reference profiles.
- Release of the ISIS version 4 in 1993.
- Development of a data transfer facility.
- Publication of ISIS datasheets in the form of Country Reports.
- To stimulate the use of the database by distribution of information to visitors of ISRIC's exposition, to other ISRIC projects and to potential user groups outside ISRIC; and by using application programmes in the fields of graphical presentation, land evaluation and land degradation.

Database status

The following table summarizes by country the status of data of reference profiles stored in ISIS.

TABLE - STATUS ISIS DATABASE (December 1992)

Country	ISIS	Archive
Australia	2	37
Belgium	4	
Botswana		7
Brazil	28	1
Cameroon	1	
Canada		21
China	16	
Colombia	18	1
Czechoslovakia		8
Denmark (Greenland)		6
Ecuador	20	
Finland		5
France		12
Gabon	3	3
Germany	15	2
Greece	3	12
Hungary	1	18
India	12	18
Indonesia	46	
Ireland	1	10
Italy	3	14
Ivory Coast	7	
Jamaica	3	1
Japan		4
Kenya	71	
Malaysia	18	
Malawi	1	
Mali	6	3
Mozambique	6	2
Namibia	2	9
Netherlands	8	16
New Zealand		5
Nigeria	16	14
Norway		3
Oman	2	2
Pakistan	6	
Poland	2	12
Romania		11
Rwanda	10	
South Africa	4	16
Spain	2	18
Sri Lanka	4	
Sweden	1	16
Switzerland		1
Syria		4
Thailand	13	
Turkey		13
United Kingdom		11
Uruguay		10
USA	3	22
USSR	1	61
West Samoa	4	1
Yugoslavia		3
Zaire		2
Zambia	6	5
TOTAL	375	440

World Soils and Terrain Digital Database (SOTER)

The soil is a natural resource, which is very difficult to renew and expensive either to reclaim or to improve following erosion, physical degradation or chemical pollution. If completely destroyed or degraded, soil is a non-renewable resource in the short term. The increasing pressure on land and water resources, leading to degradation and pollution, and a reduced productive capacity calls for a system which can store detailed information on natural resources of all kinds in such a way that these data can be accessed, combined and analyzed from the point of view of potential use, in relation to food requirements, environmental impact and conservation. Such a system is a prerequisite for policy formulation, development planning at all levels, efficient use of both internal and external resources, and for implementation of development programmes.

In a typical case such a system would consist of:

1. A computerised database containing all available information on topography, soils, climate, vegetation and land use. It should be complemented by compatible databases of socio-economic factors.
2. A geographical information system or GIS, which links each item of information to its precise geographical location, but which can display each type of information as a separate layer, or overlay.
3. A set of crop yield models which can calculate the level of production which could be obtained from each and any combination of soil and climate in the region or country, at a number of different input levels or management systems.
4. Various environmental impact models, which, for example, allow the calculation of rates of erosion for a given land unit, use, and production system.

Most developing countries are acutely aware of the need, and already many are attempting to establish computerised natural resource databases of one kind or another. Furthermore, all donors and aid agencies, particularly those such as the World Bank, which seek comprehensive solutions, will become aware that such systems are an essential tool for development, and in comparative terms, inexpensive.

A long term commitment from donor agencies is needed so that SOTER can rapidly provide the key soil and terrain attributes, which are needed to assess the potential productivity of the land, the status, risk and rate of soil degradation, to develop action to conserve or rehabilitate the land, and to improve our understanding of global change.

Basic to the SOTER approach is the mapping of areas of land (SOTER units) with a distinctive, often repetitive pattern of landform, surface form, slope, parent material and soils. The combined mapping of soil and terrain characteristics has evolved from the idea that the land in which terrain and soil occur incorporates similar processes and systems of interrelationships between physical, biological (and social) phenomena evolving through time. This idea was initially developed in the former USSR and Germany and later was accepted widely throughout the world.

Landform or physiography is the first separating criterion between areas. A subdivision can be made on the basis of lithology or parent material. This leads to units with a particular combination of landform and lithology: the "terrain" in the SOTER terminology.

These units are not homogeneous, as they possess a typical combination or pattern of terrain surface forms and soils. By means of the surface form or meso-relief, slope and texture of non-consolidated parent material it is possible to further subdivide the "terrain" into smaller homogeneous "terrain components".

Each "terrain component" will have one or more soils which are distinguished on the basis of differences in soil forming processes as reflected in major soil characteristics, such as the thickness of the major horizons/layers, texture, pH, CEC and organic carbon. It should be noted that soil classification alone does not characterize a soil, although a reference to the FAO revised legend is made in the database.

Traditional small-scale soil maps are restricted in the level of information which can be shown by the scale of the map. Such restrictions do not apply to a digital database. Nevertheless, not everything can be stored and thus selection is necessary of the terrain and soil data that should be put into the database. SOTER, being a general purpose database, has to include as many terrain and soil parameters as possible that could be of use for future interpretations. The scale, or preferably the resolution of 1:1M, sets limits to what can be delineated on the map. However, the number of attributes that can describe the geo-referenced area is manyfold. Within the database there are hardly any physical restrictions on the number and amount of attribute data.

Soil information is extracted from point observations of fully described and analyzed reference soil profiles. Following judicious selection, one of these reference profiles is designated as the representative profile for the soil component in the SOTER unit. Additionally, the range of each soil property is indicated when such information is available.

SOTER relies mainly on existing soil information. The data have to be extracted from various published and unofficial sources by local experts and coded according to a globally valid system. Attributes from representative soil profiles, characterizing SOTER units, will be entered in the database. It is assumed that soil information will be extracted from most recent soil surveys. Terrain data are derived from local sources and consist of interpretation of geomorphological maps, geological surveys, soil survey reports, etc. The 1:1M scale Operational Navigation Chart and its digital version DCW is used as a topographical base map. Where no appropriate soil survey data exist information may be extrapolated from remote sensing data.

The SOTER concept has been developed for application at small scales (basically 1:1M). However, the methodology can also be applied at other scales. This may require some adaptations. At larger scales subdivisions of an area according to the physiography, the main separating criterion at the terrain level of a SOTER unit, might result in very extensive units. A subdivision into smaller sub-units, not defined in the current methodology, might be necessary. This was the case in an application of the methodology at a scale of 1:100,000 in Sao Paulo State in Brazil. Also at the lower end of the database, the profile data, more detail could be necessary. While the SOTER database at a scale of 1:1M provides sufficient information for global change modelling and for an assessment of the main land qualities a SOTER database at larger scales (1:250,000 to 1:100,000) can be used for quantitative crop growth modelling and for quantitative assessment of degradation rates and risks.

For more details on SOTER activities reference is made to section on National Soils and Terrain Digital Databases.

Theme II *Transfer of Technology for the Assessement of Soil and Terrain Resources in Developing Countries*

National Soil Reference Collections and Databases (NASREC)

Background

The NASREC programme aims at the establishment of national soil reference collections including a soil exposition, soil database and accompanying publications. These should help to bridge the communication gap between the soil science community and user groups of soil/land information.

A soil exposition contains a selection of major soil types representative of ecological zones. Ideally a soil exposition should contain those soil types which are of interest for agriculture and environmental organisations. Presentation should be simple and clear. Although over-simplifying the distribution of soil types in a country, the aim should be to convince non-soil scientists of the value of soil information and to encourage their interest in the subject. The soil database includes the information of the profiles of the exposition as well as that of other profiles, representing all major soil types within a country and their variations.

In addition to information on soil/land properties, a soil reference collection should have ample information on the assessment of soil/land qualities and management aspects. Questions of what can be done with a specific soil, what kind of measures/improvements have to be taken for its sustainable use and how to cope with the fragility of the soil/land for specific land-uses should be answered in accompanying publications. For the latter ISRIC has developed a specific publication, the Soil Brief. For more details on exposition, database and publications reference is made to NASREC Newsletters 1 to 3, copies of which can be requested from ISRIC.

In the beginning of 1993, 15 institutions in 11 countries were cooperating with ISRIC in the establishment of a NASREC. Most participating institutions are finalizing their NASREC projects by the end of 1993. The list of addresses of participating institutions and trainees of ISRIC's international course on the establishment of national soil reference collections and databases is annexed to NASREC Newsletter 3. The NASREC programme is supported by the Directorate General of International Cooperation of the Netherlands within UNEP's Action Plan of National Soil Policies, and from ISRIC's own budget.

NASREC project activities

In the following section, a table summarizing the progress in the participating countries is given, followed by summarized information on the participating institutions and progress made.

Summary state-of-affairs of NASREC's at the national institutions (beginning of 1993)

MAJOR PHASES / COUNTRY	PROJECT PLAN	FIELD	LAB Nat.	LAB ISRIC	MONOLITH	DATABASE	SOILBRIEF	EXPOSITION
NIGERIA	+	+	+	+	+	o	o	(+)
ZIMBABWE	+	(+)	+	o	(+)	(+)	o	(+)
COSTA RICA	+	+	(+)	(+)	(+)?	o	o	o
NICARAGUA	+	+	?	+	o?	o?	o	o?
PERU	+	+	+?	+	+	(+)		o
CUBA	+	+	(+)	+	+	(+)	o	(+)
VENEZUELA	+	+	+	1)	+	o		(+)
INDIA	+	o	o	1)		o		
PAKISTAN	+	o?						
CHINA	+	+2)	o	o		o		
KENYA	+	+3)	4)	4)	(+)	o		

+ finished
(+) nearly finished
o in progress
1) samples not yet received at ISRIC
2) fieldwork in SE China finalized, NE and SW China in mid-1993
3) a large collection of monoliths assembled during the past 2 decades
4) data to be completed

Project Plan Workplan for a NASREC
Field Fieldwork, collection of soil profiles
Lab Analyses of soil samples
Monolith Preparation of soil profiles
Database Establishment of the profile database
Soil Brief Accompanying publications
Exposition Installation of the soil monolith exposition

NIGERIA
Institution: University of Ibadan [UI] - Depts. of Agronomy and Geography, Ibadan
Coordinator: Dr. Ayo Ogunkunle and Prof. Ayodele Fagbami - Dept. of Agronomy
Prof. Olusegun Areola and Dr. Adeniyi Gbadegesin - Dept. of Geography

Soil profiles from 15 sites were studied and sampled. The collection at UI includes reference profiles from major ecological regions in Southern Nigeria: the humid tropical rain forest, humid woodland, sub-humid open woodland and the delta of the Niger. 124 soil samples were analyzed at UI and ISRIC. A large hall in the Dept. of Agronomy has been allocated for the exposition. Six draft Soil Briefs of ten sites were sent to ISRIC for comments.

ZIMBABWE
Institution: Chemistry and Soil Research Institute [CSRI], Harare.
Coordinator: Mr. Julian Spurway

About 15 soil profiles representative for the high, middle and low altitude major ecological regions were studied and sampled. Additional fieldwork is planned by CSRI and the University of Zimbabwe in 1993 and will include a series of representative soils of broad, wet valley bottoms, known as Dambos. Soil samples are analyzed at CSRI and ISRIC will analyze duplicate samples. A small exposition has been installed at CSRI, a larger one is in preparation. 13 draft Soil Briefs were sent to ISRIC for comments.

COSTA RICA / NICARAGUA
Institution: Centro Agronómico Tropical de Investigación y Enseñanza [CATIE], Turrialba
Coordinator: Dr. Donald Kass

At the end of 1992, 20 soil profiles have been studied and sampled. Soils collected so far are representative of the following major ecological zones in Central America: humid tropical rainforest (deeply weathered soils, Acrisols/Ultisols), temperate humid central highland (soils derived from volcanic deposits), and the tropical dry forest of the Pacific region (relative shallow soils Cambisols/ Inceptisols and vertisol(like) soils).
120 soil samples were analyzed at the soils laboratory of CATIE, duplicate samples will be sent to ISRIC. A number of Soil Briefs of selected profiles are in preparation.

(Alfisol and Vertisol) which occur in an intricate pattern in the Nicaragua Depression near Managua. Also two soils with a duripan layer from the Pacific Coastal Plain were studied and sampled. It is envisaged that the incipient collection will form the basis for a larger collection with soils from other ecological regions of Nicaragua.

CUBA

Institution: Instituto Nacional de Investigación de Caña de la Azucar [INICA], Havana
Coordinator: Dr. Rafael Villegas Delgado and Mrs. Regla Chang

The NASREC team of INICA has realized the collection of reference profiles from all over the 1000 km long island. The soil reference collection includes a wide range of contrasting soils. 22 soil profiles were studied, sampled and monoliths were prepared. 109 soil samples were analyzed INICA and duplicate samples analyzed at ISRIC. The exposition is in preparation and will be housed at INICA's Experimental Station in Vila Clara. A selection of soil reference sites and the exposition of the complete collection of soils in Vila Clara are included in two soil excursions of the 15th World Soil Congress of ISSS in July 1994. Soil Briefs will be prepared. In addition to ISRIC's missions, additional training to INICA's staff was given by Mr. Nestor Noguera, trainee of ISRIC and coordinator of the soil collection in Maracaibo, Venezuela.

PERU

There are three collections in preparation in Peru: one national collection in Lima and two regional ones in the South (Arequipa) and in the Amazon region (Iquitos).

Institution: Instituto Nacional de Recursos Naturales [INRENA] (formerly Oficina Nacional de Evaluación de Recursos Naturales, ONERN), Lima
Coordinator: Mr. Felix Urcuhuaranga

Institution: Universidad Nacional de la Amazonia Peruviana [UNAP], Iquitos
Coordinator: Dr. Pedro Gobert Paredes Arce

Institutions: Universidad Nacional San Agustin [UNSA], Arequipa and Instituto Nacional de Investigación Agraria y Agroindustrial [INIAA]
Coordinator: Prof. Valdemar Hoyos (UNSA), successor of Mr. Egberto Soto.

The main part of the fieldwork has been executed by teams composed of staff from the mentioned institutions in 1991. In spite of the economic difficulties Peru is confronting nowadays, the participating NASREC institutions were able to realize a soil study and sampling programme in the three strongly contrasting major ecological zones of Peru. In summary: in the Coastal region terrace, valley and "Pampa" soils, having a great variation in texture, salt content etc. (Arenosols, Solonchaks), high altitude soils in the Andes Puna region and soils of the Amazon region include Acrisols, Podzols, Arenosols and Fluvisols. 22 soil profiles have been studied and sampled so far and monoliths are being prepared and ready for display. 133 samples were analyzed at ISRIC. A small exposition is ready in Iquitos, a larger one is in preparation. The exposition at INRENA and at UNSA are in preparation.

VENEZUELA

Institution: Universidad del Zulia, Dept. de Agronomía, Maracaibo
Coordinator: Mr. Nestor Noguera and Prof. Willem Peters

The first representative soils of the lake Maracaibo region are on display in the Soils Department of the Universidad del Zulia. Soils are being analyzed at the Soils Department. Progress on the database was reported, a translation in Spanish of the information sheets is anticipated.
ISRIC received from the Instituto de Edafología, Facultad de Agronomía U.C.V. in Maracay an information folder on the "Centro de Información y Referencia de Suelos". The centre has an exposition of soils of the Maracay region. Initiator of the centre is Dr. Anibal Rosales, trainee of ISRIC. The present director of the Soil Information Centre is Prof. Stalin Torres Pernalete.

INDIA

The Agricultural Universities in the States of Karnataka, Kerala and Tamil Nadu are simultaneously working on three University Soil Reference collections (USREC).

Institution: Kerala Agricultural University [KAU], Trivandrum
Coordinator: Prof. Thomas Varghese

Institution: University of Agricultural Sciences [UAS], Karnataka
Coordinators: Prof. S.K. Kenchanna Goudd and Dr. B. Badrinath

Institution: Tamil Nadu Agricultural University [TNAU], Coimbatore
Coordinator: Prof. P. Kandaswamy

Each collection will house about 15 to 20 representative soil profiles from each State concerned. Fieldwork is scheduled in 1993. The three USRECs will be finalized in 1994.
The first NASREC training course outside the Netherlands took place at KAU from 18 Nov - 11 Dec 1992, in which 10 staff members of the three Universities participated. In the first two weeks of the course, the focus was on equipment, fieldwork, monolith preparation and input of data in the database. The third week concentrated on an introduction to applications of the database; lectures followed by plenary discussions on the major phases of the USREC project and up-dating of the workplan and budgets. A second training course in organization of exposition, database applications is scheduled for the end of 1993. Expansion of NASREC/USREC projects to other agricultural universities will be investigated with assistance of the National Bureau of Soil Survey and Land Use Planning (NBSS-LUP) in Nagpur.
In addition to the USREC project of the Kerala Agricultural University, the State Soil Organization of Kerala is presently also involved in the establishment of a soil exposition at its premises. Two staff members participated in the first NASREC/USREC training course.

PAKISTAN

Institution: Soil Survey of Pakistan [SSP], Lahore
Coordinator: Mr. M.A. Tahir

No activities reported in 1992, because the Soil Survey of Pakistan has not yet received a formal approval of the Ministry of Agriculture for the NASREC project. It is anticipated that a joint Pakistan-Netherlands Project (PC1), which includes a NASREC component, can be realized when approval is received.

CHINA

Institution: Institute of Soil Science - Academia Sinica [ISS-AS], Nanjing
Coordinator: Prof. Gong Zitong, Prof. Zhao Qiguo

Within the framework of the EC-STD2-China Soils* project a NASREC project was started in 1992. See further paragraph on EC-STD 2 China Soils Project.

Activities at ISRIC

ISRIC supported the participating NASREC institutions with technical assistance missions, financial support and support at-a-distance in the fields of soil analyses, photography, database development, dataprocessing and publications. A summary is presented here, details are given in NASREC Newsletters 2 and 3.

One or two technical assistance missions were realized to each of the participating NASREC institutions in 1991/92. Activities included on-the-spot training during fieldwork, short database courses and advice on organisational aspects.

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* "Erosion assessment, classification and soil reference collection of soils in (sub)tropical China project" supported by the Life Sciences and Technologies for Developing Countries (STD2) programme of the European Community.

In addition to analyses completed in national soil laboratories, about 350 samples were analyzed by ISRIC in 1991/92 while about the same number will be analyzed in 1993.

Support at-a-distance included duplication of slides, enlargements of photographs, lay-out and printing of information posters, etc. ISRIC contributed to the development of pedon databases, with the screening of datasheets and the completion with analytical results. In addition, it assisted the NASREC institutions with dataprocessing activities by developing a graphical programme for soil and climate data, called Soil Data Graph. The programme has been made with LOTUS and dBASE and the first version was distributed to the NASREC participants for comments. Furthermore technical assistance is offered through the crop simulation model WOFOST (World Food Studies). A user-friendly shell has been developed for this model including the up-dating of key soil and climate data files. First draft Soil Briefs were sent to ISRIC at the end of 1992. ISRIC will offer assistance by reviewing and assistance with the printing of colour pages. At present work on Soil Briefs is progressing for China, Costa Rica, Nicaragua, Nigeria, and Zimbabwe.

Follow-up

Most national institutions involved in the NASREC programme have suggested follow-up activities after the finalization of the present NASREC phase 2. These suggestions include the organization of a final workshop, expansion of the database and strengthening of other institutional activities. The possibility of holding a workshop in 1994 for all national NASREC coordinators of the 15 participating national institutions will be investigated.

The expansion of the database with well documented soil profiles available in soil survey reports etc. will increase the role of the NASREC institutions as information centre for reference soils.

Participants have indicated to ISRIC their interest in strengthening other activities related to GIS technology (small scale), laboratory information management and bibliographical information on land/soil resources reports and maps.

Since the start of NASREC phase 2, ISRIC has received requests for training and support in setting up reference collections and databases from 30 institutions and individuals in 20 countries. In the period 1980 to 1989 nine international training courses on soil reference collections were realized at ISRIC, in which about 40 staff members from national institutions in 30 countries participated. With the establishment of a substantial number of National Soil Reference Collections it is ISRIC's policy to transfer this training course to a selection of national or regional centres. In November 1992 the first training course took place in India, as previously reported. Besides a continuation of the training course in India at the end of 1993, plans exist for Regional training courses in East Africa (KSS in Kenya) and at one or two centres in Latin America to satisfy these requests.

National Soils and Terrain Digital Databases (SOTER)

Summary of SOTER activities until 1991

Early in 1986 the ISSS organized an international workshop at ISRIC, Wageningen to discuss the aims and scope of a possible international programme to establish a digital soil resources map of the world, accompanied by a soil and terrain database at a scale of 1:1 million. In August 1986, the ISSS International Congress of Soil Science endorsed a project proposal for a World Soils and Terrain Digital Database (SOTER). In late 1987 UNEP formulated a project document for the development and testing of a methodology for small-scale map and database compilation in a pilot area of approximately 250.000 km^2, covering portions of Argentina, Brazil, and Uruguay. In 1988, a first version of a Procedures Manual for SOTER was prepared by the Land Resources Research Centre, Canada and a regional workshop was organized in Montevideo, Uruguay to develop an implementation plan for the preparation of a Soil and Terrain Database for the pilot area in Latin America (LASOTER). A second workshop was organized in Porto Alegre (Brazil) to evaluate progress. In 1989, a second version of the SOTER procedures manual was prepared. A workshop was organized in Ottawa to implement a second pilot study in North America covering portions of Canada and U.S.A. (NASOTER). A similar activity was initiated in central Brazil. In 1990, an international workshop was organized at ISRIC to discuss the third revision of the Procedures Manual, based on problems encountered during the data entry phase of the project. In August 1990, the ISSS working group on World Soils and Terrain Digital Databases under Commission V organized a special symposium on SOTER during the International Congress of Soil Science in Kyoto, Japan. The results of LASOTER, NASOTER, and BRASOTER were presented. Further testing of the SOTER database continued and several thematic maps were prepared using the ILWIS GIS system.

SOTER activities 1991-1992

By mid 1991, UNEP formulated a project document under the title: Reinforcement of the Regional Capabilities for Database Development and Assessment on Soil Degradation. ISRIC was asked to execute this project, which was to be considered as the second phase of SOTER. The main activities outlined in the document were:

a) The development of training materials and the organisation of a training workshop in the use of GIS technology for participants involved in LASOTER.
b) The further refinement and publication of a SOTER manual.
c) The development of methodologies to assess soil degradation rates and risks with information derived from SOTER.
d) The promotion of the SOTER concept worldwide.

This project commenced in May 1991 and will be concluded in April 1993.

— *Training workshop*

A three week training course, to familiarize the national staff of soil research organizations in Argentina, Brazil, and Uruguay involved in the LASOTER project, was held in March/April 1992 at the premises of the Dirección de Suelos y Aguas in Montevideo. A total of 12 scientists (3 from Argentina, 3 from Brazil, and 6 from Uruguay) were trained in managing and analyzing the soils and terrain data they had collected by means of a Geographic Information System. A training manual developed specially for this course was used. Apart from the GIS training the new SOTER procedures manual – the fourth version – was introduced and applied during a two-day field trip. The three institutes received ILWIS-GIS software and specific peripherals (i.c. digitizing and plotting equipment). As a result of the training, the institutes felt confident to expand the coverage of their GIS activities to other parts of the country. National activities were formulated for an expansion of the SOTER area in 2 of the 3 countries. The training course was conducted by Mr. V.W.P. van Engelen of ISRIC and Prof. W.L. Peters of Maracaibo University, Venezuela.

— *Revision of SOTER Manual*
In May 1991 the fourth version of the Procedures Manual for a World Soils and Terrain Digital Database was issued. It was the result of elaborate testing of the methodology in two pilot areas (LASOTER and NASOTER), comments raised during the Wageningen 1990 workshop, and numerous contributions from collaborators in the global soil science community.

In February 1992 UNEP organised an ad-hoc expert group meeting to discuss Global Soil Databases and to appraise the GLASOD/SOTER. The SOTER manual was carefully reviewed and modifications to the manual were listed. FAO expressed its full support for the SOTER programme and indicated its willingness to use it for storing and updating its own data on world soils and terrain resources. As a result of this workshop, FAO took an active part in this revision of the SOTER manual. A draft 5th version was distributed by the end of 1992 to the group of SOTER collaborators present in the Nairobi workshop and final publication is expected early 1993 as a joint publication of ISRIC, ISSS, UNEP and FAO.

— *Application of software*
Although support for SOTER had steadily increased from soil scientists and from the natural resources community in every corner of the world, this was not reflected in financial assistance received from donors except UNEP. Organizations which fund research are not interested in a soils and terrain database *per se*, but more in its potential use. The usefulness of SOTER must be proven by applications: using the database for the assessment of soil degradation/erosion, land evaluation, contributions to Global Change scenarios, etc.

An application programme for Water Erosion Assessment (SWEAP) was developed for use with the SOTER database. The user can choose between two erosion models: modifications of the Universal Soil Loss Equation (USLE) and the Soil Loss Estimation Model for Southern Africa (SLEMSA), run under varying management practices. It has been tested with NASOTER data. To facilitate data management activities the groundwork for a user interface running under Windows software was developed. A prototype with limited possibilities was constructed and is currently being tested.

— *Promotion of SOTER*
The SOTER concept was promoted at various international conferences and symposia. At a workshop on Increased Sustained Agricultural Productivity in Africa through the Use of Intelligent Geographic Information Systems, organised by CGIAR, UNEP, the Rockefeller Foundation, and ILRAD (Nairobi, January 1991), the SOTER approach was well-received; however, the long period to complete the database was considered disappointing. At an expert meeting on the assessment of desertification (organised by UNEP and hosted by FAO), the SOTER approach was considered a good instrument for such assessments at larger scale (Rome, April 1991).

The SOTER approach was discussed at an IGBP workshop on Requirements for Global-Scale Terrestrial Biospheric Data for IGBP core projects (Toulouse, June 1991). At that meeting UNEP expressed strong support for SOTER in support of IGBP studies. Another IGBP-DIS meeting took place in March 1992 (Montpellier, France), where the participants suggested to adopt the SOTER approach. Particularly the concept of a SOTER framework at a less detailed scale would seem to relate to the broad aims of IGBP-DIS. Discussions on a Global Soils Database continued in another IGBP-DIS meeting in September 1992 (Silsoe, U.K.). Because of the pressing need expressed by global change modellers for a Global Soils Database the SOTER approach was considered laudable but will not lead, in the short term, to a pedon database of global coverage.

In April 1992 the SOTER concept was discussed with scientists from the World Resources Institute and the Africa Technical Department, Environment Division of the World Bank. This resulted in an invitation to participate at a World Bank (AFTEN) division organised workshop on Dryland Management Practices and Information Needs in the Sudano-Sahelian Zone (Oslo, September 1992). Strong pressure was put on international donor agencies to stop talking of the usefulness of Environmental Information systems and to start acting. A major conclusion was that environmental

information has been collected and archived, but that this information is not readily accessible to potential users.

ISRIC was also invited to participate in a workshop organized by the World Resources Institute on the topic: Defining Environmental Information Needs Early in the Next Century (Washington, December 1992). It was concluded that research into Earth processes is well funded, but efforts to collect baseline information on the conditions of Earth Resources and efforts to monitor, analyze and report on those changes are few and poorly funded. SOTER was considered invaluable to local and national planners and to those seeking to set priorities for global action and environmental assistance.

At an International Conference on "Operational Methods to Characterize Soil Behaviour in Space and Time (organised by Working Group MV of the ISSS and the SSSA, Ithaca, U.S.A., July 1992) ISRIC presented a paper: A World Soils and Terrain Digital Database: An Improved Assessment of Land Resources. Proceedings of this conference will be published in a special issue of Geoderma in 1993.

Other SOTER-related developments

There is an increasing interest and demand for the implementation of SOTER activities at a national level.

CESOTER – A regional workshop on a Computerized Land Resource Development and Environmental Management System for Central Europe (Austria, Czecho-Slovakia, Hungary, and Poland) took place in April 1991 in Nitra, Czecho-Slovakia. Despite formal national support for CESOTER, funding remained a problem.

BASOTER – In June 1991, a first workshop was organised in Sofia, Bulgaria, to develop a project proposal for a Balkan Soil and Terrain Digital Database with Special Reference to Soil Vulnerability for Chemical Pollutants. A second workshop on BASOTER was convened in December 1991 in Thessaloniki (Greece). Lack of support from donors and the outbreak of unrest in the Balkan has temporarily stopped any further activities.

HUNSOTER – A national project proposal for a Hungarian SOTER, prepared by the Hungarian Institute for Soil Science and Agricultural Chemistry.

SWASOTER – A project proposal for various countries in South-West Asia (Turkey, Syria, Jordan, Saudi Arabia, Iraq) prepared by ACSAD and ISRIC.

RUSOTER – An initiative of the V.V. Dokuchaev Institute of Soil Science.

EASOTER – Jointly prepared by the Kenya Soil Survey and the National Soil Survey of Tanzania for a proposed SOTER project in Kenya, Tanzania and Uganda.

KENSOTER – By mid 1992 UNEP formulated a project document for a Kenyan Soil and Terrain Database Project (KENSOTER) to be considered as a first step towards an East African SOTER. This project, financed by UNEP and FINNIDA, will commence its activities early 1993.

Soil survey institutes in Peru, Cuba, Zimbabwe, Philippines, Indonesia, Vietnam, China have voiced their interest in SOTER. A SOTER project in West Africa has been submitted to E.C. (DG VIII) in 1990 and is still under consideration. It includes Burkina Faso, Benin, Ghana, Niger, Nigeria, and Togo. The national soil research institutes of these countries have expressed their committment to participate in WASOTER.

A SOTER approach has been formulated for South-East China in the framework of STD 3 programme of the C.E.C. DG XII under the title: An Improved Assessment of Land Resources in South-East China for Sustained Utilization of the Land.

The soil analytical laboratory

The report on ISRIC's soil laboratory activities deals with general activities in support of ISRIC's programme for the development of a World Soils Reference Database. In the second section the activities related to the LABEX programme and its successor, GLP/SOILIMS, are discussed.

LABORATORY

The regular laboratory work was, as in the previous period, concentrated on the NASREC project which was now in its second phase. Some 16 profiles from Nigeria were analyzed. Work on 16 Kenyan profiles, started in 1990, has been completed. Analysis of profiles from the following countries were completed in the reporting period: Ecuador, Peru, Nigeria and Cuba. In 1992 new profiles arrived from Costa Rica, Cuba, Nicaragua, Nigeria and Zimbabwe and were absorbed in the programme to be completed during 1993. A series of profiles from China are included also, collected by the NASREC team under an EEC programme.

Analytical work was also carried out on a number of profiles from Denmark and the Netherlands in the framework of STEP (Science and Technology for Environmental Protection): an EEC project. As usual, both in 1991 and in 1992, the laboratory spent about half a man-year on analytical work for projects and practicals of ITC.

Another activity, entering analytical data into ISIS, the institute's database was continued. Where necessary, and time allowing, the analysis of missing data revealed by the thorough process of screening, were completed and also entered. By the end of 1992 the backlog in data processing was nearly cleared.

The organization of the laboratory work was changed dramatically with the introduction of SOILIMS, the user-friendly PC-based system for the management of laboratory information, i.e. work and data. Together with the assembly of a broad set of reference samples, this system also takes care of the quality control of analytical data. SOILIMS has been developed by ISRIC under a project co-sponsored by FAO and IITA.

Stemming from the LABEX period, ISRIC received requests from various developing countries for analysis of small batches of samples for reference purposes. All these requests were duly complied with. Some 70 samples from Costa Rica were analyzed for a project of the Ministry of Health and Environment. Other work, on consultancy basis, included analysis of soils from Gabon and Madagascar, amorphous compounds in fly-ash deposits (synthetic analogues of volcanic ash), and testing of harbour and canal mud for environmental purposes. By the end of 1992, the laboratory became involved in a research project on deposits of incinerator bottom-ash. This material has also similarities with volcanic ejecta and it can present environmental problems. Some publications may result from this involvement.

Participation in the ITC/Pattimura University (Ambon, Indonesia) project, with laboratory assistance, was continued for the fifth year in 1991. A laboratory technician spent four weeks in the Ambon laboratory which was in part equipped by ISRIC in 1987 and 1988. However, this assistance had to be discontinued, much to the regret of both parties, because financial support for the project was terminated.

The contribution to the postgraduate course on Soil and Plant Analysis and Data Handling was continued for the second and third year. This course is a joint project of the Soil Science and Plant Nutrition Department of the Wageningen Agricultural University, the International Agricultural Centre and ISRIC.

TECHNOLOGY TRANSFER TO SOIL LABORATORIES IN DEVELOPING COUNTRIES

Introduction

The Laboratory Methods and Data Exchange (LABEX) Programme was initiated by ISRIC on recommendation of the Second International Soil Classification Workshop held in Malaysia and Thailand in 1978. The main aims were to cross-check, correlate and standardize analytical methods for soil characterization to facilitate and improve international soil classification and correlation studies which were seriously hampered by the large variability of analytical data. During the pilot phase from 1980 to 1984, 20 laboratories participated in the programme, 10 in developing and 10 in developed countries. With a grant from the Directorate General for International Cooperation (DGIS) of the Dutch government the operational phase lasted from 1985 to 1992. The number of participants increased to over 110, about a third of whom reside in industrialized countries which was considered indispensable for dependable results from the interlaboratory data checks.

Pilot phase

The data received during the pilot phase of LABEX indicated that, in general, the variability of data was alarmingly high but varied with the soil parameter concerned. It also became clear that a significant improvement was feasible. However, even after standardization of methods, a relatively high minimum level of between laboratory variability would be unavoidable. Estimates of this variability (coefficients of variation) for some major parameters used in soil characterization were: Clay content 11%, CEC of the clay 25%, Base Saturation 10% (Van Reeuwijk, 1982, 1984a, 1984b).

Operational phase

During the second phase, financially supported by the Dutch Government, the LABEX Programme developed into a Project which became an important quality tool for many soil laboratories in the world. At the request of many participants, more soil parameters were introduced in order to exchange more analytical results.

With the introduction of personal computers it became easier to handle data and participants were asked to analyze the samples according to their own methods as well as according to the so-called "LABEX procedures" prepared and prescribed by ISRIC, i.e. a two-pronged approach.

In August 1986 a very successful International Workshop on the project was attended by more than 60 participants (Pleijsier, 1986). Co-sponsors were FAO, ORSTOM and USAID/SMSS. The discussions during the workshop indicated clearly that the participating soil laboratories were in the first place interested in a check on the quality of their own performance using their present procedures rather than in entering into tedious standardization efforts where they had to use procedures with which they were not familiar. That such standardization is indeed not immediately successful is demonstrated by Table 1 which shows that the coefficient of variation is significantly less when laboratories use their own procedures. This is no doubt in part due to the fact that it takes time to get acquainted with a new procedure.

Table 1 Coefficients of variation (CV) for some soil parameters analyzed with LABEX-prescribed procedures and participant's own procedures.

Parameter	%CV LABEX Procedure	%CV own Procedure
pH H_2O	4.3	3.7
pH KCl	2.1	1.0
% Clay	16.6	12.0
% Silt	39.7	12.9
% Sand	61.7	51.9
% Org C	41.0	22.1
CEC	12.0	17.5
Exch. K	8.2	12.7
Exch. Na	20.2	45.3
Exch. Ca	33.1	13.1
Exch. Mg	8.7	17.8
% N	36.7	30.1

In reporting data of such round-robin exchange programmes, the identification of outliers, the *median* is preferred to the *average* so as to reduce the influence of extreme data. After the calculation of the Median (MED1), the Median of the Absolute Differences of the observed values and the median is assessed (MAD1). Values larger than MED1 + $2F \times$ MAD1 or smaller than MED1 - $2F \times$ MAD1 are tagged with two asterisks and are considered as outliers. The same procedure is repeated with the same data excluding those values already tagged with two asterisks. This results in a second median (MED2) and a second Median of the Absolute Differences of the observed values and the second median (MAD2). Values larger then MED2 + $2F \times$ MAD2 or smaller then MED2 - $2F \times$ MAD2 are tagged with one asterisk and are considered as dubious. (The factor F is such that had the data been normally distributed, 5% of the data would have been tagged). The factor F is calculated by:

$$F = (0.7722 + 1.064/n) \times t_{t-1}(0.025)$$

where: n = number of observations
t = the Student T with 0.025% confidence level (n-1 degrees of freedom)

Figure 1 is an illustrative example of a frequency distribution of clay percentages obtained by 66 laboratories for one soil sample.

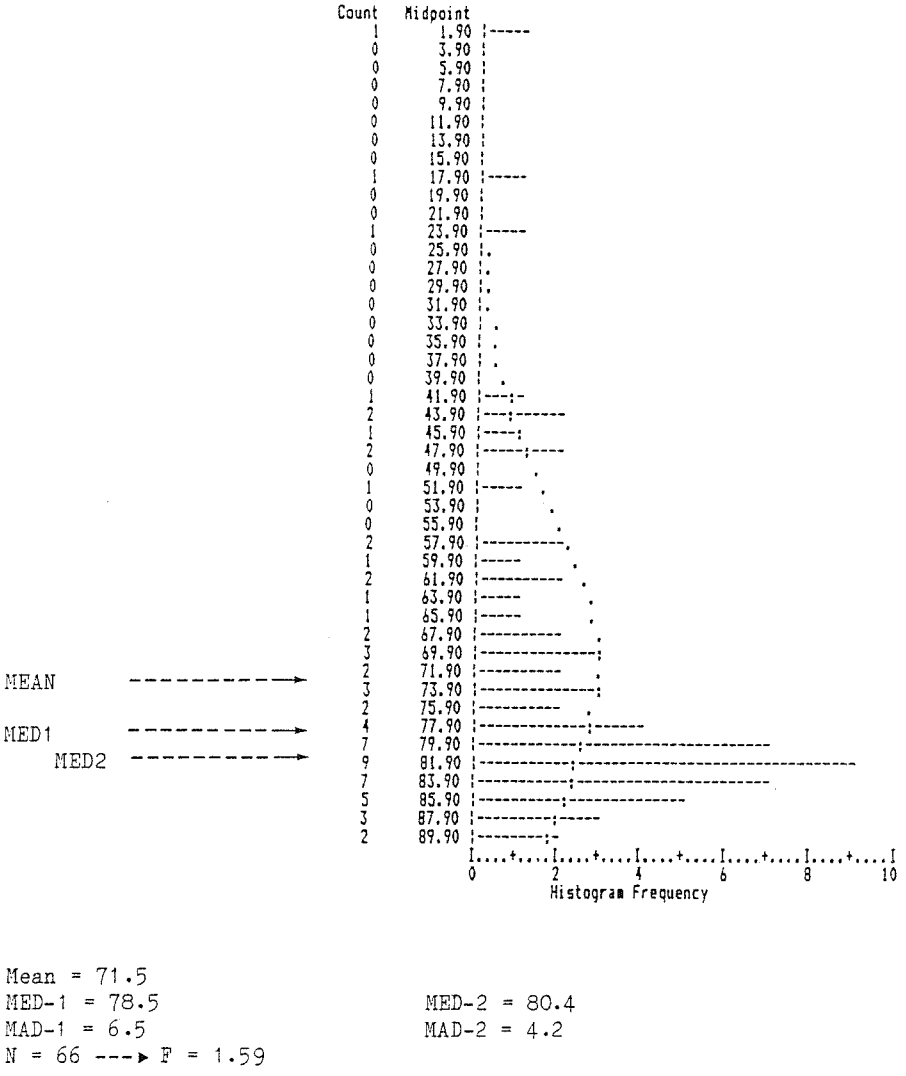

Fig. 1 Frequency distribution of clay percentages obtained for a round-robin sample (sample 17, Pleijsier, 1985, 1986)

The large variability shown in this diagram is representative for many soil parameters particularly those that involve surface reactions (CEC, extractions) or dispersion (particle-size distribution) and to a much lesser extent for those that involve total contents (carbon, nitrogen). The results of the individual rounds of analysis have been laid down in ten technical reports which were distributed among participants.

Special Activities

A special activity which needs to be mentioned is the frequent individual attention given to those participants who asked for assistance with particular problems. This was done in two ways: by correspondence or by personal contact. During the programme period many participants (heads of laboratory or their deputies) visited ISRIC, usually on their way to conferences or training courses. Several did so on repeated occasions. The programme was also discussed at several international meetings, including the last two International Congresses of Soil Science in 1986 and 1990.

In addition, ISRIC performed hundreds of analyses (in small batches at a time) at the request of participants for checking and reference purposes. Also, a special round was organized among 8 large soil laboratories to try four single-step cation-exchange capacity determinations (CEC) as a convenient substitute for the traditional but tedious methods. The silver thiourea (AgTU) procedure appeared to be favoured. This procedure is at present being tested further in several laboratories, some outside the former LABEX circle.

LABEX as self-supporting project?

External financial support for the LABEX programme came to an end in 1991. In order to continue the LABEX project an annual budget in excess of NLG 120.000 would be needed (≈ USD 60.000). This would imply an annual fee of NLG 1000 per participating laboratory. It appeared that only about 25 laboratories, mainly from industrialized countries were prepared to pay this fee. Sponsoring by donor agencies was explored but the remaining budget deficit was considered a too heavy financial burden for ISRIC.

The termination of LABEX aroused expressions of regret by many participants for whom LABEX was the only outside standard of reference. It also implied the discontinuation of a personal advice service for particular problems which had arisen in the laboratories of developing countries.

Participating laboratories interested in outside references only were advised to participate in the International Soil-Analytical Exchange Programme (ISE) organized by the Wageningen Agricultural University which has many participants (over 200) and a long standing experience particularly with crop analysis. With regard to the discontinuation of "problem solving" assistance, efforts are now made to undertake a programme of improvement of laboratory organization through the introduction of the basic elements of Good Laboratory Practice (GLP) and a Laboratory Information Management System (LIMS). This topic is discussed next.

A Handbook of Good Laboratory Practice and a Soil Laboratory Information Management System

An important lesson learned from the LABEX project was that the variability of analytical data can be traced to two main causes:

1. Lack of standardisation of analytical procedures
2. Lack of within-laboratory consistency.

Efforts to standardise procedures have recently been initiated by working groups of ISO (International Standardisation Organisation) in which ISRIC participates, but the within-laboratory problems have so far largely been left to initiatives of individual institutes and particularly to commercial laboratories whose success is directly related to the quality of their product.

It is generally accepted that the quality of the output of laboratories strongly depends on the quality of the organization of the work, not only at the level of execution of the analysis but also at management level. To achieve optimal performance, the concept of "Good Laboratory Practice" (GLP) was developed and has been used now for quite some time by many categories of laboratories where the quality of the work is of vital importance e.g. in the fields of food, medicine, toxicology, pollution, etc. Implementation of GLP in soil laboratories has not occurred on a large scale yet, particularly in developing countries, but it seems the only way to improve laboratory performance. Needless to say that the advantages of this are manifold and invaluable.

GLP prescribes a system of rules which allows better management, improves efficiency (thus reducing costs), minimizes errors, allows quality control (including tracking of errors and their cause) and quality assurance, stimulates and motivates staff, improves safety, and improves communication possibilities, both internally and externally. In this way, the performance of a laboratory can be controlled and improved, and its reputation (and that of the whole institute) raised. An important aspect is also that the standard of quality is documented and can be demonstrated to authorities and clients with the so-called Quality Handbook which contains all the practised measures and rules.

The importance of GLP is illustrated by the observation that in many countries governments are granting orders for analyses only to laboratories that are "certified". For certification the implementation of GLP is an essential requirement. Hence, for our target group we see GLP as a very valuable asset (without aiming at a much more comprehensive certification).

Unfortunately, there is no existing ready-to-use Handbook for GLP in Soil Laboratories. There are, however, guidelines and textbooks which enable laboratories to prepare their own so-called Quality Handbook (which is part of GLP). This documentation (e.g. ISO/IEC Guides no. 25, 38 etc.) is scattered and often difficult to acquire in some countries, not to mention the problems in synthesizing the information into a working manual.

Although all activities for a laboratory can be documented in writing in various note-books (e.g. planning, sample registration etc.) a superior way of doing this is with the help of a (personal) computer. Special programmes for this are commercially available (Laboratory Information Management System: LIMS). However these are generally expensive (>USD 25,000) and often not easy to adapt for soil laboratories. ISRIC has undertaken to develop a LIMS specially for soil laboratories with as major features: user-friendly, tailor-made to individual laboratory needs, containing several quality control facilities (including some expert system features such as cross-checking of results).

Thus a combination of two virtually tailor-made tools for laboratory organization have become available. The main features can be summed up as follows:

A Handbook for Good Laboratory Practice (GLP) is an assembly of protocols for the efficient organization and management of a laboratory.

This includes protocols for the use of
- personnel
- facilities
- equipment
- reagents and materials (including reference materials)
- samples (registration, identification etc.)
- analytical procedures
- calculation procedures and statistical treatment
- quality control
- data entering
- database management
- reporting

A LIMS (Laboratory Information Management System) is a powerful tool which allows:
- better management of the laboratory
- control of GLP in an efficient way (including quality control of data)
- stimulation of personnel to apply GLP
- data retrieval and demonstration of procedures to clients and authorities.

Thus a LIMS handles the dynamic part of GLP, the static parts being the protocols.

ISRIC is preparing this GLP Handbook plus LIMS package, using the relevant guidelines, textbooks and outside consultants as well as experience in our own and developing country's laboratories. This package will be made available for upgrading soil laboratories, particularly in developing countries. Since we realize that implementation may in some cases may raise practical problems, we have in mind to make available for a short period skilled staff who can assist and instruct laboratories. This would also include the installation and adaptation to local needs of the LIMS. If necessary, this visit can be repeated after a certain period of time. The laboratories themselves should find the finances for this activity.

EC-STD 2 China Soils project

Background

On advice of the Life Sciences and Technologies for Development Programme (STD) of the European Community (EC) three soil-oriented cooperation programmes of four European institutions with the Institute of Soil Science - Academia Sinica (ISS-AS) were joined into one project. Coordinators at ISS-AS are Prof. Zhao Qiguo, director and Prof. Gong Zitong, head of the Geography Department. Besides ISRIC, coordinator of the project, the other participating institutions are the Institut für Pflanzenernährung, Kiel, Germany (IPB), the Justus Liebig Universitat, Giessen, Germany (JL), the Institut Francais de Recherche Scientifique pour le Developpement en Cooperation (ORSTOM), and the Rheinischen Friedrich Wilhelms Universität, Bonn, Germany (RFW). The following table shows the framework of the three sub-projects concerned.

Sub-project	A	B	C	
Scale Objective Area	Detailed - Soil erodibility study(#) - Soil variability study Yingtan Red Soil Station (4×6 km) and direct environment	Reconnaissance Transects study Transects: Yingtan (200 km), Guangdong (200 km), Hainan (200 km)	Exploratory Major soil types study. Major ecological zones in Hainan, Guangdong and Jiangxi provinces (including A + B areas)	STD2 1992/1993
Results	- soil erodibility indices - detailed erosion model/GIS	- (pedogenetic) rules for major soil type distribution/ evaluation	- soil reference collection - prototype small scale pedon database (SOTER)	

ISRIC's main task is to carry out sub-project C: "Establishment of a soil reference collection and pedon-database at ISS-AS and ISRIC", which is a NASREC oriented project (see paragraph on NASREC). Sub-project C aims at the study and sampling of sites in SE, NE and SW China and supplements ISRIC's earlier soil reference collection missions to China in 1983 and 1986.

Activities

Besides general administration for the whole project, the coordination work of the three sub-projects included the organisation of two workshops for all participants in March and October 1992 in Nanjing.

Sub-project C

The fieldwork in Hainan Island, Jiangxi and Guangdong provinces formed the major part of the work. The fieldwork took place in October and November 1992. In view of the amount of work and the distances involved, two teams were set up. Four sites were studied on Hainan Island where the parent material included granite at three sites (dominant in Hainan) and basalt. Eight sites were studied in the Jiangxi province. Five were located in 'Red Basin' areas (=low altitude intermontane basins) where parent materials include sandstone, granite and red Quaternary clay. Five sites were studied in Guangdong province. Four were in mountainous areas with granite, shale, crystalline limestone and red Quaternary clay parent materials. In addition one old paddy soil in the Pearl River delta was studied and sampled. During the fieldwork all descriptions and other collected data have been entered in a database by using portable PCs.

Follow-up

Activities in 1993 will consist of the continuation of fieldwork in NE and SW China, soil analyses at ISS-AS and ISRIC, completion of the database, organization of the soil exposition at ISS-AS, and the drafting of accompanying publications (Soil Briefs).

During the second workshop in Nanjing in October 1992 a Soils and Terrain Digital Database follow-up project was discussed. The project proposal was submitted to the STD3 Commission of the European Community in November 1992.

World Inventory of Soil Emission Potentials (WISE)

Background

Terrestrial ecosystems, and soils in particular, are important sources and sinks of a number of naturally occurring, radiatively-active gases, such as water vapour, carbon dioxide, methane, nitrous oxide and nitric oxide. These gases play an important role in enhancing the 'greenhouse effect'. The soil conditions and chemical, physical and biological processes that regulate the production, absorption and emission 'greenhouse gases' in terrestrial ecosystems are incompletely understood and only poorly quantified. As a contribution to increase the understanding of these processes, and their inter-linkages, ISRIC initiated a project on 'Geographic Quantification of Soil Factors and Soil Processes that Control Fluxes of Greenhouse Gases'. This project, which is presently being referred to by its acronym WISE for 'World Inventory of Soil Emission Potentials' (WISE), is a follow-up of the International Conference on 'Soils and the Greenhouse Effect', held in 1989.

The WISE project is part of a wider research programme being carried out within the framework of the Netherlands National Research Programme on Global Air Pollution and Climate Change (NOP-MLK; Project No. 851039). The NOP programme comprises about 120 projects with an average duration of 2-4 years each. The first phase of the programme is to be completed by the end of 1994. The NOP programme has been initiated to support policy development and contribute to international research efforts in the field of global air pollution and climate change. The 23 "clusters" of NOP are grouped under five broad themes: (A) the System; (B) the Causes; (C) the System; (D) the Consequences, and (E) Identification of Permanent Sustainable Solutions. The WISE project reports under the cluster on "data base development" of Theme B.

Objectives and achievements

The WISE project has been divided into two phases. The first phase, September 1991 to September 1992, has been to assemble the relevant literature in a background study of the currently known chemical, physical and biological factors controlling the gaseous exchanges involved. This phase of the project culminated in a workshop in Wageningen (August 1992), attended by an international panel of scientists working in the field, whose expertise and experience were drawn upon to refine the broad lines of the project outlined in the original research agreement. The executive summary and invited papers of the workshop have been published as separate documents. The background booklet to the WISE workshop (ISRIC Working Paper and Preprint 92/4) has been published as Technical Paper 23 of ISRIC.

The second phase of the WISE project, which ends in September 1994, includes two main goals, the successful completion of the first of these will enable the second to be accomplished. A global soil data base with a grid size of 30' latitude by 30' longitude is to be compiled from the 'cleaned' digital version of the 1:5 M Soil Map of the World in close collaboration with staff of the Food and Agriculture Organisation's Land and Water Division (FAO-AGLS). To these "area" data will be linked a database of soil profiles considered representative for the various soil units identified on the 'cleaned' Soil Map of the World. As these profiles are best selected by National Soil Survey Organizations, ISRIC has prepared and mailed a questionnaire to obtain additional soil profile descriptions and analytical data sheets for each FAO soil unit. Guidelines for collecting and presenting the data have been prepared. This information is to complement the data held in ISIS, ISRIC's Soil Information System. As the number of reference pedons for the respective FAO soil units from different regions of the globe increases, it should become possible to present better information on their range in characteristics (e.g. mode, extremes and confidence intervals).

Once the "area" and "point" data have been linked, the framework will be in place for handling the soil data required to make a (refined) assessment of methane production from hydromorphic soil units as occurring in the respective 30 by 30 minute grid cells. A next activity would be to achieve a more

accurate figure of soil emissions of methane. This will require development of a scheme to model the different aspects of methane production and emission to the atmosphere. This work will take place in collaboration with researchers from the International Rice Research Institute and Nagoya University.

WISE project personnel participated in various workshops, including meetings organized by NOP, CTB, and DIS and IGAC working groups of IGBP, to discuss and strengthen awareness about ISRIC's activities related with the development of soil databases (for further details see appropriate sections).

Mapping of Soil Vulnerability to Pollution in Europe (SOVEUR)

Since January 1990, the Netherlands Ministry of Housing, Physical Planning and Environment (VROM) and the International Institute for Applied Systems Analysis (IIASA) have sponsored a series of meetings on chemicals in the European environment through the Chemical Time Bombs (CTB) project of the Foundation for Ecodevelopment "Mondiaal Alternatief". Within this framework, ISRIC convened an international workshop on the feasibility of a project on Soil Vulnerability Mapping for Europe (SOVEUR). This workshop took place in March 1991 with delegates from 17 eastern and western European countries attending.

Soil vulnerability was defined as the "capability for the soil to be harmed in one or more of its ecological functions". The workshop identified several significant soil-environmental parameters (e.g. pH, clay content/mineralogy, organic matter, length of growing period) which would be critical for the identification of soils at risk from chemical contaminants. Proposals for identifying mapping units on a 1:5M map and their classification into susceptibility classes were agreed in principle. In order to maintain uniformity of procedures at the European level, its was agreed, in principle, that the procedures and terminology of the internationally endorsed World Soils and Terrain Digital Database (SOTER) programme of ISSS/ISRIC should be used to "harness" both the spatial and key attributes. Chemicals of three significant groups of soil pollutants – heavy metals, pesticides and other xenobiotic substances such as fluorine – would be considered in the initial mapping exercise.

In this proposed programme the capacity of soil to absorb, hold and release specified chemical compounds will be considered together with the relevant dynamics to show where the most vulnerable soils occur in Europe. This will encompass the assessment of the capability of soils to release accumulated pollutants when "triggered" by changes in land use, global acidification or climate change. The relevant processes will be described using qualitative assumptions and threshold models that are compatible with the resolution of the mapping exercise.

The initial phase of SOVEUR, which included the organization of the workshop, editing of the workshop proceedings and preparation of a project proposal for the proposed follow-up phase, ended in June 1991. Funding is now sought for the initial mapping programme as outlined above. This project may form the basis for programmes which also include the identification of major sources of soil pollution and mapping of the accumulated load and rate of loading of the soil system, and dynamic modelling to assess the risk of occurrence of specific types of chemical time bombs at the European level.

In August 1991, the findings of the SOVEUR workshop were presented during a CTB-workshop in advance of the Second International Symposium on Environmental Geochemistry at Uppsala, Sweden. A final 'state of the art' conference on Chemical Time Bombs was held at Veldhoven in September 1992. ISRIC staff were invited to participate and to act as a joint editor of the conference proceedings which will be published during 1993.

In consultation with the Chemical Time Bombs project, ISRIC also edited the paper on "Methodological Guidelines for Forecasting the Geochemical Susceptibility of Soils to Technogenic Pollution" by Dr. M.A. Glazovskaya of Moscow State University.

Handbook on Soil Conservation in Europe

Following a meeting of the Group of Soil Conservation Specialists of the Council of Europe in April 1992, ISRIC received a request to prepare the first two chapters of a "Handbook on Soil Conservation in Europe".

The first chapter of this "handbook" dealt with existing data on soil degradation monitoring and soil protection. This included information on the present situation in Europe with respect to all types of soil degradation, including an assessment of causes and impacts, an inventory of existing soil monitoring systems and databases as well as an overview of soil protection and rehabilitation techniques. The World Map on the Status of Human-Induced Soil Degradation (GLASOD), prepared by ISRIC in 1990, was taken as the basis for this inventory.

The second chapter presents a correlation and evaluation of the collected information and gives some recommendations for future action at a European level. Data was supplied by the members of the Group of soil conservation experts of the Council of Europe and by other institutes and individuals in reply to a brief questionnaire sent out by ISRIC. Only a short period was available for the collection of the information, so the provided data was very variable in quantity, coverage and quality. In spite of this, the general picture that emerged was satisfactory as a first inventory of the situation.

Some of the major conclusions were that few structures, organisations or activities as yet exist which adopt both an integrated (i.e. encompassing various types of degradation) and pan-European approach. For such an approach the following activities were suggested:

a) to make a detailed assessment of all aspects of current soil degradation in Europe, based as much as possible on objective and quantitative data;
b) to make a detailed assessment of soil vulnerability to all aspects of soil degradation in Europe and to identify the areas most sensitive to soil degradation;
c) to undertake an extensive review of existing measures, techniques legislation and economic measures designed to counter soil degradation.

The first draft of the text was presented and well received at a meeting of the Group of Soil Conservation Experts in Strasbourg, November 1992. As a result, the Group requested ISRIC to prepare the following chapters as well, before mid-1993. The meeting endorsed the aforementioned recommendations while recognizing that funding of these activities would be beyond the financial capacities of the Council of Europe, hence would require additional donors. A first step in the direction of recommendation (a) was the request, soon after this meeting, from Directorate General XI of the Commission of European Communities to ISRIC to prepare a revised version of the European part of the GLASOD map, to be ready in March 1993.

Global Assessment of Soil Degradation (GLASOD)

After the World Map of the Status of Human-induced Soil Degradation was finalized in 1990 and officially presented at the 14th International Congress of Soil Science in Kyoto (August, 1990), UNEP requested ISRIC to digitize the map and to prepare a computerized GLASOD database. This made possible the preparation of single value thematic maps of the various soil degradation types and to calculate statistics on the causative factors, extent, and degree of degradation. A detailed discussion of the results of this work is presented elsewhere in this report.

The GLASOD map, and in particular the estimates of areas affected by soil degradation, generated a worldwide interest. The World Resources Institute (Washington, USA) devoted a chapter on soil degradation in its World Resources Report 1992-1993, and issued a News Release under the title: New Data Reveal Startling Degradation around the World. The news release states: *"Although the findings on global soil degradation are preliminary, the figures offer the best available estimates of this serious environmental problem. The report is drawn from a three-year Global Assessment of Soil Degradation (GLASOD) survey sponsored by UNEP and coordinated by ISRIC in the Netherlands. The data were provided by more than 250 soil scientists around the world."*

UNEP's Governing Council noted at its May 1991 meeting in Nairobi that the Global Assessment of Soil Degradation, the preparation for the World Atlas of Desertification, and the development of the Soil and Terrain Digital Databases SOTER *"were capable of providing essential ingredients for the formulation of national soil policies"*. The World Atlas of Desertification, published by Edward Arnold under the auspices of UNEP reproduced a series of thematic maps based on the digitized version of the GLASOD map with a detailed description of the methodology developed by the GLASOD project. Additional articles on GLASOD appeared in U.S. newspapers, in Sciences et Avenir (June 1992) and in Contour, the newsletter of the Asia Soil Conservation Network (vol 3, nr 3, 1993). The Encyclopaedia Britannica, Inc. requested to be informed about the GLASOD results for incorporation in their World Data Annual: *"We are greatly impressed with your efforts at documenting global soil degradation"*.

The ad-hoc expert group meeting to discuss Global Soil Databases and Appraisal of GLASOD/SOTER (UNEP, February 1992) concluded that GLASOD, as an attempt to portray soil degradation in the form of a world map, has accomplished its main objective. Nevertheless there is concern about how this map/database could be improved to include other parameters and additional information to express the processes of soil degradation at a national scale. The group also felt that GLASOD should be improved by including an assessment of the risks and current trends of land degradation rather than present only a static picture of soil degradation. *"Such an improvement should be done in a step-wise mode and should be relayed principally in the information and analytical data and results of SOTER"*. This ad-hoc expert group meeting also recommended that as a follow-up to GLASOD an assessment of the successes and failures of programmes designed to counter soil degradation should be initiated. A similar opinion was expressed at the ISSS International Symposium on "Soil Resilience and Sustainable Land use" (Budapest, September 1992) organised by the Hungarian Academy of Sciences and CAB International. The symposium recommended that *The Global Assessment of Human-induced Soil Degradation, developed by UNEP, ISRIC, and ISSS in cooperation with many country specialists, should be complemented by a similar assessment of showing areas with a) sustainable land management systems, b) areas where degraded lands have been rehabilitated, and c) the resilience of the land resource base in different ecosystems"*.

As a result of these recommendations ISRIC has indicated its interest to participate in WOCAT (A World Overview of Conservation Activities and Techniques): a project of the World Association of Soil and Water Conservation, which was submitted in November 1992 to the STD 3 programme of the CEC (DG VIII) by the Group for Development and Environment of the Institute of Geography of the University of Berne. WOCAT is an immediate response to the recommendation of the Budapest Symposium.

Collection of Reference Laterite Profiles (CORLAT)

During the Plenary Session of the Second Seminar of the Unesco-sponsored IGCP Project 129: Laterization Processes, held in São Paulo, Brazil, 1982, it was recommended to establish a collection of reference laterite profiles (CORLAT) and to compile and publish a Handbook on the description of laterites and laterite profiles for interdisciplinary use. In 1991 the EEC decided partly to fund these activities. In the reporting period, guest researcher Dr. G.J.J. Aleva, retired exploration and mining geologist of Billiton International Metals, in cooperation with ISRIC scientists, and especially D. Creutzberg, prepared a draft of this Handbook for full discussion at a well-attended workshop, held at ISRIC in March 1992.

The Handbook will be published in 1993. Together with the laterite profiles, the handbook will be an important tool to facilitate communication in laterite research at international and interdisciplinary levels.

Glinka Memorial Collection

The Glinka Memorial Collection consists of 55 soil monoliths, collected by Russian soil scientists in the 1920's under the supervision of Konstantin D. Glinka. The collection represents a soil geographical sequence from St. Petersburg to the Caucasus together with a number of soils from Georgia, Azerbaijan, Kazakhstan, the Amu Darya region and the Siberian Far East. It was meant to be exhibited as a part of the much larger exposition on Russian soils and soil science at the First International Congress on Soil Science at Washington D.C. in 1927. Shipping problems delayed these monoliths so they did not arrive in time to be shown at the congress. It was decided to store the monoliths at the U.S. Soil Conservation Service, where they remained undisturbed in their original wooden boxes and they are still in a fair to good condition. The collection was named after Glinka by ISRIC in the 1980s.

In about 1974 the Soil Conservation Service donated the 55 monoliths to ISRIC. Since then seven monoliths have been made ready for exposition. Early in 1990, guest researcher J.A.K. Boerma (Dept. of Physical Geography, University of Utrecht) undertook the task to describe and prepare the remaining 48 monoliths. As the monoliths were collected at a time when pollution by heavy metals, acid rain and the use of chemical fertilizers were almost absent in the U.S.S.R., these monoliths are unpolluted. In this respect the monoliths offer the possibility of establishing background values with respect to heavy metal contamination for Russian soils. Comparison of the Glinka monoliths with (monoliths and) samples collected today at the same places may provide an opportunity to determine the amount of pollution accumulated, as well as its eventual effects on soil genesis. It is fair to say that such a study is of great interest.

In cooperation with the V.V.Dokuchaev Soil Institute at Moscow (Dr. V.S. Stolbovoy) a common project is proposed. A feasibility study, carried out in 1991 and 1992, made clear that the project can be carried out succesfully. In June 1991, a 14 days trip was made to the Soviet Union to work out details on the project, and to establish contacts with the V.V.Dokuchaev Central Soil Museum at St. Petersburg and the V.R.Wil'yams Soil Museum at Moscow. Furthermore a trial run was made to locate the 1920 site of one monolith. This made it clear that the location of at least a number of profiles will be possible but that in most cases considerable research in various institute and personal archives is necessary.

The experience gained in 1991 enabled a pilot study to take place in 1992. It concerned monoliths from the area around St. Petersburg. The study of the appropriate 1920's monoliths at ISRIC was followed by site visits. The field excursion (one month) included archive-research and locating the 1920's sites as well as acquiring fresh monoliths and samples. A total of 6 sites were located and sampled. The success of the pilot study was made possible by the effective and highly appreciated support and cooperation of the V.V. Dokuchaev Soil Institute at Moscow and the V.V. Dokuchaev Central Soil Museum at St. Petersburg. They made the search for sites relatively easy and they greatly assisted in making the necessary contacts with the relevant authorities.

During the period 1990-1992, ten of the 1920's monoliths have been prepared and described. Analysis of samples of the 1920 and 1990 collections are underway. On the basis of the experience gained in 1991 and 1992, a project proposal has been formulated but funding has not yet been found. It is expected that completion of the description and preparation of the Glinka Memorial Collection, together with the necessary resampling and analytical work, will take several years.

Bibliography of Soil Science in Indonesia 1890-1963 (SOBIN)

This bibliography is a structured compilation of published and unpublished literature about soil science in Indonesia. It includes extended abstracts from literature about soil surveys, classification, management, erosion and conservation, manuring, fertility, pest and diseases, that appeared in a period that tropical soil science was developing. Theoretically, part of the work may be outdated, but practically, the old literature still contains valuable information. However, these data have become increasingly unaccessible to present-day researchers, since most of it was published in the Dutch language. The present bibliography contains over 1400 abstracts on authors, subjects, plant-taxonomical names, and geographical locations. Recently, a CDS-ISIS database of the bibliography has also become available.

The bibliography is the result of a collaborative project of the DLO-Institute for Soil Fertility Research (IB-DLO, Haren), the Centre for Soil and Agroclimate Research (Bogor, Indonesia) and ISRIC.

The bibliography was compiled in the period 1990-1992 with financial support from the Netherlands Directorate-General for International Cooperation. The amount of literature was much larger than originally foreseen, so a follow-up project to complete the bibliographical database is anticipated and additional funds are being sought.

Soil and Terrain Resources Information Network Generation (STRING)

STRING is a project carried out for the Sahara and Sahel Observatory (L'Observatoire du Sahara et du Sahel - OSS). OSS is a cooperative programme aimed, among other things, at improved transfer of knowledge between and among researchers, develoment officials and policy makers in the Saharan and Sahelian Zones.

Within the framework of the OSS programme, a number of projects have been identified, each for a specific resources-oriented discipline. Because of its experience in collecting, processing and disseminating information on soils and terrain, ISRIC was contracted to execute a project concerned with information on soils, in its broadest sense. The first phase of this project started in September 1992.

STRING is concerned with the systematic inventory of existing cartographic and bibliographic documentation on soils and terrain resources, including organizational details of the national and regional institutions responsible for resources inventories.

As a long range objective, STRING has adopted the overall policy of the OSS in its specific area of interest: improved land and soil management in line with national strategies aiming at sustained provision of food, shelter and clothing for the people. Subscribing to the objective of a better accessibility and exchange of information in the OSS region, the more specific objective of STRING is to arrive at an orderly arrangement and a more efficient use of cartographic as well as bibliographic information on soils and terrain resources.

In achieving this objective, the main activity of STRING is to set up a computerized documentation system on soils and terrain for the OSS region. During the initial period in 1992, selection of software, development of a database structure and drafting worksheets for data input have been the main concerns. Also, development of a working database with addresses of potential participating institutes and organizations, has been a major task. Other important activities were the preparation and mailing introduction letters, project questionnaires and a general project brochure. In addition to setting up the database, data gathering has started, mainly from databases available on CD-ROM.

Finally, outputs of the first phase of STRING will be

1. An inventory of readily available, published soils and terrain data, in its broadest sense, including data on land use, land evaluation, land degradation and agro-ecological zonation. Bibliographic as well as cartographic information are gathered. Cartographic information includes only small-scale maps (with a scale of 1:100.000 or smaller). For bibliographic information, a restriction is made that the area of concern within the OSS-region should be specified.
2. An inventory of national, regional and international institutions in the OSS region that are responsible for soil resources inventories and evaluation, indicating their institutional details and their mandate.
3. A computerized cartographic and bibliographic information system for the storage and easy access of the inventories. Information is stored in a database, using CDS-ISIS software, which was developed by Unesco and is used at a number of national and international organizations in the OSS region.
4. A report on the information collected, with hard copies of the inventory (in French and English).

Library, map collection, and slide collection

The aim of ISRIC is to make a systematic collection of books and reports, including 'grey' literature, soil maps, related thematic maps and data. This relates especially to the compilation of a World Soils and Terrain Digital Database (SOTER), as a follow-up of the FAO-Unesco Soil Map of the World. Book and map collections increasingly are consulted as a source of information for scientists, students and consultants in soil studies and in the preparation of missions to developing countries.

Books and Journals

The library is deliberately kept small, acquiring only books dealing with soil science, and the most important soil science journals, since the nearby Staring Building houses the specialized 'soil and water' library in Wageningen. As an exception, attention is being given to reference books and periodicals on environmental issues. At present, the library contains about 8000 books, classified mainly on a regional basis. It subscribes to about 40 journals. Nearly all books have been entered in a database, using the Cardbox Plus programme. This facilitates the use of titles stored in Agralin, the database of agricultural institutions in the Netherlands.

Soil maps and reports

ISRIC is building up a worldwide collection of soil maps and reports, with an emphasis on the developing world. This is available for consultation by interested persons, and will provide material for updating the 1:5 million FAO-Unesco Soil Map of the World and the compilation of a new Soils and Terrain Digital Database (SOTER) at a scale of 1:1 million.

At present, ISRIC aims at a comprehensive collection of small-scale maps at 1:200,000 or smaller of each country, and a reference system of soil surveys carried out at any scale, accompanied by maps showing the area covered. The maps are complemented by the accompanying reports and related thematic and derived maps. The collection consists of more than 5000 maps and some 600 photonegatives.

Slides

The collection of nearly 20,000 slides includes soils, landscapes, vegetation, crops, forests, etc. from sites throughout the world. It is a much sought-after resource for teachers, publishing companies, etc. The slides are being listed in a database, a time-consuming activity which will last for some years. A selection of about 70 slides covering major soils and landscapes and some land uses is permanently available for sale.

Publications

The aim of ISRIC is to issue publications on the soil collection, analytical methods and techniques, project activities, and to make available teaching materials. For those purposes, cooperation takes place with other organizations and publishing companies.

The publication programme includes the following:

Soil Monographs: This series contains results of studies in soil genesis and classification, soil analysis and land evaluation of a major group of soils (Podzols, Ferralsols, Andosols, Vertisols, etc.). The general aim is to strengthen the state of knowledge on the world's soil resources. They are intended for teachers and students in soil science at university level, soil survey institutes, etc.

Technical Papers: This series mostly contains papers on methodology, procedures, standards, and field extracts of major soil classification systems.

Soil Briefs: This series has recently started in the framework of the NASREC project. It offers information about selected soil reference profiles including characterization and classification of the soils, land evaluation, and the description of the associated landscape, vegetation, and climate. The aim is to provide the soil specialist, as well as specialists in other fields such as agronomists, ecologists, teachers, etc. with relevant information.

Annual Reports: These reports highlight the activities of ISRIC, and contain scientific articles on subjects of general interest.

For limited distribution "***Working Papers and Preprints***" and "***Consultancy/Mission Reports***" are also prepared.

Reports and publications/articles issued in 1991/1992 are listed as they relate to ISRIC's main project activities:

Reports and Publications issued in the framework of GLASOD/SOTER

- ISRIC 1991. Project Proposal for an East African Soil and Terrain Digital Database (EASOTER). Ed. by L.R. Oldeman. ISRIC, Wageningen. 8 p.
- Oldeman, L.R. and H.T. van Velthuyzen, 1991. Aspects and Criteria of the Agro-Ecological Zoning Approach of FAO. ISRIC Working Paper & Preprint 91/07.
- Rademacher, F.E.P., 1991. Using the SOTER database for soil erosion assessment, with example for a pilot area in South America. ISRIC Working Paper & Preprint 91/08.
- van Engelen, V.W.P. and J.H.M. Pulles 1991. The SOTER Manual, procedures for small scale map and database compilation of soil and terrain conditions. ISRIC Working Paper & Preprint 91/3, 92 p. (in English) and 92/2, 97 p. (in Spanish).
- Oliveira, J.B. and M. van den Berg 1992. Application of the SOTER methodology to a semi-detailed survey (1:100,000) in the Piracicaba region (São Paulo State, Brazil). SOTER Report 6, ISRIC, Wageningen. 28 p.
- van Engelen 1992. Manual del curso de entrenamiento LASOTER SIG. Papel de Trabajo y Edición Preliminar 92/3, ISRIC, Wageningen. 44 p.
- Shields, J.A. 1992. Preliminary report for North American pilot area of the SOTER project (NASOTER). Agriculture Canada/ISSS, Ottawa/Wageningen. 25 p.
- ISRIC 1992. Informe del curso de entrenamiento LASOTER GIS. 16 de Marzo-3 Abril de 1992, Montevideo. ISRIC Consultancy/Mission report 92/1, 45 p.
- Batjes, N.H., van Engelen, V.W.P. and Oldeman, L.R. 1992. Proposed assessment of the vulnerability of soils to pollution in Europe using a SOTER-shell approach. Transaction of the Chemical Time-bomb meeting, 18-20 June, Potsdam. p. 11.

- Oldeman, L.R. 1992. Bodemdegradatie, een mondiaal probleem. In: Spectrum Jaarboek: De wereld in 1991: feiten en achtergronden. Kluwer Algemene Uitgeverijen/Uitgeverij het Spectrum, Utrecht, p. 346-350.
- Oldeman, L.R. and V.W.P. van Engelen 1992. A World Soils and Terrain Digital Database (SOTER). An Improved Assessment of Land Resources for Sustained Utilization of the Land. ISSS/SSSA Conference Operational Methods to Characterize Soil Behaviour in Space and Time, Ithaca, New York, 27-30 August 1992. Geoderma (in prep.).
- van den Berg, M. 1992. SWEAP, a computer program for water erosion assessment applied to SOTER. SOTER report 7. ISSS-UNEP-ISRIC, Wageningen. p. 37.

Reports and Publications issued in the framework of NASREC
- NASREC Newsletters 2 (March 1992) and 3 (May 1993).
- Brunt, J. and J.H. Kauffman 1992. Soil Data Graph. Soil and climate data diagrams and tabular soil/land parameter assessment. ISRIC Working Paper & Preprint 92/08.
- Kauffman, J.H. and D. Creutzberg (1991). Ecuador, Reference soil of the Amazon region, Haplic Nitisol (Typic Kandiudult). ISRIC Soil Brief EC06.
- Pulles, J.H.M., J.H. Kauffman and J. Wolf (1991). A user friendly menu and batch facility for the crop simulation model WOFOST v4.3. ISRIC Working Paper & Preprint 91/09.
- Vogel, A.W. 1992. Mission report to Costa Rica and Nicaragua for the Central American Soil Reference Collection and Database Project (CASREC), October 21 - November 19, 1992. ISRIC Consultancy Mission Report 92/03.

Report issued in the framework of EC-STD 2 China Soils Project
- Kauffman, J.H. and Chen Fu Xing 1992. Observations on soils, climate and current land use in areas of the PRC-ADB Red Soils Development Project in Hunan Province, China. ISRIC Working Paper & Preprint 92/02.

Reports and Publications issued in the framework of WISE
- Batjes, N.H. (ed.) 1992. World Inventory of Soil Emissions: Report of Working Group Discussions and Recommendations. Proceedings of an international workshop organized in the framework of the Netherlands National Research Programme on Global Air Pollution and Climate Change (24-27 August 1992). WISE Report No. 1, ISRIC, Wageningen, 20 p.
- Batjes, N.H. and E.M. Bridges (eds) 1992. World Inventory of Soil Emission Potentials. Proceedings of an International Workshop organized in the framework of the Netherlands National Research Programme on Global Air Pollution and Climate Change (NOP). WISE Report No. 2, ISRIC, Wageningen, 125 p.
- Batjes, N.H. and E.M. Bridges 1992. A review of soil factors and processes that control fluxes of heat, moisture and greenhouse gases. ISRIC Technical Paper 23, 204 p.

Reports and publications issued in the framework of SOVEUR
- Batjes, N.H. (ed.) 1991. Mapping of Soil and Terrain Vulnerability to Specified Chemical Compounds in Europe at a scale 1:5M: Report of the working group discussions and recommendations. Proceedings of an International Workshop organized in the framework of the Chemical Time Bombs Project of VROM-IIASA-MA, Wageningen, 20-23 March, 1991. ISRIC, Wageningen. ii + 19 p.
- Batjes, N.H. and E.M. Bridges (eds.) 1991. Mapping of Soil and Terrain Vulnerability to Specified Chemical Compounds in Europe at a scale of 1:5M. Proceedings of an International Workshop organized in the framework of the Chemical Time Bombs Project of VROM-IIASA-MA, Wageningen, 20-23 March, 1991. ISRIC, Wageningen. vi + 177 p.
- Glazovskaya, M.A. 1991 (ed. N.H. Batjes, Trans. M.I. Gerasimova). Methodological Guidelines for Forecasting the Geochemical Susceptibility of Soils to Technogenic Pollution. ISRIC Technical Paper 22, ii + 40 p.
- Bridges, E.M. 1992. Dealing with Contaminated Soils. Soil Use and Management 7:151-158.
- van Lynden, G.W.J. 1992. Handbook of Soil Conservation in Europe (Introduction, Chapter I & II). Council of Europe/ISRIC, October 1992. ISRIC Working Paper and Preprint 92/10.

Other reports issued as ISRIC Working Paper & Preprint

- Bridges, E.M. 1989. The Origins and International Implications of Soil Horizon Nomenclature. Paper presented at the International Meeting on Soil Horizons, Rennes, 4-6 September 1989. ISRIC Working Paper & Preprint 91/02.
- Sombroek, W.G. 1991. Amazon Landforms and Soils in Relation to Biological Diversity. Proceedings of a workshop to determine priority areas for conservtion in Amazonia, 10-20 January 1990, Manaus, Brazil ("Workshop 90"). ISRIC Working Paper & Preprint 91/05 (revised version of Working Paper & Preprint 90/8).
- Aleva, G.J.J. 1992 CORLAT Handbook. Working Paper 92/01, 2nd draft. (revised version of Working Paper 91/06).
- Brunt, J. and L.P. van Reeuwijk 1992. SOILIMS – User Manual Laboratory Information System (draft). ISRIC Working Paper & Preprint 92/05.
- Mooney, H.A. and W.G. Sombroek 1992. Chapter 9: Terrestrial systems. From: Int. Conf. on an Agenda of Science for Environmental and Development into the 21st Century (ASCEND 21). ICSU, Cambridge Univ. Press, 1992, pp. 173-186. ISRIC Working Paper & Preprint 92/07.
- Oldeman, L.R. 1992. The Role of ISRIC in the Collection and Dissemination of Baseline Information on Soils of the World. L.R. Oldeman. ISRIC Working Paper & Preprint 92/09.

Cooperative Publications

- World Resources Institute. World Resources 1992-93, Chapter 8. WRI, p. 111-125.
- World Atlas of Desertification. UNEP, Edward Arnold, London, 1992 (maps and explanatory texts).

APPENDIX Acronyms used in Bi-Annual Report 1991-1992

ACSAD	Arab Centre for the Studies of Arid Zones and Dry Lands, Syria
AFTEN	World Bank, Africa Technology Department, Environment Division, U.S.A.
ALES	Automated Land Evaluation System
BASOTER	SOTER project, Balkan region
BRASOTER	SOTER project, Brazil
CAB	Commonwealth Agricultural Bureau International, United Kingdom
CABO-DLO	Centre for Agrobiological Research, the Netherlands
CASREC	Central American Soil Reference Collection
CATIE	Centro Agronomico Tropical de Investigación y Ensenanza, Costa Rica
CEC	Commission of the European Communities
CESOTER	SOTER Project, Central Europe
CGIAR	Consultative Group of International Agricultural Research
CORLAT	International Collection of Reference Laterite Profiles, ISRIC
CSAR	Centre for Soil and Agroclimate Research, Indonesia
CSRI	Chemistry and Soil Research Institute, Zimbabwe
CTB	Chemical Time Bombs project, the Netherlands
DGIS	Directorate-General for International Cooperation, Ministry of Foreign Affairs, the Netherlands
DHV	DHV Consultants, the Netherlands
DLO	Agricultural Research Department of the Ministry of Agriculture, Nature Management and Fisheries, the Netherlands
EASOTER	SOTER Project, East Africa
EC/STD	Science and Technology for Development Programme, European Community
EC	European Community
EUROLAD	European Assessment of the Current Status of Human-induced Land Degradation
EUSOPOL	Assessment of the Status of Human-induced Soil Pollution in Europe, Council of Europe
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environment Facility, World Bank/UNDP/UNEP
GIS	Geographic Information System
GLASOD	Global Assessment of Soil Degradation project, ISRIC
GLASOTER	GLASOD/SOTER project
GLP	Good Laboratory Practice
FINNIDA	Finnish International Development Agency
HUNSOTER	SOTER project, Hungary
IB-DLO	Institute for Soil Fertility Research, the Netherlands
ICSU	International Council of Scientific Unions
IGAC	International Global Atmosphere Chemistry programme, IGBP
IGBP	International Geosphere-Biosphere Programme, Sweden
IGBP-DIS	International Geosphere-Biosphere Programme, Data & Information System, France
IGCP	International Geological Correlation Project
IITA	International Institute of Tropical Agriculture, Nigeria
ILRAD	International Laboratory for Research on Animal Diseases, Kenya
ILRI	International Institute for Land Reclamation and Improvement, the Netherlands
ILWIS	Integrated Land and Water Information System
INIAA	Instituto Nacional de Investigación Agraria y Agro-industriaal, Peru
INICA	Instituto Nacional de Investigación de Cana de la Azucar, Cuba
INRENA	Instituto Nacional de Recursos Naturales, Peru
IPB	Institut für Pflanzenernahrung und Bodenkunde, Germany
IRRI	International Rice Research Institute, Philippines
ISE	International Soil Exchange programme, WAU
ISIS	ISRIC Soil Information System
ISNAR	International Service for National Agricultural Research, the Netherlands
ISO	International Standardisation Organisation
ISS-AS	Institute of Soil Science, Academia Sinica, P.R. China
ISSS	International Society of Soil Science
ITC	International Institute for Aerospace Survey and Earth Sciences, the Netherlands
JL	Justus Liebig Universität, Germany
KAU	Kerala Agricultural University, India
KENSOTER	SOTER project, Kenya
LABEX	Laboratory Methods and Data Exchange Programme, ISRIC
LASOTER	SOTER Project, Latin America
LIMS	Laboratory Information Management System
NASOTER	SOTER project, North America
NASREC	National Soil Reference Collections, ISRIC
NBSS-LUP	National Bureau of Soil Survey and Land Use Planning, India

NOP-MLK	Netherlands National Research Programme on Global Air Pollution and Climate Change
NSI	National Soil Institution
ONERN	Oficina Nacional de Evaluación de Recursos Naturales, Peru
ORSTOM	Institut français de recherche scientifique pour le développement en coopération, France
OSS	Observatoire du Sahel et du Sahara
PUDOC-DLO	Centre for Agricultural Publishing and Documentation, the Netherlands
RFW	Rheinischen-Friedrich Wilhelms Universität, Germany
RIVM	National Institute of Public Health and Envrionmental Protection, the Netherlands
RUSOTER	SOTER Project, Russia
SAC	Scientific Advisory Council of ISRIC
SC-DLO	The Winand Staring Centre for Integrated Land, Soil and Water Research, the Netherlands
SLEMSA	Soil Loss Estimation Model for Southern Africa
SMSS	Soil Management Support Services
SOBIN	Soil Bibliography of Indonesia
SOILIMS	Soil Laboratory Information and Management System, ISRIC
SOTER	World Soils and Terrain Digital Database, ISSS
SOVEUR	Soil and Terrain Vulnerability Mapping Europe, ISRIC
SPALNA	Soil and Plant Analtyical Laboratories Network of Africa
SSP	Soil Survey of Pakistan
SSSA	Soil Science Society of America, U.S.A.
STEP	EC project on Weathering Processes and Rates in Relation to Acidification and Vulnerability of Forest Ecosystem in northern Europe
STRING	Soil and Terrain Resources Information Network Generation, ISRIC
SWASOTER	SOTER project, South-West Asia
SWEAP	SOTER Water Erosion Assessment Programme
TNAU	Tamil Nadu Agricultural University, India
UAS	University of Agricultural Sciences, India
UI	University of Ibadan, Nigeria
UNAP	Universidad Nacional de la Amazonia Peruviana
UNCED	United Nations Conference on Environment and Development, Rio de Janeiro
UNEP	United Nations Environment Programme
UNESCO	United Nations Education, Scientific and Cultural Organisation
UNSA	Universidad Nacional San Agustin, Peru
UNSO	United Nations Sudano-Sahelian Office, U.S.A.
USDA	United States Department of Agriculture
USLE	Universal Soil Loss Equation
USREC	University Soil Reference Collection, India
VROM	Ministry of Housing, Physical Planning and the Environment, the Netherlands
WASOTER	SOTER project, West Africa
WAU	Wageningen Agricultural University
WG/MV	ISSS Working Group on Soil and Moisture Variability in Time and Space
WISE	World Inventory of Soil Emission potentials
WOCAT	World Overview of Conservation Activities and Technologies, Switzerland
WOFOST	World Food Study model
WRB	World Reference Base for soil classification
WRI	World Resources Institute, U.S.A.