SK

ANNUAL REPORT 1990

ISRIC was born out of an initiative of the International Society of Soil Science and was adopted by Unesco as one of its activities in the field of earth sciences. I was formally founded on 1st January 1966 by the Government of The Netherlands upon assignment by the General Conference of Unesco in 1964.

Most of the working funds are provided by the Dutch Ministry of Education anc Sciences, and are accountable to the Directorate-General for Internationa Cooperation (DGIS) of the Ministry of Foreign Affairs.

The constituent members of the Board of ISRIC are the International Institut for Aerospace Survey and Earth Sciences (ITC) in Enschede, the Wageninge Agricultural University (WAU) and the Government Service for Agricultura Research (DLO).

Advice on the programmes and activities of ISRIC is given by a Unesco-FAC appointed International Advisory Panel (IAP) and by a Netherlands Advisory Counci (NAC).

The financial-administrative responsibility for the working funds and for th ISRIC's personnel rest with the Board of ITC.

CIP-GEGEVENS KONINKLIJKE BIBLIOTHEEK, DEN HAAG

Annual

Annual Report/International Soil Reference and Information
Centre.-1979-...-Wageningen:
International Soil Reference and Information Centre
Verschijnt jaarlijks.
Report 1990 - Ill.
ISBN 90-6672-047-6
SISO 563 UDC [061.2:55](060.555)

ANNUAL REPORT 1990

ISRIC

International Soil Reference and Information Centre
Wageningen - The Netherlands

CONTENTS

1 THE ORGANISATION AND ITS DEVELOPMENTS

1.1 ORGANISATION

The organisational structure outlined in previous Annual Reports was revised towards the end of the year. At present ISRIC has three sections:

SECTION ON EDUCATION AND INFORMATION

The section deals with assembling the reference collection of soil profiles and their impregnation; the exhibition of soil monoliths and relevant information; educational matters and visitors servicing; computer systems and ISRIC Soil Information System (ISIS); library and map documentation; and graphical design and photography.

SECTION ON RESEARCH AND LABORATORY

Many of the activities of ISRIC have research aspects in one way or the other. This Section coordinates the main lines of research. In particular procedures and methods connected with the production and collection of soil data in the widest sense receive attention. This includes such diverse topics as impregnation and conservation techniques of soil monoliths, photographic techniques, procedures for soil analysis, and database management.

The laboratory carries out the physical, chemical and mineralogical analyses of the soil profiles belonging to ISRIC's collection. It is involved in advisory work and training of laboratory personnel in developing countries. Connected to this is the development of procedures and guidelines for the improvement of the performance of laboratories in developing countries. This includes procedures for Good Laboratory Practice (GLP), Quality Control as well as the development of Laboratory Information Management Systems (LIMS).

SECTION ON PROGRAMMES AND PROJECTS

This section deals with programmes – long-term activities, for which however only fixed-term extra funds have been secured – and with projects – fixed-term activities at ISRIC or abroad in the consultancy sphere.

PROGRAMMES

Laboratory Methods and Data Exchange (LABEX)

The LABEX programme was initiated by ISRIC on recommendation of the Second International Soil Classification Workshop in 1978. The main aims were to cross-check, correlate and standardise analytical methods for soil characterisation to facilitate and improve international soil classification and correlation studies. Experience gained during this project indicated the necessity of a shift in the activities to efforts to improve the performance of soil laboratories in general, leaving part of the original aims, cross-checking and standardisation of methods, to others. At present, the main objective is to upgrade laboratories in developing countries by training and implementing the system of Good Laboratory Practice (GLP), which includes better internal organisation and quality control of data. For details see Section 3.3 on LABEX.

National Soil Reference Collections (NASREC)

This programme encompasses support for the building up of a number of national soil reference collections annex database in selected countries in Africa, Asia and Latin America. Phase II of NASREC was approved and will continue to end 1992. For detailed information see Section 3.3 on NASREC.

Global Assessment of Soil Degradation (GLASOD) and World Soils and Terrain Digital Database (SOTER)

This is a programme to support the establishment of a geographic information system on the soils of the world at scale 1:1 million, an ISSS initiative that is a sequel to the FAO-Unesco Soil Map of the World project of the sixties.

The United Nations Environment Programme (UNEP) in Nairobi awarded a major contract for the preparation of a world map on the assessment of soil degradation (GLASOD project) to be accompanied by quantification of status and hazards of the various forms of soil and land degradation in at least one pilot area – the latter based on the ISSS-initiated methodology for the establishment of a World Soils and Terrain Digital Database (SOTER). In 1990 the GLASOD map was published at a scale of 1:15 Million, with an explanatory note. For further information see Section 3.3 on GLASOD/SOTER.

PROJECTS and CONSULTING

This embraces not only missions of ISRIC staff members, but also the employment of extra personnel at ISRIC to carry out specific projects. For details see Section 3.3

A prominent project in 1988/89 was the 'Soils and the Greenhouse Effect' activity (ISEC); the proceedings of the conference under this name were published by Wiley & Sons in 1990.

As a follow-up of earlier consultations, a mission was made to the Amazon region in Brazil for project formulation (BAMEZ).

Another activity is the preparation of an Annotated bibliography of pre-independence literature of soils in Indonesia (SOBIN).

1.2 INSTITUTIONAL DEVELOPMENTS

During 1990 much attention was given to a continued cooperation with many institutions, mainly in the developing world, on the establishment of National Soil Reference Collections annex Database (NASREC), the Laboratory Methods and Data Exchange Programme (LABEX), and especially, on the preparation of a World Map on the Status of Human-induced Soil Degradation (GLASOD) which was published at the end of the year. Requests for the development of a Soils and Terrain Digital Database (SOTER) came from many countries in Africa, South and Central America, and from Central Europe. Also, various activities about soil classification systems took place, as well as on soil and site description.

In the course of years the LABEX and NASREC projects have moved from a development stage into regular programmes, and the same is about to take place with the SOTER project activities. In fact, time has come to strengthen the links between these programmes, both in-house and as outreach packages for individual countries, mainly in the developing world.

Work on soil classification and related activities will be reduced to a lower level in the forthcoming years. It will mainly concern up-to-date documentation on newly emerging national classification systems, and comparing new suggestions with the ISIS pedon database on their global relevance and on the third level of the FAO-Unesco Soil Map of the World revised legend.

ISRIC's attention over the years to the building up of a reference collection and the preparation of an interdisciplinary manual on description and analysis of whole "laterite" profiles (CORLAT) had to be done without additional funding. The EEC decided to give some funds for a part of this activity, to be carried out in 1991.

Servicing of the International Society of Soil Science will continue, but on a more limited scale than before now that the office of its Secretary-General has moved to Vienna and only that of the Deputy Secretary-General will be housed at ISRIC. The functioning of ISRIC as "resource centre" centre on national and international activities in the field of soil sciences and related natural resources will be maintained. In this connection the liaison, through the director, with ICSU's IGBP ("global change") programme, and its Standing Committee on Data and Information Systems should be mentioned, as well as Unesco's Man and the Biosphere (MAB) programme and the IUBS/Unesco Tropical Soil Biology and Fertility (TSBF) programme. Since a decade ISRIC has provided support to some associate soil scientists/ecologists at Unesco's regional offices in Africa, Asia and Latin America. With the probable increase of the number, the matter of financial implications needs to be addressed, since up to now this work has been done without compensation.

Another important project is "Mapping of Soil and Terrain Vulnerability to Specified Groups of Chemical Compounds in Europe at an average scale of 1:5 M (SOVEUR), on which partial financing has already been agreed to by VROM-CTB. An international workshop to discuss the feasibility of this activity will be held at ISRIC in March 1991.

Updating of existing smaller-scale soil maps and improved accessibility of the existing map materials at national and regional level is an important element for the successful implementation for the above projects. Hence, it is hoped that another project proposal, viz. "Establishment of a Database of Soil and Related Maps, with emphasis on those from developing countries" (IMADOC) will receive favourable response from possible funding agencies. A computer-aided easy access to the substantial map collection of the Centre, through the application of the system "Central Catalogue on Cartographic Materials" (CCK system of the Dutch Royal Library) will also be necessary to live up to the international expectations on the availability of soil information. In part, these expectations are a consequence of ISRIC's recent admittance as a member of ICSU's World Data Centre's System in the field of soil geography and soil classification (the only one in the world thus far).

Cooperation with the relevant Technical Divisions of UNEP, FAO and Unesco was continued at the same pace, while strengthening of the contacts with several CGIAR research centres will be sought in the near future. In particular, attention will be paid to cooperation in complementary subjects with the International Board of Soil Research and Management (IBSRAM) and with the EEC Centre for Technical Cooperation with Lomé Convention countries (CTA).

Participation in international workshops/seminars/conferences in the broad field of soil sciences and its applications continued to be a regular feature of the Centre's scientific staff's activities, because of its strengthening effect on ISRIC's programmes and projects.

The time of staff members spent on projects sometimes interferes with such basic activities as feeding ISRIC's Soil Information System (ISIS) with site data, soil information, analytical results; the description of thin sections; preparation of publications; and the impregnation of soil profiles and work for the exposition.

The re-direction of work was but one of the reasons for the Board of ISRIC to embark on an Internal Review, to be followed by an External Review in 1991. The Internal Review was made in cooperation with some members of the Netherlands Advisory Council.

Little progress was made on formalising the organisational structure of the Centre in relation to other entities (ITC, LU, DLO, Dutch Ministries; Unesco, FAO, UNEP, IBSRAM). The Statutes and Management Contract remained in the draft status in which they have been for several years.

The increase in documentation materials (monoliths, samples, books, survey reports, maps) and in project activities has made working space in the Centre's building extremely cramped. After lengthy negotiations agreement was reached with the Wageningen Agricultural University on the interior restructuring and refurbishing of an old University building annexed to the present ISRIC building.

Reconstruction work of this annex will be completed in May 1991. It will yield about 300 m^2 of net working space to be hired by ISRIC for at least 10 years. Costs are borne by a one-time grant of DGIS, the Agricultural University, and ISRIC.

The ground floor will be used for storage and preparation of soil monoliths and instruction (bi-annual training course). The top floor is an office mainly for project activities such as SOTER. The freed space in the main building will then be used for documentation (library, map collection, etc.), for additional staff and guest researcher's offices, and a meeting room.

ISRIC's staff. Standing from left: Wouter Bomer, Ad van Oostrum, Hans van Baren, Sjef Kauffman, Dik Creutzberg, Jan Huting, Piet van Reeuwijk, Wim Sombroek, Mateen Ahmad, Rob Smaal, Rob Bleijert, Niels Batjes, Maurits van den Berg, Rudolf Stork, and Vincent van Engelen. Sitting: Iraj Manuchehri, Roel Oldeman, Jan Brussen, Yolanda Karpes-Liem, Albert Bos, Marie-Bé Clabaut, John Pulles, and Joke Jonker-Verbiesen (photo: Rein Heij, Wageningen)

2 ARTICLE

AMAZON LANDFORMS AND SOILS IN RELATION TO BIOLOGICAL DIVERSITY[1]

Wim Sombroek

ABSTRACT

Thirteen main landform units are distinguished for the whole of the forested Amazon region, each with its specific soil pattern and vegetational structure. These landform-soil-vegetation units are delineated on a small-scale map and illustrated by a schematic cross-section.

Floristic species diversity is highest in the steepland-and-valley complexes of the Andean fringe, on the crystalline shield uplands, on the inselberg complexes, and on the eutric variant of the western sedimentary plains.
Endemism is highest on the sandy plains, and parts of the table lands and inselberg complexes.

Speciation, linked to the concept of forest refuge areas, is likely to be highest on the sandstone table lands, on the stretches of Amazon planalto, and in the areas of relic valleys, in view of the long-term geomorphological stability of these units.

1. INTRODUCTION

An international workshop to define priority areas for conservation in Amazonia on the basis of a biogeography map of the region was held in Manaus, Brazil, in January 1990. It recognised the need to augment the aggregated information on flora and fauna with geographically-oriented studies on the Amazon climates, geomorphology/landforms, soils, hydrology/limnology, and human population patterns. The reasons were threefold:

- The characteristics and history of the physical and human resources may explain some of the observed spatial differences in the various aspects of floral and faunal species diversity;
- The geography of these resources may help in establishing boundaries of biogeographic units in areas where the number of observations on flora and fauna is scarce or skewed;

[1]Text and maplets prepared after an international workshop to determine priority areas for conservation in Amazonia (January 10-20, 1990, Manaus, Brazil); to be included in a publication, with a conservation priority map at 1:5,000,000 scale for the whole nine-country region, by Conservation International, New York and INPA, Manaus.

- The ecological fragility of the physical resources themselves may constitute a reason on its own to include certain areas in the map on priority areas for conservation.

The present text deals with the aspects of landforms and soils. It is accompanied by a sketch map on landforms (Fig. 1), schematic cross section of the region showing the relationships between landforms, vegetation and soils (Fig. 2), as well as a drawing of the main soil profiles involved (Fig. 3).

Knowledge on landforms, soil conditions and their biota of the Amazon region has long remained rudimentary (Sombroek, 1966; Ab'Saber, 1967) because of difficult access of this largest area of tropical forest in the world. In recent years, however, this has changed considerably. This not only because of the construction of a network of roads, but especially through the availability of airborne radar images as produced by government entities of Brazil, Venezuela, Colombia, and Peru. For instance, the results of multidisciplinary surveys on the basis of radar photography are contained in a series of volumes, with 1:1.000.000 scale maps, of Radambrasil (1972-1981) and for Colombia on 1:500.000 scale maps by Proradam (1979).

On the basis of such new information, a schematic synthesis of the landforms is presented, with postulations on their origin and degree of stability during the Cenozoic era.

With each main landform a non-technical description of the predominant soils is given. Only the FAO/Unesco terminology for soil classification (FAO, 1974; 1988) is used. For the naming in other systems such as the US "Soil Taxonomy" and the Brazilian scheme see the review of Sombroek (1984). The latter gives also more details on the physico-chemical characteristics and properties of the soils, with an assessment of the agricultural potential of the soils and references to the pertinent soil literature.

The landform and soil descriptions are accompanied by an indication of the structure of the present-day vegetative cover. For soil-vegetation relationships see also Brown (1987) for the Brazilian part, and Huber (1982) for the Venezuelan part of the region.

Floristic species occurrence in relation to soil and landform conditions is discussed in the second part of the paper.

2. LANDFORMS, SOILS AND VEGETATIVE COVER

2.1 Mountainous Lands

2.1.1 Flat to gently undulating high-level (> 500 m alt.) table lands, mainly formed by weathering-resistant arkosic sandstones (Proterozoic Roraima formation and others), are concentrated in the water divide regions of the main tributaries of the

Amazon. Examples of these **sandstone Table lands** (symbol T of the maplet) are the "tepuis" of Venezuela, the "chapadões" of Brazil and the "mesas" of the Colombian part. It is assumed that these table lands are geomorphologically stable since Cretaceous times, if not earlier, although the process of upheaval may have lasted until the Pleistocene (Kubitzki, 1989).

The soils of these sandstone table lands are predominantly shallow, sandy and podzolised (albic Arenosols; Podzols; Lithosols). They support at present a savanna or low-forest vegetation ("campina rupestre"). The scarps have often stony soils, with more vegetative cover than the flat tops.

2.1.2 Steeplands occur on weathering-resistant parts of the crystalline shields. These are the **Inselberg complexes** (I) of the frontier zone Guyana-Brazil-Venezuela-Colombia, the mountainous lands of the Brazilian shield, and associated colluvia and alluvia. Reshaping of the land has likely taken place all through the Pleistocene.

The inselberg complexes have a catenary sequence in soil conditions. Bare rock outcrops and very shallow soils (Lithosols) of the inselbergs themselves and other mountainous parts alternate with deep, often sandy soils (albic and ferralic Arenosols) on the colluvia at the feet of the inselbergs, and yellowish to reddish loamy soils on the bands of well-drained uplands and alluvia in-between (xanthic Ferralsols and Acrisols). The inselbergs have a shrubby vegetation, the footslopes a mosaic of forest and savanna, while the uplands and alluvia support high forest.

2.1.3 Steeplands, interhill valleys and colluvial fans are found in the Andean fringe, on a variety of geologic materials: the **Selva alta areas** (S) of Colombia, Ecuador, Peru and Bolivia, with dissection still active.

These steepland-and-valley complexes have an extremely strong variation in soil conditions, as a consequence of the prevalent short-distance variation in lithology, slope position and meso-climatic conditions (the area around Tarapoto in Peru has even a subhumid climate, with a long dry season). A schematic subdivision is as follows: Rock outcrops or shallow and stony soils (Lithosols; shallow phases of Cambisols) are found on steep upper slopes; they often carry low forest only. Well-drained, deep, reddish, loamy to clayey and in part stony soils with variable ion exchange capacity, base saturation, and mineral reserve (Ferralsols, Acrisols, Luvisols, Nitisols) are found on the middle slopes, and they support high forest. Bands of Pleistocene terrace lands may have a strong internal differentiation in texture and acidity ("duplex" soils, or Planosols), on which a shrubby vegetation prevails. Low upland and bottomland parts can have base-rich cracking clay soils (Vertisols) with a scrub vegetation, while floodplain stretches have base-rich silty soils (Fluvisols) with high forest.

2.2 Uplands

2.2.1 Rolling to hilly dissected lands and rounded hills with convex slopes are found on the crystalline basement rocks where weathering resistance is smaller than in the inselberg areas, as well as on adjacent outcropping Paleozoic-Mesozoic sedimentary rocks. They occupy the main part of the Guiana and Brazilian shield areas and can be denominated as **crystalline shield Uplands** (Uc). Dissection has presumably been active as recent as in the Late Pleistocene. In places the terrain may be only gently undulating, constituting remnants of early planation surfaces (Sul-americana and Velhas levels of King, 1957).

The shield uplands have often a short-distance variation in soil conditions. Areas with steep slopes or resistant rocks have rather shallow soils, with a substantial content of weatherable minerals (Cambisols). Most of the soils are however deep to rather deep, well-drained, reddish, loamy to clayey and acid. Part of them have a textural differentiation with relatively compact subsoils, a reserve of weatherable minerals and varying clay-mineral activity (ferric or orthic Acrisols); these soils often sustain an open-canopy forest with a dense undergrowth. Other soils are more homogeneous in their vertical build-up, with little or no weatherable mineral reserve and an inactive clay mineralogy (orthic and rhodic Ferralsols); these carry predominantly closed-canopy high forest.

Areas with a substratum of dioritic crystalline rocks, basalts, or ferro-magnesian rich Paleozoic-Mesozoic sedimentary rocks have dusky red, deep and clayey soils of good structure, with a high percentage of active clay-sized ironoxides (Nitisols). These so-called "terra roxa estruturada" soils of the Brazilian soil classification system occur along parts of the Transamazon highway; in the upper Xingu area, and in places in Rondonia (Camargo, 1981). They support a luxuriant forest cover, but are also much sought after for permanent settlement (cocoa growing!) because of their favourable physical and chemical properties.

2.2.2 Flat, intermediate-level plateaus (100-300 m alt.) occur in the eastern part of the sedimentary basin, with a cover of kaolinitic sedimentary clay. This is the **Amazon planalto** (A) with the so-called Belterra clay, probably of lacustrine or inland-sea origin. These plateau lands, often with steep scarps, prevail between the lower reaches of the Tapajós and Xingú rivers (see maplet in Klammer, 1984), as well as in the upper reaches of the Gurupú catchment (Sombroek, 1966, p. 18-26 and appendices 1, 4 and 5). The plateau remnants have not been dissected in the Pleistocene epoch.

The Amazon planalto has a monotonous cover of very deep, very clayey, acid, yellowish soils of very low physico-chemical activity and no mineral reserve (xanthic to acric Ferralsols). Most of them are porous and friable to great depth and then support high, closed-canopy forest. Central parts of planalto stretches, far away from the scarps, can have compact subsoils; in these cases the vegetative cover is a liana-rich open-canopy forest, or even pure liana forest or "cipoal" (Sombroek, 1966,

p. 194-196). The latter vegetation type predominates on the left bank of the lower Xingú and may be the enduring result of past Amer-indian occupation (Balée and Campbell, 1989).

2.2.3 Gently undulating, relatively high lying land with concave slopes can be found on either crystalline basement or Cretaceous-Tertiary deposits. These can be denominated **relic Valleys (V)** and prevail in the southern fringe of the region (headwaters of the Xingu and the Tapajós rivers in northern Mato Grosso, 400-500 m. alt.). They can also be observed locally in the central basin, for instance in the upper reaches of the Curuá-una river southeast of Santarém (Klammer, 1984, p. 64-65), the upper reaches of the Capim river south of Belém, and in some sections of the sedimentary area between Manaus and Itacoatiara. In the latter cases it apparently often concerns an Early Pleistocene remodelling of Belterra clay by erosion and short-distance redeposition, without any dissection in later parts of the Pleistocene.

The areas of the relic valleys with their gentle concave slopes have predominantly very deep, sandy loam to clayey and sometimes concretionary, acid, yellowish to reddish soils of low to very low physico-chemical activity (xanthic or orthic Ferralsols and ferralic Arenosols). They support high forest of large timber volume unless climatic conditions are marginal such as in the uppermost reaches of the Xingú and Tapajós catchments.

The savanna areas around Boa Vista (Roraima State of Brazil) may constitute a variant (Vr) of these relic valleys. In the past the area was apparently in direct hydrographic contact with the Atlantic Ocean through the present-day Essequibo river valley of Guyana, which forms part of the Takuto basin, an intra-continental NE-SW running rift valley structure dating from the Jurassic (McConnell et al., 1969). During the Sicilian or Milazzian glacio-eustatic high sealevel of the Early Pleistocene (Zeuner, 1959) the Boa Vista area may have been a small inland sea or bay of this rift valley, during which time the sediments of the Boa Vista Formation were deposited.

The Boa Vista relic valleys have predominantly a savanna cover because the soils have a strong textural differentiation (sandy topsoils over compact, clayey subsoils) and/or occurrence of massive ironstone layers (Arenosols, Planosols, Plinthosols, ironstone Lithosols). Also because of locally high Mg/Ca ratios in the deeper subsoil and the presence of "whale-wallow" or "olho-de-agua" type of terrain depressions (cf. Carneiro Filho, 1991), it is hypothesized that this divergent soil development is due to a brackish-water lagoonal depositional character of the parent materials (cf. Sombroek et al., 1970, for similar features in the Lagoa Merim area of southern Brazil).

2.2.4 An alternation of flat and undulating land, the latter often with convex slopes, is found in the Pleistocene glacio-eustatic terrace levels in the eastern part of the Amazon basin. These stepped depositional plains, or **eastern sedimentary Uplands (Uf)**, occur on fluviatile sediments derived from crystalline shield material that was pre-weathered during the Cretaceous and Tertiary. Dissection has taken place throughout the Pleistocene due to pluvial-interpluvial climatic alternations and base-level oscillations, as demonstrated by Klammer (1984).

The eastern sedimentary uplands have well-drained, very deep, acid, yellowish soils with textures that vary laterally from loamy sand to light clay with low percentages of silt, but that are vertically homogeneous. The soils have no weatherable mineral reserve and are physico-chemically very inactive, especially on the flat parts of the upper terraces (Sombroek, 1966, p. 167-171) but they are porous and friable throughout (xanthic Ferralsols; some ferralic Arenosols). They support a closed-canopy high forest of large to fair timber volume. In part, the soils contain ironstone concretionary layers, but this has normally no detrimental effect on the forest structure. Very sandy patches on the higher uplands may have a white-sand soil profile, but then without any water-stagnating subsoil layer ("Ortstein", see below). Such patches of albic Arenosols or "Giant Podzols" also support closed-canopy forest, be it of low timber volume; at disturbance by present or past occupation there is however no forest regrowth.

2.2.5 Undulating to rolling land, often with convex slopes occupies the western part of the basin, on sediments derived from the Andean cordillera by fluviatile and sometimes volcano-aeolean deposition. Also these **western sedimentary Uplands (Ua)** have undergone dissection throughout the Pleistocene.

The soil conditions contrast distinctly with those of eastern sedimentary uplands described above, because the sediments concerned were less pre-weathered at the time of their deposition. The soils are also predominantly deep, well drained, yellowish red and acid, but they have a different clay mineral assemblage that results in higher ion-exchange capacities. The over-all textures vary, but the silt content is relatively high, and there is some reserve of weatherable minerals. Many of these soils show a substantial textural differentiation and the deeper subsoils may show reddish mottling ("pseudo-plinthite", i.e. not hardening upon exposure). These ferric or haplic Acrisols and Alisols (FAO, 1988) have a forest cover, often with a rather open canopy.

In the southwestern part, viz. Acre state of Brazil and the adjoining part of Peru (tentative unit **Ue** on the map), soils with high base status occur, due to the presence of richer sedimentary deposits and in places also volcanic ash admixtures (Möller and Kitagawa, 1982, and recent Japanese research); the soils are either deep (ferric Lixisols) or shallow (eutric Cambisols). The forest structure is determined by the occurrence of bamboo (*Bambusa superba*), either scattered or in dense stands

(Cardoso da Silva et al., 1990); the dense stands may be the result of erstwhile Amer-indian burning practises.

Some of the soils of the northwestern sedimentary uplands, notably in the Ecuadorian part (also unit Ue), show little or no textural differentiation. They may have a high base saturation (eutric Cambisols, eutric Nitisols) or be acid (ferralic Cambisols); in both cases high and closed-canopy forest prevails.

2.3 Plains

2.3.1 Flat to gently undulating, relatively low-lying lands with a sandy surface over basement rocks are prevalent in the Rio Negro and middle Rio Branco areas. It is speculated that these denudational **sandy Plains (Pa)** were formed in the Late Pleistocene, after capture of some of the former tributaries of the Orinoco and Essequibo rivers by the Amazon river system. This capture would have resulted in a sudden huge increase in river discharge of the Amazon tributaries, causing a selective removal of the clayey components of Early Pleistocene or Tertiary-Cretaceous sediments that may have covered the areas originally. Sandy plains also occur in a band between the crystalline uplands and the coastal floodplains of the Guyanas, notably near the mouth of the Essequibo river.

The sandy plains of the Rio Negro and middle Rio Branco areas and of the Guyanas have year-round imperfectly drained soils. They are characterized by a subsurface horizon that consists of light grey to white sand or loamy sand of single-grain structure. This is underlain by a subsoil, at strongly varying depth, that is homogeneously or banded dark brown to black, with a texture that is only little heavier than the overlying layer but with a firm consistence or even cementation, causing low water permeability and poor root penetrability. This hardpan, or "Ortstein", may be continuous or show a very irregular lateral pattern to the extent that in places it may be completely absent. The soil is very acid throughout and has no reserve of weatherable minerals whatsoever (gleyic Podzols, or albic Arenosols if the white layer is thicker than 200 cm). The natural vegetation on such soils is either a savanna with common bare sand patches ("campina" or "bana") or a closed-canopy low forest often with a scleromorphic physiognomy (Amazon "caatinga"). Clearing of this vegetation would result in permanent exposure of the white sandy soil, which is the reason why the areas with these fragile soil conditions have been delineated separately on the 1:5 M conservation priority map of Conservation International.

2.3.2 Flat to gently undulating, relatively low-lying lands with loamy sediments are prevalent in the lower Juruá-Purús-Madeira river areas southwest of Manaus. These are apparently plains with Late Pleistocene or Early Holocene sediments, deposited by the rivers originating in the southern part of the Andean Cordillera. The surfaces of these **loamy Plains (Pp)** still show relic features of meandering rivers, as demonstrated by Klammer (1984) and Irion (1976 et seq.) The surface deposits in the lower Juruá-Madeira area may date from the postulated Late Pleistocene or Early Holocene disengorgement of an antecedent of Lake Titicaca in the Altiplano area of Bolivia and Peru, which would have resulted in a huge temporary interior lake (Campbell et al., 1985; Frailey et al., 1988).

Late Pleistocene loamy plains are also found in the Beni area of northeastern Bolivia, in the lower Gurupí-Maracassumé area of northern Maranhão, on the west bank of the lower Tocantins river and the erstwhile continuation thereof on the southeastern fringe of Marajó island (Camargo, 1981).

The loamy plains have seasonally imperfectly drained soils of low structural stability. A relatively light textured topsoil overlies a loamy to clayey subsoil that has a compact consistence with prominent, coarse and abundant red mottles in a light grey matrix. The centres of these mottles are usually hardened, and at the transition zone between topsoil and subsoil a thin layer of discrete iron-manganese concretions may occur. The mottles, called "plinthite" in modern soil science, become irreversibly hardened to slag-like material upon exposure to the open air for several seasons and are then known as petroplinthite, laterite concretions, or "ironstone". The base saturation in the soil is low throughout, and the physico-chemical activity of the clay minerals is low to very low. These soils are the "groundwater laterites" of early pedological literature, now denominated plinthic Acrisols (FAO, 1974) or Plinthosols (FAO, 1988). Their vegetation consists either of a poor type of forest, often with a predominance of palms, or of a shrubby or open grass savanna ("campo"). Clearing of this vegetation would result in irreversible hardening of some of the plinthitic subsoil, which may be aggravated upon erosion of the unstable topsoil. For this reason the area with plinthitic loamy plains have also been delineated on the 1:5 M conservation priority map.

2.4 Lowlands

2.4.1 Flat lands and inland waters alongside the major rivers constitute Holocene floodplain generations. Details of these **Floodplain complexes** (F) are given by Sutmöller et al. (1966) and Klammer (1984, p. 68).

The floodplains along the major rivers have a strong short-distance variation in soil conditions. Although a broad grouping as "alluvial soils" can be made because the sedimentary stratification still overrides any pedogenetic profile development, the soils vary much in texture, internal drainage conditions, organic matter content, acidity, and clay mineralogy - depending on the local flooding conditions, the source of the sediments and the time elapsed since their deposition or re-deposition (Fluvisols, Gleysols, gleyic Acrisols, Vertisols, Histosols).

In general, the floodplains with sediments from the Andean cordillera ("varzeas" or "barriales" of "agua branca" rivers) are base-rich and have a clay mineralogy of high physico-chemical activity. They support a luxuriant forest cover, often with many palm species, or rich natural grasslands where the hydrological regime impedes tree growth.

The rivers originating in the crystalline shield areas or in the sedimentary basin itself carry little or no sediments and may contain high percentages of humic acids ("varzeas" and "igapos" of "agua azul" or "agua preta" rivers). The resulting soils are predominantly acid, with clay minerals of lower activity, and the forest cover is less luxuriant.

2.4.2 In the western part of the Amazon region extensive **Bottomland complexes (Fb)** occur. The largest area is the Pastaza-Marañon basin of Peru-Ecuador, which is in fact a huge late Pleistocene-Holocene aggrading alluvial fan of approximately 60.000 km^2 (Räsänen, 1991). The soils of these bottomlands are predominantly poorly drained and in part peaty (Histosols; humic and eutric Gleysols) and the vegetation is forest with a high frequency of palms.

2.4.3 Along the Atlantic coast and on Marajó island in the mouth of the river system **coastal Lowlands (Fc)** occur. Their soils are, or have been, subject to the influence of brackish or salt water (Solonchak, thionic Fluvisols, Gleysols). The natural vegetation is mangrove forest or grassland, the latter on the central and northern parts of Marajó island.

3. SPECIES DIVERSITY, ENDEMISM AND REFUGIA

3.1 Definitions

The foregoing descriptions and tentative dating of major landforms-soils-vegetation structures, as spatial combination of habitats, allow for a discussion of the geographical aspects of the Amazon biological diversity in general, and the species diversity in particular, with some notes on species endemism and speciation.

Biological diversity, defined as the variety and variability among living organisms and the ecological complexes in which they occur, has three levels: ecosystem diversity, species diversity and genetic diversity (McNeeley et at., 1990). The **ecosystem diversity**, reflected in the variety of habitats, biotic communities and ecological processes, has been implicitly described in the preceding chapter. The term **species diversity** refers to the variety of living organisms, while the **genetic diversity** refers to the sum total of the genetic information contained in the genes of individual plants, animals, and microorganisms.

Species diversity (or heterogeneity) combines species richness with species evenness (Magurran, 1988). Species richness is the number of different species in an area expressed per size unit of land (f.i. per km^2), and species evenness is the degree of equal abundance of the different species within this unit of land; thus, the more species and the more equally abundant they are, the greater the species diversity.

The measurement of species diversity is habitat-related (habitat being defined as the type of site where a plant or animal naturally and normally lives and grows). Whittaker (1977) distinguishes **alpha**-diversity (the within-homogeneous-habitat diversity); **beta**-diversity (the between-habitat diversity, or the degree of difference between two contrasting habitats in their species composition as measured along an ecological gradient); **gamma**-diversity (the diversity of a large geographic unit such as an island or a major landscape, i.e. the over-all diversity of a group of alpha diversities; in other words, the richness in species of a range of habitats in the geographic unit, as the consequence of the alpha diversity of the habitats together with the extent of the beta diversity between them); and **epsilon** diversity (the total diversity of a group of areas, as applying to large biogeographic regions or "biomes").

When taking the description of the major landform-soil units, i.e. landscapes or "land systems" within the Amazon region as framework, it should be evident that species diversity in the following discussion is essentially of the gamma type.

Related to beta diversity is the concept of **endemism**: a species occurs only in a certain area and nowhere else, thus it has an ecological niche specificity; it is native, restricted or peculiar to a locality or region (McNeely et al., 1990).

Genetic diversity includes both **intra-specific variation** (i.e. a large variation in observable character among individuals belonging to the same species, or "germ-plasm" variation) and **speciation** (i.e. the formation of a new species). According to Krebs (1984) such speciation can be **allopatric** (having disjunct or mutually exclusive areas of geographic distribution), **parapatric** (occupation of a new habitat which is adjoining the original area of geographic distribution), or **sympatric** (having the same or overlapping areas of geographic distribution). Allopatric genetic diversity in particular is supposed to be stimulated by a long-time presence of a biomes in the same geographic area, with only minor changes in the environment (stability of climatic and landform-soil conditions). It is therefore linked to the concept of forest **refugia**: small and disjunct areas where forest coverage was present throughout the Late Tertiary and the Pleistocene (Whitmore and Prance, 1987).

The following short discussions on species diversity, endemism and speciation refer only to the plants, and trees in particular, but it may be evident that faunal and micro-organism communities are closely related.

3.2 Species diversity

Species diversity (of the gamma type as defined above) is bound to be highest in areas with a short-distance strong variation in habitat, in other words where landscapes or landsystems are composed of land facets of strongly different topography, soil, hydrological and micro-climatic conditions. These situations can be found in areas where geomorphogenetic processes were active in several episodes of the Pleistocene, as the result of periodic changes in pluviosity, linked with glaciations in the higher latitudes and altitudes and concurrent lowering in base level of the hydrographic catchments. Especially where such geomorphologic activity resulted in exposure of fresh rocks of short-distance contrasting lithology and mineralogy, the new pedogenesis resulted in soils of different depth, drainage condition, nutrient content, clay mineral assemblage and trace elements occurrence – allowing for many floristic species to find their required habitat for growth, reproduction and seed dispersal.

From the descriptions of major landform-soil units in section 2, and the schematic cross section of figure 2 it may be obvious that such conditions can be found most pronouncedly in the steepland-and-valley complexes of the Selva alta area (unit S of the maplet) on the crystalline shield uplands with their convex slopes (Uc), on the Inselberg complexes (I) and on the eutric variant (Ue) of the western sedimentary plains. To a lesser degree it applies to the dystrophic eastern and western sedimentary uplands (Uf and Ua, respectively) because of the relatively monotonous nature of the parent materials.

A special case is formed by the floodplain complexes (F) of the "agua branca" rivers originating in the Andean Cordillera: the fluvial dynamics during the Late Pleistocene and the Holocene has caused rapid temporal and spatial vegetational successions due to changing sedimentological and hydrological habitats, as demonstrated by Salo and Räsänen (1988).

3.3 Species endemism

Endemism, or the restriction in occurrence of certain species to specific areas within the Amazon tropical forest biome, is likely to be linked to extreme climatic, hydrological or soil conditions where such species have a relative advantage in the competition with other species.

Some tree species find their niche in conditions of year-long excessive rainfall such as the upper Colombian part of the Amazon region; others apparently thrive in areas with a strong dry season, such as large parts of the southern and southeastern fringe. This applies for instance to the prized timber species Cedro (*Cedrela odorata*) and Mahogany (*Swietenia macrophilla*), the nut-producing Castanha-do-Pará (*Bertholetia excelsa*). Within this zoning a species may still require a specific edaphic habitat, as shown by a special study carried out by a FAO/Unesco forest inventory team in 1961 in the Lower Araguaia area. The species was found to be concentrated on – though not completely confined to – well-developed hydromorhic soils with a high physico-chemical activity ("hydromorphic grey podzolic soils", or gleyic Luvisols; Sombroek, 1966, p. 203-208 and maplets).

Extreme hydrological conditions are found in the various floodplains and bottomlands; their influence on species endemism is discussed in detail by Junk (1984) and others.

Amongst extreme soil conditions the white-sand soils of the sandy plains (Pa) and part of the table lands (T) and Inselberg complexes (I) stand out. The specific floristic species composition of the "campina" and "caatinga amazonica" vegetative cover is rather well documented. It has a low degree of species diversity but a high number of endemic species (Ducke and Black, 1953; Murça Pires, 1978; Anderson, 1981; Jordan, 1989).

The floristic composition of the various shallow soils of the table lands and Inselberg complexes is less well known, with the exception of those of the Venezuelan "tepuis" (Huber, 1982 et seq.).

The author is not aware of any endemism-oriented study of the species composition of the loamy plains (Pp) with their imperfectly drained Plinthosols or plinthic Acrisols. In the parts with savanna vegetation, such as the "campos" of Humaita-Lábrea, sclerophyllous and fire-resistent tree and shrub species are found that are also found in the cerrado areas of central Brazil (Ducke and Black, 1954); they would qualify as endemic only within the context of the Amazon forest region.

The forests in the areas with Nitisols on the shield uplands (minor parts of the Uc unit, not separately delineated on fig. 1) reportedly have an aberrant tree species composition, viz. more light-timber species (Ducke and Black, 1954). The nutrient-rich soils of the western sedimentary uplands with a surmised or established influence of volcanic ash (unit Ue) may also have several endemic species.

Even in the areas with a seemingly monotonous cover of well-drained acid yellowish soils (xanthic Ferralsols) of the eastern sedimentary uplands (Uf) and the Amazon planalto (A) there are phytogeographic differences. This applies for instance (Sombroek, 1966, p. 198-203) to the occurrence of the valuable tree species Angelim-pedra (*Hymenolobium excelsum*). It if found predominantly on non-compacted soils on the Belterra clay, either in its original position on the Amazon planalto or in remodelled form in the associated relic valley parts of lower level. Another sought-after timber species, the Pau-amarelo (*Euxilophora paraensis*) is found only on soils with a substratum of plinthitic or concretionary material of the Ipixuma type, which immediately overlies bauxitic material such as in the Paragominas area south of Belém; in both cases a specific micro-nutrient content of the substratum is surmised to be the determining factor.

3.4 Speciation and refugia

As discussed in 3.1, areas with large intra-specific variation and the evolution of new species, as forms of genetic diversity, are supposed to occur where past climatic, geomorphologic and soil conditions were not much different from those of today. it is rather commonly held that large parts of the presentday Amazon region where devoid of a forest coverage during several parts of the Late Tertiary and the Pleistocene, due to the occurrence of times of aridity, or interpluvials, which would have coincided with glacials in the higher latitudes and altitudes. Only in isolated parts forests would have been able to survive as refuge areas or refugia, and in such areas genetic diversity of the allopatric type would be highest. Maplets about those Amazon areas where humid tropical forest probably persisted during the last glacial (Winconsin/Würm) are given by Brown & Ab'Saber (1979) and Brown (1987).

The validity of the location of these refugia is much debated these days, in part because of the geographically imbalanced amount of groundtruth on the floristic and faunal species (Whitmore and Prance, 1987; Colinvaux, 1987). From the geomorphologic point-of-view however, sites of high genetic diversity are likely to be found on the sandstone table lands (T), on the Amazon planalto stretches (A) and in the areas of relic valleys (V). These are all stable landscapes, were soils development continued uninterruptedly since the Early Pleistocene, resulting in strongly weathered and often very deep soils. The rather extreme soil conditions of these geomorphic units, especially the table lands and the Amazon planalto (sandiness, subsoil compactness, very low clay mineral activity, strong acidity, lack of weatherable minerals) would however be a detrimental factor for the survival of a number of forest species *in-loco*, especially during times of droughty conditions in the region as a whole. It is hereby postulated that, at the advance of such times, the forest species gradually moved to the edges and scarps of the table lands and the Planalto stretches. The occurrence at these sites of less extreme soil conditions, the presence of seepage water, and the likelihood of more orographic rainfall at the windward sides of these scarps would allow for survival of the species, with a creeping back of the species to the flat tops at the return of pluvial conditions in the region-at-large. A case in point may be the relatively high and steep scarps (100-200 m) of the planalto stretches of the upper Gurupí catchment, on the boundary of Pará and Maranhão states of Brazil, which is one of the suggested refugia.

In the case of the relic valleys (V) at the southern fringe of the phyto-geographic Amazon region, the forest vegetation would have temporarily withdrawn to narrow fringes of gallery forest in the lower parts of the stable concave-slope landscape, where a steady supply of groundwater would recompense for a seasonal shortage of rainfall.

Detailed multidisciplinary studies are needed to establish geographic relationship between speciation, past climatic conditions, stability of landforms and uninterrupted soil development during successive geologic periods, before more definite conclusions can be drawn on the validity of the refugia concept and their precise location.

REFERENCES

Ab'Saber, A.N., 1967. Problemas geomorfológicos da Amazonia Brasileira. Atas do Simpósio sobre biota amazônica. Rio de Janeiro, Vol. I: 35-67.

Anderson, A., 1981. White-sand vegetation of Brazilian Amazonia. Biotropica 13(3):199-210.

Balée, W. and D.G. Campbell, 1989. Evidence for the successional status of liana forest (Xingu river basin, Amazonian Brazil). Biotropica (in press). See also: New York Botanical Garden's periodical "Garden" 11(6) of 1987.

Brown, K. and A. Ab'Saber, 1979. Ice-age forest refuges and evolution in the Neotropics. Instituto de Geografia, Universidade de São Paulo.

Brown, K., 1987. Soils and Vegetation. In: T.C. Whitmore and G.T. Prance. Biogeography and Quaternary History in Tropical America. Clarendon Press, Oxford, p. 20-44.

Camargo, M.N., 1981. Mapa de Solos do Brasil, escala 1:5.000.000. EMBRAPA-SNLCS, Rio de Janeiro.

Campbell, E., C.D. Frailey and J. Arellano, 1985. The Geology of the Rio Beni: further evidence for Holocene flooding in Amazonia. Contributions in Science 364, Natural History Museum of Los Angeles.

Cardoso da Silva, T., A. Pereira de Araujo, A. Luiz de Carvalho et al., 1990. Diagnóstico Geoambiental e Sócio-economico da Área de influência da BR-364, trecho Porto Velho/Rio Branco. PMACI-I report, IBGE, Rio de Janeiro.

Carneiro Filho, A., 1991. Contribution to the study of the forest-savanna mosaic in the area of Roraima, northern Amazon basin, Brazil. Unpublished M.Sc. thesis, ITC-Enschede, Holland.

Colinvaux, P., 1987. Amazon Diversity in Light of the Paleo-ecological Record. Quaternary Science Reviews 6:93-114.

Ducke, A. and G.A. Black, 1954. Phytogeographical notes on the Brazilian Amazon. Anais Acad. Bras. de Ciencias 25(1):1-46.

FAO, 1974. FAO-Unesco Soil Map of the World 1:5,000,000. Volume I, Legend. Unesco, Paris.

FAO, 1988. FAO-Unesco Soil Map of the World. Revised Legend. FAO World Soil Resources Report 60. Rome.

Frailey, C.D., E.L. Lavina, A. Rancy and J.P. de Souza Filho, 1988. A proposed Pleistocene/Holocene Lake in the Amazon Basin and its Significance to Amazonian Geology and Biogeography. Acta Amazonica 18(3-4):119-143.

Huber, O., 1982. Esboço de las Formaciones Vegetales del Territorio Federal Amazonas, Venezuela. MARNR Serie Informe Tecnico DGSIIA/IT/103, Caracas.

Irion, G., 1976. Quaternary sediments of the Upper Amazon Lowlands of Brazil. Biogeographica 7:163-167.

Jordan, C.F. (ed.), 1989. An Amazonian Rain Forest; the structure and function of a nutrient-stressed ecosystem and the impact of slash-and-burn agriculture. Man and the Biosphere Series 2, Unesco, Paris, pp. 176.

Junk, W.J., 1984. Ecology of the Várzea, floodplain of Amazonian white-water rivers. In: H. Sioli, 1984. The Amazon, limnology and landscape ecology of a mighty tropical river and its basin. Dr. W. Junk Publishers, Dordrecht/Boston/ Lancaster:215-243.

King, L.C., 1957. A geomorfologia do Brasil Oriental. Separata, Rev. Bras. de Geogr., Rio de Janeiro (2):147-265.

Klammer, G., 1984. The relief of the extra-Andean Amazon basin. In: H. Sioli, 1984. The Amazon; limnology and landscape ecology of a mighty tropical river and its basin. Dr. W. Junk Publishers, Dordrecht/Boston/Lancaster:47-83.

Krebs, Ch.J., 1984. Ecology; the experimental analysis of distribution and abundance. Harper and Row, New York.

Kubitzki, K., 1989. Amazonas-Tiefland und Guayana-Hochland; historische und ökologische Aspekte ihrer Florenentwicklung. Amazoniana XI(1):1-12.

Magurran, A.E., 1988. Ecological diversity and its measurement. Croom Helm Ltd., London.

McConnell, R.B., D. Masson-Smith, and J.P. Berrange, 1969. Geological and geophysical evidence of a rift valley in the Guiana shield. Geologie en Mijnbouw 48(2):189-199.

McNeely, J.A., K.R. Miller, W.V. Reid et al., 1990. Conserving the world's biological diversity. IUCN, Gland, Switzerland; WRI, Conservation International, WWF-US and Worldbank, Washington, D.C.

Möller, M.R.F. and Y. Kitagawa, 1982. Mineralogia de argilas em Cambissolos do Sudoeste da Amazonia brasileira. Boletim de Pesquisa 34, EMBRAPA-CPATU, Belém, Brazil.

Murça-Pires, J., 1978. The forest ecosystems of the Brazilian Amazon: description, functioning and research needs. In: Tropical Forest Ecosystems. Natural Resources Research 14, Unesco, Paris:607-627.

Proradam, 1979. La Amazonia Colombiana y sus Recursos. Proyecto Radargrametico del Amazonas, Bogotá, Vol. I-V.

Radambrasil 1972-1981. Levantamento de Recursos Naturais, Vol. 1-26. Ministério das Minas e Energia/IBGE, Rio de Janeiro.

Räsänen, M.E., 1991. History of the fluvial and alluvial landscapes of the western Amazon andean forelands. Annales Universitaties Turkuensis, Ser. A. 75. The Academic Bookstore, Helsinki.

Räsänen, M.E., J.S. Salo and R.J. Kalliola, 1987. Fluvial Perturbance in the Western Amazon River Basin: regulation by long-term sub-Andean tectonics. Science 238:1398-1401.

Salo, J. and M. Räsänen, 1989. Hierarchy of Landscape Patterns in Western Amazon. In: L.B. Holm-Nielsen, I.C. Nielsen and H. Balslev. Tropical Forests; Botanical dynamics, speciation and diversity. Academic Press, London.

Sombroek, W.G., 1966. Amazon Soils; a reconnaissance of the soils of the Brazilian Amazon region. Centre for Agricultural Publications and Documentation PUDOC, Wageningen, pp. 302 + maps.

Sombroek, W.G., 1984. Soils of the Amazon Region. In: H. Sioli 1984. The Amazon, limnology and landscape ecology of a mighty tropical river and its basin. Dr. W. Junk Publishers, Dordrecht/Boston/Lancaster:521-536.

Sombroek, W.G., A. Duran and H. Averbeck, 1970. Soil studies in the Laguna Merin Basin (Uruguay-southeast Brazil). Technical Report LM-131, CLM/FAO, Treinta y Tres, Uruguay, pp. 300 + maps.

Sutmöller, P., A. Vahia de Abreu, J. van der Grift and W.G. Sombroek, 1966. Mineral imbalances in cattle in the Amazon valley. Communication 53, Royal Tropical Institute, Amsterdam.

Whittaker, R.H., 1977. Evolution of species diversity in land communities. Evolutionary Biology 10, Plenum, New York:1-67.

Zeuner, F.E., 1959. The Pleistocene period. Its climate, chronology and faunal successions. Hutchinson Scientific and Technical, London.

ACKNOWLEDGMENTS

The author gratefully acknowledges the comments and suggestions of Prof. Salle Kroonenberg of Wageningen Agricultural University on geomorphological aspects, and those of Mrs. Anna Tuomisto of Turku University in Finland on species diversity aspects.

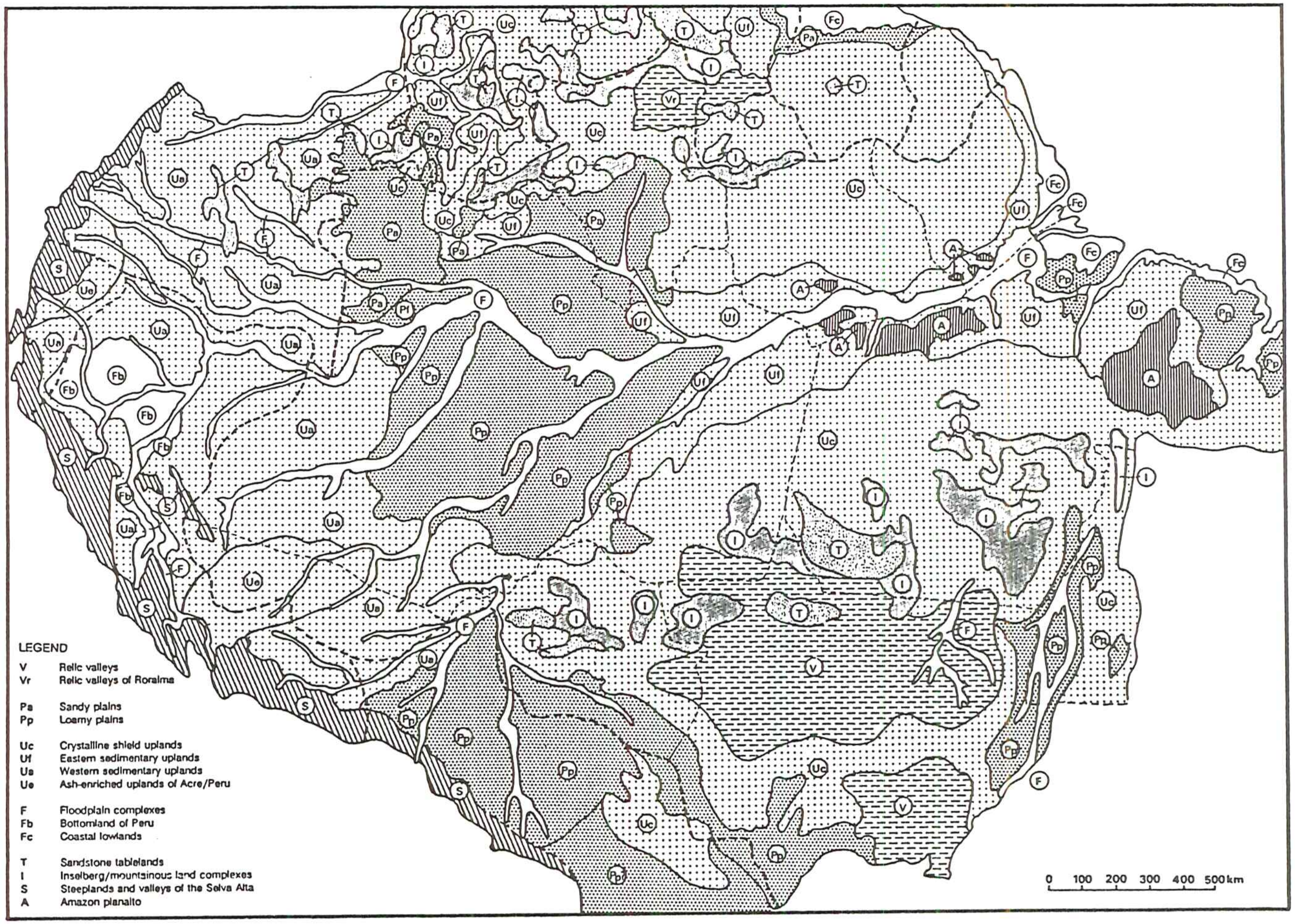


Fig. 1 Sketch map of the main landforms of the Amazon region

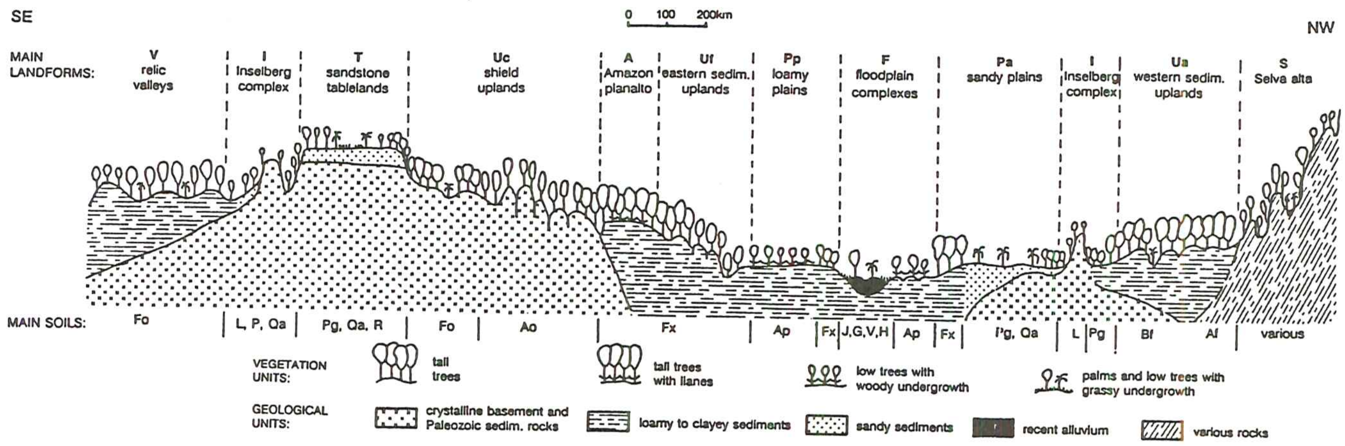


Fig. 2 Schematic cross-section of the Amazon region, showing the relationship lithology-landforms-soils-vegetation structure-species diversity

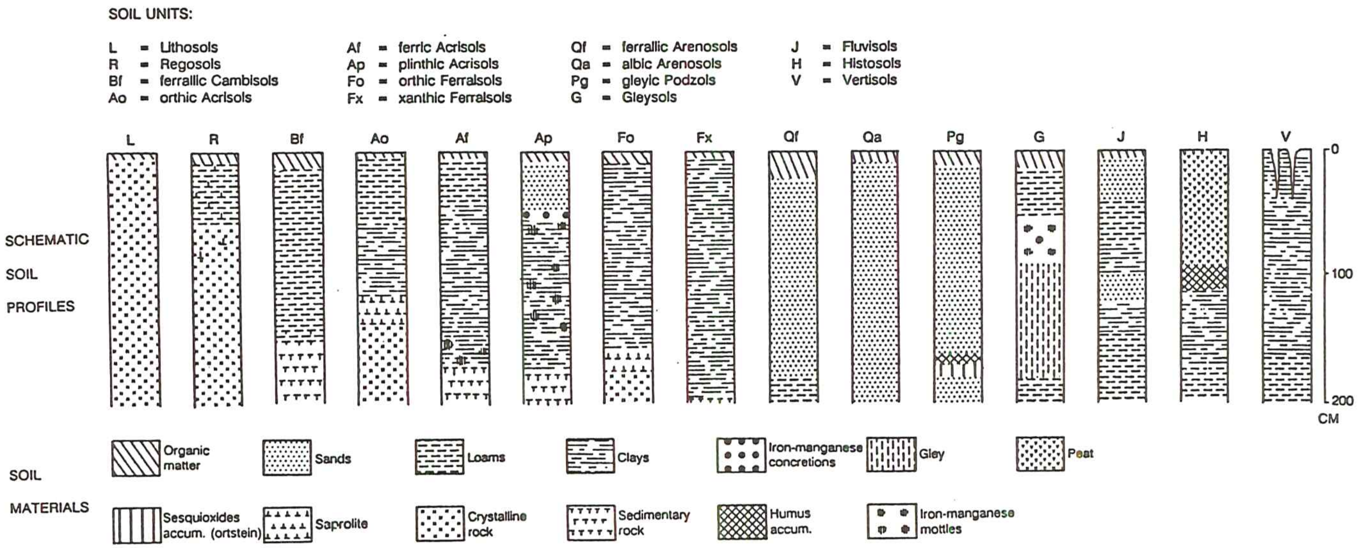


Fig. 3 Main soil profiles of the Amazon region

3 REGULAR ACTIVITIES BY THE SECTIONS

3.1 SECTION ON EDUCATION AND INFORMATION

SOIL MONOLITH COLLECTION

During the reporting period the number of soil monoliths remained at 785 from 58 countries (see table in Annual Report 1989, p. 29). The loss of about 55 monoliths in 1989 was financially compensated by the Ministry of Education and Sciences. About a dozen were impregnated. This work is handicapped by shortage of staff and inadequate facilities, expected to improve with the occupation of a better equipped working place in an annex, to be hired in 1991.

DOCUMENTATION

ISRIC Soil Information System (ISIS)

The soil pedon documentation with information on site and soil in the field and chemical, physical and micromorphological data is essential for ISRIC to function as a reference and information centre.

The Soil Information System ISIS will help to improve storage, retrieval and selection of the data. Although it has been primarily developed for ISRIC to handle detailed site and soil description, including for instance climatological data, it can be considered as a concept for soil information systems with other purposes. Anyone familiar with the dBase application language can change the unprotected programme to fit other objectives. In fact, this programme has already been applied in some countries, while it was used as the basis for the development of the FAO-ISRIC Soil Database (SDB), published in 1989 as World Soil Resources Report 64.

ISIS is also used by a number of national soil institutions/universities establishing a national soil reference collection (see section 3.3. on NASREC). It enables a rapid exchange of data on reference soils between all these institutions.

At the end of 1990 the data of about 250 monoliths were stored.

Map collection and Library

The coverage of maps and publications is the whole world, with strong emphasis on developing countries. The collection is dominated by soil and related geographic information on climate, vegetation, land use, land capability, geology and geomorphology. At present the map collection includes about 500 sheets and some 600 photo-negatives and transparencies.

One of the purposes of maintaining the map collection is its use for updating of the Soil Map of the World at scale 1:5 million and the compilation of a new, computerized world soil and terrain map at 1:1 million.

Efforts are being made within the Netherlands to have map information included in a database. The work is being coordinated at an office located in the Royal Library, the Hague to take care of cataloguing. A project proposal for an additional staff member for three years was made in 1989, but not honoured by the Dutch Government.

The library collection includes about 5000 publications, about 2500 of which are on a regional basis, mostly reports on soil and land surveys. The remainder is constituted mainly by textbooks on soil science and related subjects, bibliographies and more-and-more atlases. The map and book collection increasingly serves as a source of basic information for scientists, students and consultants in soil correlation studies and in the preparation of missions.

Since 1989 the titles of newly acquired publications are entered in a database using the Cardbox Plus computer programme. This facilitates the use of titles stored in Agralin, the database of Wageningen Agricultural University and many other agricultural establishments in the Netherlands. Retroactively the older publications will be entered in the years to come.

TRANSFER OF KNOWLEDGE

Group visits

About 1100 persons visited ISRIC in groups, mainly from educational institutions such as universities, agricultural and technical colleges, and from international training courses, congresses and meetings. The ISRIC collection has been incorporated in courses on regional soil science by the Wageningen Agricultural University and for its M.Sc. Course on Soil Science and Water Management. ISRIC was visited several times by students of the College for Land and Water Management, Velp, the National Agricultural College at Deventer, and international courses held in the Netherlands, e.g. ITC, Enschede, and ILRI, Wageningen.

In addition, ISRIC received students from Universities and Colleges from Belgium, Federal Republic of Germany, Sweden and the United Kingdom.

The facilities of ISRIC were repeatedly used for lecturing, courses and meetings organized by institutes outside ISRIC, such as the International Agricultural Centre, the Winand Staring Centre, the Wageningen Agricultural University, the "Tropenbos" programme, and various commission and working groups of the Wageningen agricultural scientific community. For complete list see Appendix 1.

Individual visits

The number of people coming individually or in small groups is estimated at about 350. Most visitors are professional soil scientists, the majority coming from abroad. The purpose of their visit concerns discussion with staff members, consultation of the soil collection, the library or the collection of soil and other maps.

Extramural lectures

As in the preceding years, staff members of ISRIC participated in the Basic Course Soil Survey of ITC in Enschede, by giving lectures and training of soil genesis and classification, mineralogy and soil chemistry. Both the FAO-Unesco Soil Map of the World and the USDA system of soil classification, Soil Taxonomy, were discussed. These lectures were illustrated with slides, hand-outs and lecture notes, and other materials derived from the ISRIC collection.

ISRIC was invited by the Swedish University of Agricultural Sciences, Uppsala, Sweden, to give lectures on classification of soils in the tropics and on land evaluation.

Publications issued in 1990

Technical Paper

TP 19 Soil horizon designations. E.M. Bridges

TP 21 Technical report on agroclimatic characterization of Madagascar. L.R. Oldeman

Working Paper and Preprint

90/1 The laboratory methods and data exchange programme. Interim Report on the exchange round 1990. J. Brunt

90/2 Soter procedures manual for small-scale map and database compilation. 3rd revised version. March 1990

90/3 Soils on a Warmer Earth: The Tropical Regions. International Workshop on Effects of Climatic Change on Soil Processes, UNEP-Nairobi, 12-14 February, 1990. W.G. Sombroek

90/4 Suelos en una Tierra mas Caliente: Cambios en America Latina. XI Congreso Latinoamericano de la Ciencia del Suelo, 11-17 de marzo de 1990. W.G. Sombroek, May 1990

90/5 Proceedings of the International Workshop on Procedures Manual Revisions for the Global Soils and Terrain Digital Database. N.H. Batjes (ed.), May 1990

90/6 Introduction to Photographic Registration of the Microscopic Image. R.O. Bleijert, May 1990

90/7 World Map of the Status of Human-induced Soil Degradation. An Explanatory Note. L.R. Oldeman and R.T.A. Hakkeling, June 1990

90/8 Amazon landforms and soils in relation to species diversity. Proceedings Workshop to determine priority areas for conservation in Amazonia, 10-20 January 1990, Manaus, Brazil. W.G. Sombroek, July, 1990

90/9 Macro-scale land evaluation using the 1:1M world soils and terrain digital database. A possible approach. N.H. Batjes, July 1990

90/10 The Laboratory Methods and Data Exchange Programme. Interim Report on the Exchange Round 1990. J. Brunt

90/11 An Introduction to X-Ray Diffraction Analysis and X-Ray Fluorescence Spectrocopy. L.P. van Reeuwijk

90/12 Use of Computers in a Laboratory Environment. An Introduction to MS-DOS and Lotus 123. J. Brunt

Also published were:

Bouwman, A.F. Land-use related sources of greenhouse gases. Present emissions and possible future trends. Land Use Policy, April 1990, p. 154-164.

Bouwman, A.F. (ed.). Soils and the Greenhouse Effect. Proceedings of the International Conference Soils and the Greenhouse Effect. John Wiley & Sons, Chichester, 1990, xviii + 575 p.

Bouwman, A.F. Part II, Background. Soils and the Greenhouse Effect, p. 25-192.

Bouwman, A.F. Analyses of global nitrous oxide emissions from terrestrial natural and agro-ecosystems. In: Transactions 14th International Congress of Soil Science, Kyoto, Vol. II, p. 261-266.

Bouwman, A.F. and W.G. Sombroek. Inputs to climatic change by soil and agriculture related activities. Present status and possible future trends. In: H.W. Scharpenseel, M. Schomaker and A. Ayoub (eds.) Soils on a Warmer Earth. Developments in Soil Science 20. Elsevier, 1990, p. 15-30.

Creutzberg, D., J.H. Kauffman, E.M. Bridges, and Guillermo del Posso M. Micromorphology of 'Cangahua': a cemented subsurface horizon in soils from Ecuador. In: L.A. Douglas (ed.), Soil Micromorphology. Developments in Soil Science 19, Elsevier, 1990, p. 367-372.

Oldeman, L.R. and W.G. Sombroek. Use of the Soter Database to model Global Change. In: Transactions 14th International Congress of Soil Science, Kyoto, Vol. V, p. 136-141.

Oldeman, L.R., R.T.A. Hakkeling and W.G. Sombroek. World map of the status of human-induced soil degradation. An explanatory note + 3 sheets, scale 1:15 M. UNEP/ISRIC, 1990, 27 p.

Sombroek, W.G. Geographic quantification of soils and changes in their properties. In: A.F. Bouwman (ed.). Soils and the Greenhouse Effect, 1990, p. 225-244.

Sombroek, W.G. Soils with nitic attributes. In: Transactions 14th International Congress of Soil Science, Vol. V, p. 43-48.

Sombroek, W.G. Soils on a warmer earth: tropical and subtropical regions. In: H.W. Scharpenseel, M. Schomaker and A. Ayoub (eds.) Soils on a Warmer Earth. Developments in Soil Science 20. Elsevier, 1990, p. 157-174.

Sombroek, W.G. Several contributions to Global Soil Change, Report of an IIASA, ISSS, UNEP Task Force on the Role of Soil in Global Change, ed. by R.W. Arnold, I. Szabolcs and V.O. Targulian. IIASA, Laxenburg, 1990.

UNEP/ISRIC. World map on status of human-induced soil degradation, Nairobi, Kenya. 3 sheets. Scale 1:15 M.

Van Baren, J.H.V. and L.R. Oldeman. Soter and Glasod Projects. In: Transactions 14th International Congress of Soil Science, Kyoto, Vol. V, p. 428-429.

Miscellaneous

- Messrs. Oldeman and Van Baren were the organizers of the 106th Scientific Meeting of the Dutch Soil Science Society on 19 and 20 April 1990. Dr. Sombroek chaired the meeting on 19 April.
- Mr. Oldeman presented the Glasod/Soter programme to the CGIAR Mid-Term meeting on 21 May 1990 in Wageningen.
- Mr. Bomer made 96 posters on boards depicting soil profiles, landscapes, etc., to be on exposition in Indonesia.
- During 1990 and preceding years advices on soil-related issues were given to the following Museums: Netherlands Zoutmuseum, Delden; Tropical Museum, Amsterdam; Museum de Casteelse Poort, Wageningen; Museon, the Hague.
- For several presentations at the ISSS Congress in Kyoto, Japan, and other international and national meetings a large variety of posters/slides, overhead sheets, folders and brochures were prepared.

3.2 SECTION ON RESEARCH AND LABORATORY

LABORATORY

Entering the nineties in the laboratory implies entering all data that were produced during the past 25 years into the institute's information system (ISIS). This major enterprise is accompanied by a programme of thorough checking and, where necessary and possible, of filling gaps.

Analytical work was done on 16 monoliths from Kenya which were close to completion by the end of the year.

This year, work for the NASREC-1 project was wound up. This implied completion of monoliths from Ecuador (20), Indonesia (9) and Mali (8).

Almost a whole man-year was spent on soil and water analysis for ITC. It is expected that the increase in this work, which is mostly related to post-graduate student's field work, is of a structural nature.

Time spent on research, although restricted in amount, could be divided into laboratory organisation and actual analysis. In cooperation with the LABEX programme, which was formally terminated by the end of 1990, the implications of introducing GLP as well as LIMS (Good Laboratory Practice and Laboratory Information Management System) in soil laboratories, particularly in developing countries, was further studied.

A comparison was made of total sulphur determination by wet chemical and X-ray fluorescence analysis.

In cooperation with KEMA, the weathering of dumped fly ash, a synthetic analogue of volcanic ash, was studied.

Participation in the ITC/University of Pattimura project (Ambon, Indonesia) entailing assistance to the soil laboratory, was continued for the fourth year.

The laboratory contributes to the new International Postgraduate Course on Soil and Plant Analysis and Data Handling. This course is a joint venture of ISRIC, the International Agricultural Centre and the Wageningen Agricultural University, initiated by the Soil Science and Plant Nutrition Department of the latter.

MICROMORPHOLOGY

The preparation of thin sections for ISRIC is carried out at the Winand Staring Centre.

During 1990, 61 thin sections were prepared for ISRIC; 45 of these were related to the NASREC sampling programme: Ecuador (5), Indonesia (27), Malaysia (13). 7 thin sections were prepared for a soil from France which was sampled by Dr. N.M. Pons-Ghitulescu. For the regular collection of samples for special projects included: Brazil (4, Prof. E. Klamt); Spain (2, Dr. W. Siderius, ITC); and KEMA (Van Reeuwijk, ISRIC).

SOIL CLASSIFICATION, CORRELATION AND MAPPING

Towards the end of 1989 a start was made with proposals for the third level of classification, as well as with proposals for a revised edition of the Guidelines for Soil Profile Description (FAO, 1977). In 1990 these Guidelines for Soil Description (third edition, revised), FAO/ISRIC, were published by FAO.

3.3 SECTION ON PROGRAMMES AND PROJECTS

PROGRAMMES

LABORATORY METHODS AND DATA EXCHANGE (LABEX)

The LABEX Programme was initiated by ISRIC on recommendation of the Second International Soil Classification Workshop 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. During the experimental phase from 1980 to 1984, 20 laboratories participated in the programme. After a research grant from the Directorate General for International Cooperation (DGIS) of the Dutch Government, the number of participants increased to over 120 in 1989.

The LABEX programme continued the collection of analytical data received from the previous round, they were entered in the database and elaborated statistically. Laboratories who participated this year received three reports enabling them to compare their performance with that of others.

These were the last reports of the programme as, most unfortunately, the financing of the LABEX programme by the Dutch Government was terminated by the end of 1990. This ending of a most useful and informative exercise has aroused many protests of participants, particularly in the developing countries, for many of whom LABEX was the only external reference. In addition, this ending also implied the discontinuation of a personal approach in case particular problems arose in their laboratories.

The rapid increase of LABEX members during the past twelve months clearly demonstrated the need of an International Quality Control Programme. Those laboratories only interested in outside references were advised to participate in the International Soil Exchange Programme (ISE) of the Wageningen Agricultural University.

With regard to the discontinuation of "problem solving" assistance, efforts are now made to continue the trouble shooting services in a more structural way through a programme aimed at the improvement of laboratory performance. From the LABEX results it appeared that one of the major causes for the noted unacceptably large variability of analytical results was the within-lab variability. (Another cause being the lack of standardisation of analytical procedures.) Improvement of laboratory performance can to a large extent be effected by the adoption of the rules of Good Laboratory Practice (GLP). ISRIC intends to develop a Handbook of GLP for Soil Laboratories in such a form that it could easily be implemented in laboratories, particularly in developing countries. In addition, efforts are being made to develop a simple accompanying LIMS (Laboratory Information Management System) for easy management of all laboratory information (data, planning, quality control, etc.). This LIMS is intended both for direct use and for training purposes.

A reflective report of the LABEX results of the past five years will be given in the Annual Report 1991.

Dr. H. de Bakker leading an excursion of participants FAO training course at ISRIC

NATIONAL SOIL REFERENCE COLLECTIONS (NASREC)

1. BACKGROUND

ISRIC activity to support the establishment of National Soil Reference Collections and Databases (NASREC) has developed during the eighties into a full programme. Reference is made to ISRIC's Annual Report 1989 for details on the developments of this programme and the results of the NASREC-1 period (1986-1988).

The NASREC programme aims at strengthening of National Soil Institutions in the fields of education, extension and comparative research. National Soil Institutions, further referred to as NSI, comprise national soil/land survey institutions, soil departments of national agricultural universities, etc. The required inputs for the programme are based on the combination of the NSI's own resources – working and exposition space, personnel, transport and materials/equipment – while ISRIC provides the technology and a part of the material and equipment.

The continuation of the NASREC technical assistance programme at the NSIs, was secured for the period 1990-1992 with major financial support from the Government of the Netherlands (DGIS) within UNEP's Action Plan for the strengthening of National Soil Policies. In some cases additional support comes directly from ISRIC own budget.

2. IMPLEMENTATION

2.1 Goals for the 1990-1992 period

The objectives to be achieved by the end of 1992 are the establishment of NASRECs in six countries. Each NASREC will consist of an exposition of profiles of major soil types, a soil database (including climate, land use and other relevant environmental information), and publications for users of the exposition and database.

The major function of a NASREC is to provide information on major soil types in their ecological settings to a variety of user groups. Potential users are found in universities, agricultural research and extension services, farming sectors, but visitors may also come from secondary schools, while the general public also shows great interest, e.g. at agricultural shows.

The information in the soil exposition, the database and the publications includes soil (land) characterisation, classification, capability evaluation, including soil/land management aspects and soil formation. Although the selection of sites for the NASREC is the responsibility of the NSI, general criteria for selection are representativity for dominant soil types and major ecological regions, economic importance, ecological aspects such as soil erosion or land degradation and major soil limitations (hardpans, strong acidity, etc.).

2.2 Activities in 1990

Elaboration of workplans in close collaboration with the each NSI and a start of fieldwork were the major components of the work in 1990. Missions were made to the participating countries for drafting of plans of implementation, giving information on the following activities:

- selection of suitable locations for sampling;
- fieldwork, data collection and transport of samples and monoliths. Besides the sampling of monoliths for the national collections duplicates or triplicates are taken for ISRIC's world soil collection and for other national/regional collections;
- analyses of samples at national and ISRIC soil laboratories, and preparation of monoliths;
- establishment of a computerized soil profile database;
- processing of data for exposition and publications;
- installation of the exposition, inauguration and publicity;
- publications.

2.3 Summary of the activities at the participating institutions (end 1990)

Costa Rica

The Centro Agronomico Tropical de Investigacion y Enseñanza (CATIE) will be responsible for the Central American Soil Reference Collection [CASREC]. CATIE has the mandate for research and educational activities in Central America and is therefore a good base for the collection. At present Mr. W. Campos and Dr. D. Kass are coordinating the activities.

Peru

The Oficina Nacional de Evaluación de Recursos Naturales (ONERN) will be the institution responsible for the establishment of a National Soil Reference Collection. The coordinator for the collection is Mr. Felix Urcuhuaranga, Head of the Soils Department. It was decided to establish two smaller regional collections at universities in the Amazon region and in South Peru. An outline of a cooperation document including a workplan and links with other Peruvian institutions was drafted in 1990. The institutions responsible for the establishment of regional collections are the Universidad Nacional de la Amazonia Peruviana (UNAP) in Iquitos and the Instituto Nacional de Investigación Agraria y Agro-industrial (INIAA) in Arequipa. Coordinators of these regional collections are Dr. Pedro Gobert Arce of UNAP and Mr. Egberto Soto of INIAA. The establishment of one national and several small regional collections is in line with the regionalisation policy of Peru. It has the advantage that the same sites will be used for both the national and regional collections. The two regional collections are partly supported from ISRIC funds.

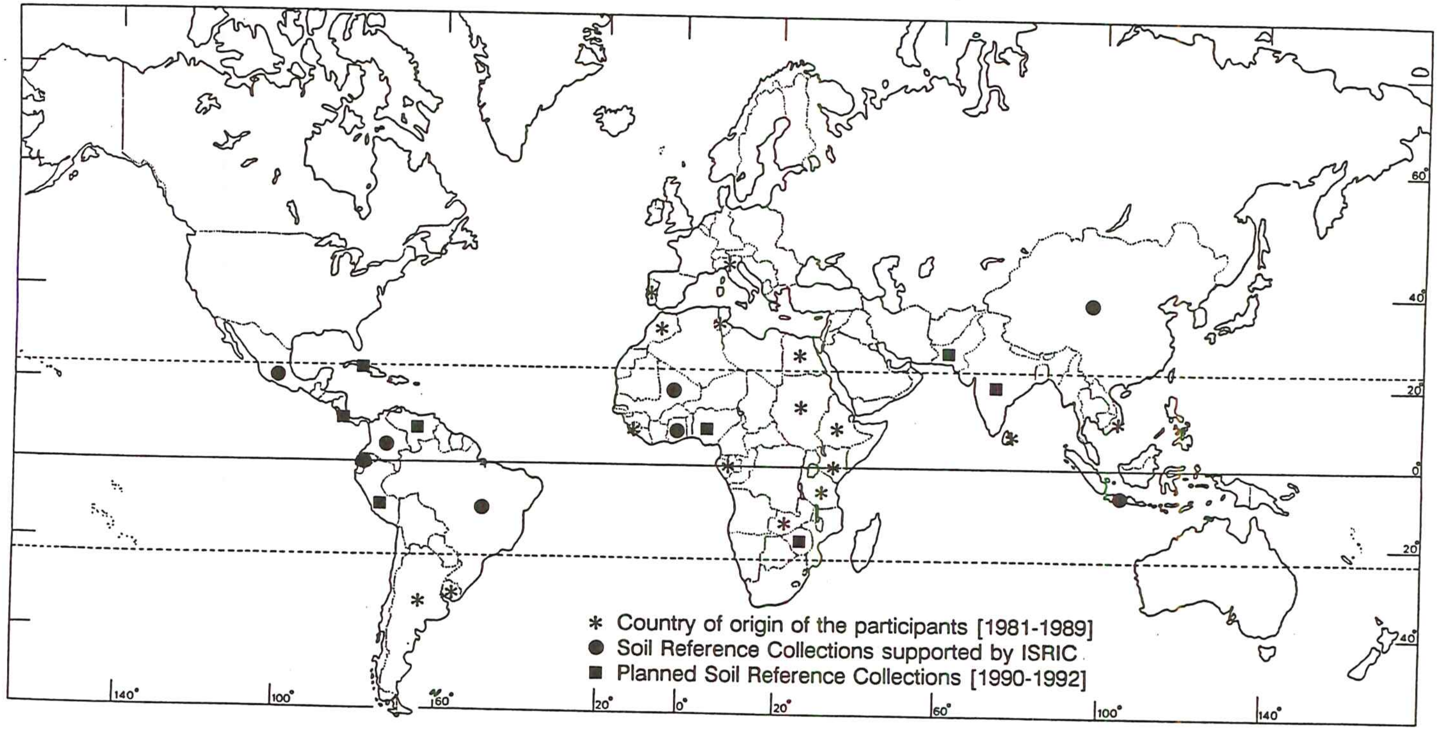


Figure - Nasrec programme

Cuba
The Instituto Nacional de Investigación de Cana de la Azucar (INICA) in Havana requested support for a reference collection of 'sugarcane growing' soils of various countries in Latin America. GEPLACEA (the group of Latin American and Caribbean Sugar Exporting Countries) favours the establishment of such a collection in Cuba (Villa Clara). The Cuban request is supported from ISRIC funds.

Venezuela
A regional soil collection can already be visited at the Universidad Nacional in Maracay. Mr. A. Rosales, in 1990 working in MARNR in Caracas, was coordinator of this collection. In 1990 the Agronomy Faculty of the Universidad del Zulia in Maracaibo initiated activities for a soils collection. The coordinator is Mr. Nestor Noguera. This collection is supported by ISRIC with short visits of ISRIC personnel in combination with NASREC missions to other Latin American countries.

Nigeria
The creation of the South Nigerian Soil Reference Collection will be the responsibility of University of Ibadan (UI). Dr. Ayodele Fagbami of the Department of Geography and Dr. Adeniyi Gbadegesin of the Department of Agronomy are coordinators of the project activities for their Departments. The materials and equipment ordered were received and installed. The first field programme took place in November.

Zimbabwe
The creation of the Soil Reference Collection of Zimbabwe is the responsibility of the Chemistry and Soil Research Institute (CSRI) in Harare. CSRI falls under the Ministry of Lands, Agriculture and Rural Settlement. The national NASREC coordinator is Mr. Julian Spurway of the Soil Survey Section of CSRI. Fieldwork was initiated in 1990 and a small soil exposition of 3 monoliths could already be put on display at the Agricultural Technology Fair in Masvingo in November 1990. A promising prospect is the participation of the Department of Soil Science of the University of Zimbabwe (UZ), in order to expand its own incipient collection.

Pakistan
The Soil Survey of Pakistan will establish a National Soil Reference and Information Centre [NASRIC]. The plan for such a centre was approved by the Ministry of Food, Agriculture and Cooperatives in 1988. A part of the technical assistance for this centre will come from the NASREC-2 programme. The coordinator of the NASRIC activities is Mr. M.A. Tahir, Deputy Director of the Reconnaissance Survey Section.

Furthermore contacts were made with in Senegal with the Institut Senegalais de Recherches Agricoles (ISRA) and with the Soil Survey Division (SSD) of the Land Development Department in Thailand for national collections.

2.4 Developments

As indicated before, a NASREC should give relevant information to many different user groups. During the NASREC-2 period, more emphasis is laid on data processing and publications, and the following activities for exposition and publication purposes were formulated:

- improvements in the printing of standard datasheets, such as lay-outs, translation in Spanish, etc.;
- improvements in graphical presentation, such as property *vs.* depth diagrams and tables;
- statistical comparison studies;
- qualitative land evaluation according to the FAO Framework, with or without the assistance of computer programmes such as the Automated Land Evaluation System (ALES);
- quantitative assessment of a limited number of land qualities with crop simulation models. Technical assistance for the World Food Study model (WOFOST) is offered in the NASREC programme.

One of the conclusions of the NASREC-1 period was the need of a suitable publication for the visitor/user of the exposition and database. The comprehensive datasheet served the professional visitor, in principle, but was of little use to others. An informative booklet, called Soil Brief, should offer sufficient information for a wide range of professional and non-professional users. In 1990, first drafts were made for two soil monoliths of Ecuador. Mr. R. Hennemann, guest researcher at ISRIC, continued to work on this concept. Toward the end of 1990 the first Soil Brief of a soil monolith from Jamaica could be presented to the coordinators of participating NASREC countries.

WORLD SOILS AND TERRAIN DIGITAL DATABASE (SOTER) and GLOBAL ASSESSMENT OF SOIL DEGRADATION (GLASOD)

1. BACKGROUND

Most developing countries are contending with rapidly increasing populations and increasing expectations on the part of that population for higher living standards. In many cases, however, standards of living are actually falling, especially in rural areas. There is also an intense and increasing pressure on national land and water resources, leading to degradation and pollution of those resources and of the environment, and a permanent loss of productive capacity. In all such countries there is a pressing need, which most of the governments are fully aware of, for a system which can store detailed information on natural resources of all kinds in such a way that this data can be accessed and combined immediately and easily, and so that each combination of land, water, vegetation, and population which exists within the country can be rapidly analyzed and classified from the point of view of potential use, in relation to food requirements, socio-economic factors, and environmental impact or 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.

The lack of such as system in most countries has, until now, been one of the most important constraints to the solution of fundamental problems and to the efficient use of resources. This has been felt both by the countries themselves, and by aid donors frustrated at the meagre results resulting from their contributions. Now however, due to the rapidly falling real costs of computer hardware and software, and the equally rapid development over the past two to five years of easy-to-use computer programmes, the necessary systems can be provided in a relatively short time at what is, comparatively speaking, an insignificant cost.

Early 1986 the International Society of Soil Science (ISSS) organised 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 and accompanying soil and terrain databases at a scale of 1:1 M [1]. The only document on the geography of the World's soil resources, at that time available, was the FAO/Unesco Soil Map of the World at 1:5 M scale, prepared by conventional cartography and resulting from a major international action programme to aggregate all soil survey information of the past 15 to 20 years. There was a unanimous agreement as to the need and desirability of the proposed 1:1 M soil map, and a project proposal for a World Soils and Terrain Digital Database (SOTER) was prepared (ISSS, 1986B) and endorsed at the ISSS International Congress of Soil Science in Hamburg, 1986 [2].

In 1987, ISRIC undertook to carry out a global assessment of soil degradation for the United Nations Environment Programme (UNEP) which involved the preparation of a World Map on the Status of Human-induced Soil Degradation [19], and the development and testing of a methodology for small-scale map and database compilation in a pilot area of approximately 250000 km^2, which included portions of Argentina, Brazil, and Uruguay.

This project, known as the GLASOD project, was executed in close cooperation with the Winand Staring Centre, individual members of the ISSS, and in consultation with staff of the FAO and the International Institute for Aerospace Survey and Earth Sciences (ITC).

2. IMPLEMENTATION

Obviously the preparation of the World Map of the Status of Human-induced Soil Degradation required a completely different approach compared to activities leading to the preparation of a soils and terrain digital database for the Latin American pilot area.

2.1 Activities for the preparation of the World Map of Soil Degradation

In order to achieve the ambitious goal to prepare and publish a world map on the status of human-induced soil degradation within a time frame of three years, cooperation with a large number of soil scientists throughout the world was sought. They were asked to give their expert opinion on soil degradation in their particular region. The use of this "expert system" approach called for the preparation of general guidelines for the assessment of the status of human-induced soil degradation, to ensure uniformity in reporting and delineating on maps the seriousness of various soil degradation processes [3]. In order to avoid that maps of different scales and projections would be used, simplified geographic base maps were also provided. Regional correlators – institutes and individual experts – were designated and/or contracted to prepare draft soil degradation maps and complementary datasets. Early 1990 all regional maps and data sets were returned to ISRIC for further compilation. Through a fruitful cooperation with the Winand Staring Centre guiding principles were developed for the compilation of the regional soil degradation maps. These were tested when the first regional maps arrived, improvements were made, compiled sections of the map returned to the cooperators for comments. These comments were incorporated wherever possible to ensure that the final GLASOD map was the best possible approximation of the global status of soil degradation.

The final draft version of the GLASOD map was then sent to national soil institutions throughout the world for their comments and acceptance. Only then cartographers of the Winand Staring Centre, contracted in a separate agreement with UNEP, carried out the final map preparation. The World Map of the Status of Human-induced Soil Degradation, in three sheets, was officially presented at the occasion of the 14th International Congress of Soil Science in Kyoto (August, 1990) and the explanatory note was published later that year [19].

2.1.1 *Content of the map*

Broad physiographic units are delineated on the map. For each unit the major type of soil degradation is reflected by four basic colours: bluish green for water erosion; yellowish brown for wind erosion; red for chemical deterioration; pink for physical degradation. Units without any sign of human-induced soil degradation – stable terrain – were indicated by a light grey colour, while units that were turned into wastelands as a result of historic or recent natural degradation processes and without appreciable vegetative cover or agricultural potential were indicated by a dark grey colour. Water and wind erosion were divided into two subtypes: loss of topsoil (a uniform displacement of topsoil) and terrain deformation. Chemical deterioration was divided in four subtypes: loss of nutrients; salinization, acidification, pollution. Physical deterioration was divided in three subtypes: compaction, sealing and crusting; waterlogging, and subsidence of organic soils.

Each degradation type was characterized by the degree of degradation, which was estimated in relation to changes in agricultural suitability and productivity, and in some cases in relation to its biotic functions. As it is not possible at the chosen scale to separate areas of soil degradation individually, an estimate is given of the relative extent of each type of soil degradation within the delineated unit. Combination of the degree and the relative extent of the degradation process in four classes is a measure of the severity of the process, which on the map has been indicated by different shades of the colour of the dominant process.

In addition to degree and relative extent the map also provides information through the use of symbols of the recent past rate of the degradation process and of the kind of physical human intervention that has caused the soil to be degraded (by deforestation and removal of the vegetative cover; by overgrazing; by improper management of the agricultural land; by over-exploitation of vegetation for consumptive use; or by (bio)industrial activities).

2.1.2 *Follow-up activities*

The World Map on Soil Degradation is the first of its kind that shows the severity of the problems of human-induced soil degradation in a global perspective. However, the information on the map in terms of areas being affected by various types of soil degradation should be further quantified. In a joint follow-up activity by UNEP and ISRIC, the mapped units have been digitized and a GLASOD computerized database has been prepared. It is now possible to prepare single value thematic maps of the various processes of soil degradation and to calculate statistics on actual areas being degraded, its degree and their causative factors.

UNEP is compiling a World Atlas on Desertification, to be presented at the United Nations Conference on Environment and Development in Rio de Janeiro in 1992.

As stated in Forum (1991): "The single most important data set is the 1:10 M scale Global Assessment of Soil Degradation Map". In another follow-up activity a more detailed map of the status of human-induced soil degradation for continental Africa was prepared and digitized (scale 1:5 M).

2.2 Activities for the World Soils and Terrain Digital Database – SOTER

Development and testing of methodologies for the preparation of a world soils and terrain database involved – in chronological order – the following activities:

January 1988. Preparation of a first version of a Procedures Manual for small scale map and database compilation, by the Land Resources Research Centre (LRRC), Ottawa, Canada [4].

March 1988. Organisation of the first regional workshop, held in Montevideo, Uruguay to develop an implementation plan and to instruct soil scientists from Argentina, Uruguay, and Brazil to use the Procedures Manual for correlation of soil maps and soil and terrain attributes to a uniform system for data entry into the SOTER database [6].

April 1988-December 1988. Acquisition of maps and attribute data from each of the three countries for the pilot area in Latin America (LASOTER). Preparation of a SOTER database structure using ORACLE5 as the relational database management system. Meanwhile, a model was developed for a soils and terrain digital database to be used for data entry [5].

December 1988. Organisation of the second regional workshop, held in Porto Alegre, Brazil. Presentation of results on data acquisition [7]. Development of a separate climate database and discussions on a separate land use database.

January 1989. Preparation of a second version of the Procedures Manual, based on recommendations from the Porto Alegre workshop [8].

March 1989. Organisation of a workshop and implementation meeting in Ottawa for an US-Canada Pilot area along the western border [11]: a cooperative effort by the U.S. Soil Conservation Service and the LRRC, Canada (NASOTER).

August 1989. Organisation of an advisory committee meeting on the Assessment of a Geographic Information System for SOTER [9, 12]. The committee recommended PAMAP. Implementation of activities for a SOTER pilot area in the geo-economic region of Central Brazil (BRASOTER) in cooperation with EMBRAPA/CPAC with Dr. T.T. Cochrane as consultant.

Throughout 1989. Data entry of soil and terrain attributes into the SOTER database of the LASOTER pilot area.

April 1990. Preparation and presentation of a third revision of the Procedures Manual at an international workshop, held at ISRIC, Wageningen, based on problems encountered during the data entry phase of the project [13, 14].

January-July 1990. Finalization of data entry for the LASOTER, BRASOTER, and NASOTER pilot areas. The database is linked to GIS as follows: the GIS "IDRISI" is used in the BRASOTER region; "ILWIS" is used in the LASOTER pilot area; and "ARCINFO" is connected to the NASOTER database.

August 1990. At the International Congress of Soil Science, held 8-16 August in Kyoto, Japan, the ISSS Working Group under commission V on World Soils and Terrain Digital Databases organised a special symposium on SOTER, where results of LASOTER [16] and NASOTER [15] were presented. Results of BRASOTER were presented as a poster [17].

September-December 1990. Further testing of the use of SOTER. Several thematic maps were prepared using ILWIS and the LASOTER database. An assessment was prepared for a macro-scale land evaluation using the 1:1 M Soils and Terrain Digital Database [18].

Related developments

Late 1988 a project proposal was developed for a pilot area in West Africa (WASOTER), covering portions of Benin, Burkina Faso, Ghana, Niger, Nigeria, and Togo [10]. The proposal was discussed during a FAO-sponsored West and Central African Soil Correlation meeting in Cotonou, Benin. The WASOTER proposal is now (November 1990) formally submitted by the ICRISAT Sahelian Center in Niamey, Niger, acting as regional authorizing office, to the E.C. in Brussels for funding. The request is formally endorsed by four of the six Governments involved in WASOTER. It is expected that an implementation workshop will be held by the middle of 1991.

A joint project proposal for a Central European SOTER has been prepared by Hungary, Czechoslovakia, Poland and Austria (CESOTER) and support is being solicited. An implementation workshop is scheduled to convene in April 1991.

Another priority area for action is located in Central America (CASOTER). A proposal was positively received during the XIth Latin American Soil Science Congress in March 1990. It involves portions of Belize, Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua. The International Centre for Tropical Agriculture (CIAT) has indicated its interest and willingness to cooperate.

Although the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD, Damascus) and the International Centre for Agricultural Research in Dry Areas (ICARDA, Aleppo) have indicated interest for a SOTER activity in Southwest Asia, the proposal for SWASOTER, including portions of Turkey, Syria, Iraq, Jordan, and Saudi Arabia has not yet been submitted for funding.

Finally, initial talks were held in East Africa for a SOTER activity covering portions of Kenya, Tanzania, and Uganda (EASOTER).

3. CONCLUDING REMARKS

Most developing countries are quite acutely aware of the need, and many are already attempting, to establish computerised natural resource databases of one kind or another, though attempts to set up systems which will support land evaluation and land use planning are as yet quite rare. It is expected that many countries will do so within the next five to ten years. Furthermore, donors and aid agencies, particularly those such as the World Bank, which seek comprehensive solutions, are becoming aware that such systems are an essential tool for development, and are also very cheap in comparative terms.

The SOTER system has now been tested in three pilot areas involving five countries, using local data and training national staff in operation. Experts in soil/climate resources and land use inventory and evaluation in a number of other developing countries, especially Africa, have moreover used their experience at improving the system's manual. Though further up-grading and improvement will continue, this system can now be established as an almost routine operation, which mainly involves the provision of equipment and training.

It is expected that in 1991/92 training materials will be developed and a first training course will be conducted in South America.

Documents prepared/published in the framework of GLASOD/SOTER

[1] ISSS, 1986. Proceedings of an International Workshop on the Structure of a Digital International Soil Resources Map annex Data Base (20-24 January 1986, ISRIC, Wageningen). Ed. by M.F. Baumgardner and L.R. Oldeman. SOTER Report 1, ISSS, Wageningen. 138 p.

[2] ISSS, 1986. Project proposal "World Soils and Terrain Digital Database at a scale 1:1M (SOTER)". Ed. by M.F. Baumgardner. ISSS, Wageningen. 23 p.

[3] ISRIC, 1988. Guidelines for General Assessment of the Status of Human-Induced Soil Degradation. Ed. by L.R. Oldeman. Working Paper & Preprint 88/4, ISRIC, Wageningen. 11 p. (in English and French).

[4] Shields, J.A. and D.R. Coote, 1988. SOTER Procedures Manual for Small Scale Map and Database Compilation (for discussion). Land Resources Research Centre under contract to GLASOD Project. Working Paper & Preprint no 88/2. ISRIC, Wageningen. 141 p.

[5] Pulles, H.M., 1988. A Model for a Soils and Terrain Digital Database. Working Paper & Preprint 88/8. ISRIC, Wageningen. 32 p.

[6] ISSS, 1988. Proceedings of the First Regional Workshop on a Global Soils and Terrain Digital Database and Global Assessment of Soil Degradation (20-25 March 1988, Montevideo). Ed. by W.L. Peters. SOTER Report 3. ISSS, Wageningen (81 p. in English, 86 p. in Spanish).

[7] ISSS, 1989. Proceedings of the Second Regional Workshop on a Global Soils and Terrain Digital Database (12-16 December 1988, Porto Alegre). Ed. by W.L. Peters. SOTER Report 4. ISSS, Wageningen (97 p. in English, 104 p. in Spanish).

[8] Shields, J.A. and D.R. Coote, 1989. SOTER Procedures Manual for Small Scale Map and Database Compilation and Procedures for Interpretation of Soil Degradation Status and Risk. (Revised version of Working Paper & Preprint no. 88/2). For discussion. Working Paper & Preprint no. 89/3. ISRIC, Wageningen. 188 p.

[9] ISSS, 1989. Selection of a Geographic Information System (GIS) for SOTER. Final Report of a Sub-Committee on GIS Selection. Ed. by B. MacDonald. LRRC, Canada. 7 p.
[10] ISRIC, 1988. Project Proposal for a West African Soils and Terrain Digital Database (WASOTER). Ed. by L.R. Oldeman. ISRIC, Wageningen, 9 p. (in English and French).
[11] ISSS, 1989. Report on a Workshop on Implementation Plan for North American Pilot Area of the SOTER Project (NASOTER) (6-9 March 1989, Ottawa). Ed. by M.F. Baumgardner. ISSS, Purdue.
[12] van Engelen, V.W.P., 1989. Selection Procedure of Geographic Information System Software for SOTER. Working Paper & Preprint 89/5, ISRIC, Wageningen. 35 p.
[13] ISRIC, 1990. SOTER Procedures Manual for small-scale map and database compilation (for discussion, draft, 3rd revised version of Working Paper & Preprint 89/3). Ed. by V.W.P. van Engelen and J.H.M. Pulles. Working Paper & Preprint 90/2, ISRIC, Wageningen. 69 p.
[14] ISRIC, 1990. Proceedings of the International Workshop on Procedures Manual Revisions for the Global Soils and Terrain Digital Database. 24-26 April 1990, Wageningen. Ed. by N.H. Batjes. Working Paper & Preprint 90/5. ISRIC, Wageningen. 25 p.
[15] Shields, J.A.M. & D.R. Coote, 1990. Development, Documentation and Testing of the Soil and Terrain (SOTER) Database and Its Use in the Global Assessment of Soil Degradation (GLASOD), ISSS, Kyoto.
[16] Scoppa, C. J. Salazar, R. DiGiacomo, R. Godagnone, C. Irurtia, P. Fasolo, J. Olmos, R. Potter, J. Molfino and C. Alvares, 1990. Compiling, Generating and Correlating a Common Soils and Terrain Database for Argentina, Brazil and Uruguay. ISSS, Kyoto.
[17] Cochrane, T.T. and J. Macedo 1990. An inexpensive computer system for the World Soils and Terrain Digital Database, SOTER. ISSS, Kyoto.
[18] Batjes, N.H., 1990. Macro-scale land evaluation using the 1:1 M world soils and terrain digital database. SOTER Report 5. ISSS, Wageningen. 45 p.
[19] Oldeman, L.R., R.T.A. Hakkeling and W.G. Sombroek, 1990. World Map on the Status of Human-induced Soil Degradation, an explanatory note. UNEP Nairobi and ISRIC, Wageningen. 27 p. + 3 maps.

PROJECTS AND CONSULTING

AGROCLIMATOLOGY

An agroclimatic characterization of Madagascar was carried out by L.R. Oldeman in the framework of a cooperative rice research project between the Centre National de la Recherche Appliqué au Developpement Rural (FOFIFA) of Madagascar and the International Rice Research Institute (IRRI) in the Philippines.

The technical report, which includes an agroclimatic map of Madagascar at a scale of 1:2 million and an annex with a climatic databank of Madagascar with monthly climatic patterns for 178 sites, was published by ISRIC in 1990 as Technical paper 21.

The need to define agroclimatic conditions is essential for the setting of research priorities, for the allocation of research resources, for the definition of specific constraints to focus research efforts, and for recognizing climatic homologues for technology transfer. The agroclimatic characterization of Madagascar is an attempt to organize, characterize and delineate zones of a certain homogeneity of the climatic regime. The agroclimatic map will directly assist breeders and agronomists with the selection of appropriate location-specific rice genotypes and in the determination of rice-based cropping systems.

ANNOTATED BIBLIOGRAPHY OF PRE-INDEPENDENCE LITERATURE OF SOILS IN INDONESIA (SOBIN)

During the period 1850-1950 a large number of soil science studies was realized in the Dutch East Indies/Indonesia. Because virtually all data were published in the Dutch language, this important collection of data becomes more and more inaccessible. An annotated bibliography of this material is now being prepared in the English language.

The SOBIN project started in 1990 with the following participating institutions: Centre for Soil Research (Bogor, Indonesia), the Institute for Soil Fertility (IB, Haren, the Netherlands), ISRIC and PUDOC (Wageningen, the Netherlands). The bibliography of soil fertility and soil geography studies will be published in 1993 in printed form and as a computerized database. Additionally, a link to a Geographical Information System is envisaged. Activities in 1990 comprised an inventory of available and a first test of different types of bibliographies. One staff member of the IB-Haren is full-time involved. The coordinating institution, IB-Haren, gives assistance on fertility aspects; ISRIC on soil geography and GIS; and PUDOC on bibliographical and database aspects.

(AGRO)ECOLOGIC AND (SOCIO)ECONOMIC ZONING OF THE BRAZILIAN AMAZON REGION

The project encompasses the support of the Brazilian Government's efforts to a systematic ecologic-economic zoning of the whole of the Amazon region. The project document of this proposed 5-year activity addresses the following issues: a priority macro zoning of the whole region at a scale of 1:2.5 M, a zoning at 1:500.000 of selected hydrographic sub-basins and the establishment of multidisciplinary teams in the nine provinces concerned for detailed zoning work and subsequent land use planning and controlled implementation. The consultation for FAO was carried out by W.G. Sombroek during October-November 1990.

FELLOWSHIPS AT ISRIC

During the last decade a number of foreign soil scientists have spent a period from a few months up to one year at ISRIC, mostly for the preparation of a Soil Monograph or a Technical Paper.

Soil Monographs are publications of 100-150 pages on a major group of soils, taking ISRIC's soil monolith collection as starting point. 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. Up to now Soil Monographs on Podzols and Andosols have been published, those on Ferralsols and Vertisols are in preparation.

Technical Papers mostly concern methods, procedures and standards of analysis and work, and are of varying length.

ISRIC should like to get in touch with soil scientists who are acquainted with an important group of soils, e.g. soils in arid regions (Calcisols, Gypsisols), saline/sodic soils (Solonetz, Solonchaks), claypan soils (Planosols) or low-activity-clay soils (Lixisols, Acrisols).

The fellowships only cover lodging and full board, pocket money and insurance. No travel funds are available. Since the fellowships are tenable for scientists from OECD countries, only citizens of these countries need apply.

Please direct your interest to the Director of ISRIC.

4 GUEST RESEARCH

Soil Horizon Designations

Dr. E.M. Bridges, University College, Swansea, U.K.

Funding: Fellowship of the Dutch Ministry of Agriculture, Nature Management and Fisheries - International Agricultural Centre and ISRIC.

During stays of several months in 1987, 1988, 1989, and 1990 a discussion document was formulated on the historical development of systems of horizon designation, on systems currently in use with their areas of agreement or disagreement, and on proposals for unification based upon current practices and in line with the International Reference Base for soil classification of the ISSS.

After the circulation of a draft report published in 1987, changes were incorporated and presented to the Working meeting on Soil Horizons of ISSS Commission V in Rennes, France in September 1989. The final text was published in 1990 as Technical Paper 19.

5 TRAVEL AND MISSIONS

Visit to Japan, January 1990. *Participant: W.G. Sombroek.*

To give two lectures, a press conference, and discuss with Organizing Committee about 14th International Congress of Soil Science, Kyoto, August 1990.

Visit to Washington, U.S.A., January-February 1990. *Participant: W.G. Sombroek.*

To attend, as a member, a meeting of Working Group on Data and Information Systems of the International Geosphere-Biosphere Programme (IGBP).

Visit to Environment Department, World Bank, on co-funding ISRIC project.

Consultancy to Ambon, Indonesia, January-February 1990. *Participant: J.R.M. Huting.*

During this follow-up mission to the Muluku Regional Development Project, University of Pattimura, some apparatus was installed and repaired, instruction and training was given in analytical methods and laboratory management data handling. Some handling procedures were made. Four profiles collected for the University of Pattimura in 1989 were impregnated and put on display.

Workshop on Priority Areas for Conservation in Amazonia, Manaus, Brazil, January 1990. *Participant: W.G. Sombroek.*

To discuss all elements related to biodiversity with a view to determine priority conservation areas in the Amazon region.

Workshop "Trace gas exchange in a global perspective", Sigtuna, Sweden, February 1990. *Participant: A.F. Bouwman.*

This planning meeting by SCOPE-IGBP was a follow-up of a Dahlem Conference and the Soils and the Greenhouse Effect meeting held in 1989 to identify priority research projects. These are included in the IGBP-International Global Atmosphere Chemistry (IGAC) programme.

Workshop on "Effects of Expected Climatic Change on Soil Processes in the Tropics and Subtropics", Nairobi, Kenya, February 1990. *Participant: W.G. Sombroek.*

To attend as co-organiser this UNEP-ISSS-CTA international workshop. The 22 contributions and the conclusions and recommendations were published in 1990 under the title: Soils of a Warmer Earth by Elsevier.

Consultation on "Assessment of Global Desertification: status and methodologies", Nairobi, Kenya, February 1990. *Participant: W.G. Sombroek.*

Travels to Nigeria, Senegal and Zimbabwe (February-March); Costa Rica, Cuba, Ecuador, Peru and Venezuela (June-August); and Nigeria, Pakistan, and Zimbabwe (November-December). *Participant: J.H. Kauffman.*

These missions were carried out in the framework of the National Soil Reference Collections annex Database (NASREC) project. They consisted of discussions on the proposed Nasrec and the preparation of project proposals, fieldwork for the collection of soil profiles, the installation of computers for the database and instruction on their use.

XI Congreso Latino-americano de la Ciencia del Suelo, Cuba, March 1990. *Participant: W.G. Sombroek*[*]).

To attend the congress and present the keynote address entitled: Suelos en una tierra mas caliente: cambios en America Latina. Together with Prof. W. Peters, Venezuela, organising a special symposium on the use of the Soils and Terrain Digital Database (SOTER) in Latin America.

Travel to Victoria and Ottawa, Canada, April 1990. *Participant: V.W.P. van Engelen.*

To attend a PAMAP Geographical Information System training course. To discuss proposed changes in the SOTER Procedures Manual and methodology for derived maps.

Meetings of the Advisory Group on Desertification Assessment and Mapping, Geneva, Switzerland, May 1990 and Nairobi, Kenya, November 1990. *Participant: L.R. Oldeman.*

To attend, as a member, this meeting to assist UNEP with the preparation of the World Atlas on Desertification, to be presented to the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, August 1992.

14th International Congress of Soil Science, Kyoto, Japan, August 1990. *Participants: W.G. Sombroek*[*]), *J. van Baren and L.R. Oldeman.*

To attend the Congress and present oral and poster presentations on a number of subjects. Special meetings were held on GLASOD/SOTER and LABEX projects. Sombroek relinquished his position of Secretary-General of the ISSS, Van Baren was elected Deputy Secretary-General.

Sombroek attended also the 5th International Congress of the Humic Substances Society (IHSS), the IBSRAM Board meeting, the UNESCO-MAB regional Asian workshop, and the 5th International Congress of Ecology (INTECOL), all in Japan, August 1990[*]).

Visit to Madrid, Spain, September 1990. *Participant: V.W.P. van Engelen.*

To discuss the selection of pilot areas for mapping and measurement of soil erosion in the Mediterranean zone, and select procedures and develop guidelines for this exercise.

Second Scientific Advisory Council meeting of ICSU's International Geosphere-Biosphere Programme (IGBP), Paris, France. *Participant: W.G. Sombroek*[*)].

To discuss established and proposed core projects and auxiliary services.

Visit to World Bank, Washington, U.S.A., September 1990. *Participant: W.G. Sombroek.*

To attend the Special Programme for African Agricultural Research (SPAAR) brainstorming session on development of concepts of action frameworks for national and regional agricultural research in Southern Africa and Sahelian zone.

First Meeting of the Working Group on the "Land Cover Change" Project, Paris, October 1990. *Participant: N.H. Batjes.*

In preparation of the International Space Year (ISY) in 1992 this meeting was held to discuss the objectives and status of the ISY activities with special reference to the "Land Cover Change" (LCC) activities. The international global land cover projects were reviewed and contributions to the LCC were defined.

Visit to E.E.C., Brussels, Belgium, October and November 1990. *Participant: L.R. Oldeman.*

To give information on the GLASOD/SOTER projects, and especially about the application of the proposed Soils and Terrain Digital Database (SOTER) in West Africa. EEC is a possible funding agency for this WASOTER project.

Visit to FAO, Rome, Italy, November 1990. *Participant: V.W.P. van Engelen.*

To discuss and come to an agreement on the structure and the content of a standard crop environmental requirements database, which will satisfy the needs of as wide a range of users as possible.

Visit to FAO, Rome, Italy, November 1990. *Participant: J. van Baren* (on behalf of ISSS).

To attend the second meeting of FAO, UNEP and ISSS on National Soil Policies in Syria and Uganda. Discussed were the two country reports on the implementation of a National Soil Policy. It is foreseen that both reports will be submitted to Governments for approval mid-1991.

Visit to Niger and Kenya, November 1990. *Participant: L.R. Oldeman.*

To discuss the proposed West African Soils and Terrain Digital Database (WASOTER) project with ICRISAT Sahelian Center in Niger and with UNEP, Nairobi, Kenya. At UNEP follow-up activities in the years ahead were discussed, as well as a possible East African Soils and Terrain Digital Database covering parts of Kenya, Tanzania, and Uganda.

International Workshop on the Assessment of Chemical Time Bombs in Soils, Sediments and Groundwaters in the Danube Basin, Budapest, Hungary, December 1990. *Participant: W.G. Sombroek.*

This workshop was held to discuss the programme for the identification of sources of pollution and vulnerability of soils in the Danube watershed. This should be used for the benefit of an environmental management master plan for the region, to be financed by the E.E.C. The Central Europe Soils and Terrain Digital Database (CESOTER) was included, together with its extension to the whole Balkan (BASOTER).

*) travels partly or wholy made by W.G. Sombroek in his capacity of Secretary-General of the International Society of Soil Science

6 RELATIONS WITH OTHER INSTITUTIONS

6.1 INTERNATIONAL RELATIONS AND ACTIVITIES

Contacts and activities with international institutions included the following:

Food and Agricultural Organization of the United Nations (FAO, Rome)
- Further development of the third level of the new FAO-Unesco Soil Map of the World Legend.
- Improvement of the 'Guidelines for Soil Description', which was published in 1990.
- Collection of maps for the updating of the FAO-Unesco Soil Map of the World at scale 1:5 million, and for a digitized soil and terrain map at 1:1 million.
- Exchange of publications and documentation on soils and their management, agroclimatic zones, etc.

United Nations Educational, Scientific and Cultural Organization (Unesco, Paris)
- Unesco's financial support and identification of candidates for ISRIC's International Course on the Establishment and Use of National Soil Reference Collections.
- Unesco's interest to have several associate experts ecology/soil science cooperate with the Dutch "Tropenbos" programme. ISRIC provides technical backstopping of associate experts in Africa (Nairobi, Kenya) and Latin American (Montevideo, Uruguay).

United Nations Environment Programme (UNEP, Nairobi)
- Advise on the promotion of UNEP's World Soils Policy and National Soil Policies programmes.
- Consultancy to assess the global extent of soil degradation at an average scale of 1:10 million, and its quantification in a pilot area in South America (GLASOD project) at a scale of 1:1 million. The world map on human-induced soil degradation was published in 1990.

International Society of Soil Science (ISSS)
- Administrative assistance to the Secretariat-General of ISSS, housed at ISRIC (up to August 1990) and that of the Deputy Secretary-General since then.
- Organizing and editing of the book-review section of the six-monthly Bulletin of the Society.
- Participation in the ISSS Working Group "International Reference Base for soil classification" (WG/RB), through formulation of proposals and assembling of documentation.

- Participation in the ISSS Working Group on the preparation of a digitized international soil and terrain map (WG/DM).
- Registration of visual training aids on soil science.
- Repository of biographical material on outstanding soil scientists and on the early history of organized soil science for the ISSS Working Group on the History, Philosophy and Sociology of Soil Science (WG/HP).

Other major international contacts
- Commission of the European Communities (Brussels); submission and screening of research proposals; contacts on support for educational functions of ISRIC.
- International Service for National Agricultural Research (ISNAR, the Hague); exchange of programmes information.
- Institut français de recherche scientifique pour le développement en coopération (ORSTOM, Paris); exchange of information.
- Centre Technique de Coopération Agricole et Rurale of EEC/Lomé Convention countries (CTA, Wageningen/Ede); exchange of data.
- U.S. Agency for International Development (USAID) and several of its soil-related programmes (IBSNAT, SMSS); exchange of information; attendance of workshop.
- Several of the International Agricultural Research Centres of the Consultative Group on International Agricultural Research (IITA, IRRI, CIAT, ICARDA); exchange of information.
- National Soil Survey Institutes, Soil Research Institutes and Agricultural Universities in many countries.

6.2 NATIONAL RELATIONS AND ACTIVITIES

- Royal Netherlands Academy of Arts and Sciences (KNAW, Amsterdam); continuation of cooperation programme with Nanjing Institute of Soil Science of the Academia Sinica; participation in a Dutch national committee for MAB/ SCOPE/IGBP.
- Netherlands Foundation for the Advancement of Tropical Research (WOTRO); board membership.
- International Institute for Aerospace Survey and Earth Sciences (ITC, Enschede); management servicing of ISRIC; lecturing at ITC Soils Course; analysis of soil and water samples; soil database development.
- Department of Science Policy of the Dutch Ministry of Education and Sciences (MOW-WB, the Hague); cooperation on the elaboration of a multidisciplinary research programme on tropical forests (Tropenbos).
- Department of Soil Science and Geology of Wageningen Agricultural University; cooperation on clay mineralogy; exchange of information; representation at international meetings; lecturing.
- International Agricultural Centre (IAC, Wageningen); visitors accommodation; guest researcher's fellowships; advice on soil-related projects in developing countries.
- M.Sc. Course in Soil Science and Water Management of Wageningen Agricultural University; guidance of students at thesis work.
- Winand Staring Centre (WSC, Wageningen); cooperation on micromorphology, including methodology of description; exchange of information; representation at international meetings.

7 PERSONNEL

7.1 BOARD OF MANAGEMENT

Members of the Board of Management on 31 December 1990 were:

- Dr. J.P. Andriesse, Chairman Netherlands Advisory Council
- Dr.Ir. A.W. de Jager, Free University, Amsterdam
- Prof.Dr. L. van der Plas, Wageningen Agricultural University
- Dr.Ir. L. Fresco (personal member).

It is with great regret that the sudden passing-away of the Chairman of the Board, Dr.Ir. F. Sonneveld, has to be mentioned. Dr. Sonneveld played an important role in the development of ISRIC during the last decade and his wise advices will be missed.

7.2 INTERNATIONAL ADVISORY PANEL

The International Advisory Panel (IAP) met in 1967, 1972, 1979 and 1983. The members of the last IAP were:

- Dr. F. Fournier, Division of Ecological Sciences, Unesco, Paris, France
- Dr. H. Ghanem, Institut Agronomique et Vétérinaire, Rabat, Morocco (for northern Africa)
- Prof. E.G. Hallsworth, IFIAS Save-Our-Soils Project, Brighton, U.K. and past President ISSS (for Australia and ISSS)
- Mr. G.M. Higgins, Land and Water Development Division, FAO, Rome, Italy
- Dr. C.S. Holzhey, USDA Soil Conservation Service, Lincoln, Nebrasca, U.S.A. (for North America)
- Dr. M. Jamagne, Service d'Etude des Sols et de la Carte Pédologique de France, Olivet, France (for Western Europe)
- Dr. F.N. Muchena, Kenya Soil Survey, Nairobi, Kenya (for Africa South of the Sahara)
- Dr. A. Osman, Soil Science Division, Arab Centre for the Studies of Arid Zones and Dry Lands (ACSAD), Damascus, Syria (for the Middle East)
- Dr. C.R. Panabokke, Sri Lanka (for South and East Asia): could not attend
- Dr. C. Valverde, Programa Nacional de Suelos, Lima, Peru: at present International Service for National Agricultural Research (ISNAR), The Hague, The Netherlands (for Latin America and CGIAR institutes)
- Dr. G. Varallyay, Research Institute for Soil Science and Agricultural Chemistry, Budapest, Hungary (for eastern Europe).

7.3 NETHERLANDS ADVISORY COUNCIL

Members of the NAC on 31 December 1990 were:

- Ir. J.G. van Alphen, International Institute for Land Reclamation and Improvement, Wageningen
- Dr. J.P. Andriesse, International Course for development oriented Research in Agriculture, Wageningen
- Ir. G.W. van Barneveld, DHV Consultants, Amersfoort
- Prof.Dr. J. Bouma, Department of Soil Science and Geology, Wageningen Agricultural University
- Prof.Dr. P.A. Burrough, State University Utrecht
- Prof.Dr.Ir. A. van Diest, Royal Netherlands Society of Agriculture, Wageningen
- Dr.Ir. P.M. Driessen, Department of Soil Science and Geology, Wageningen Agricultural University
- Ir. A.L.M. van den Eelaart, Euroconsult, Arnhem
- Dr.Ir. G.W.W. Elbersen, International Institute for Aerospace Survey and Earth Sciences (ITC), Enschede
- Ir. J. van der Heide, Institute for Soil Fertility, Haren
- Ir. W.B. Hoogmoed, Soil Tillage Laboratory, Wageningen Agricultural University
- Ir. E.R. Jordens, M.Sc. Course in Soil Science and Water Management, Wageningen Agricultural University
- Prof.Dr.Ir. H. van Keulen, Centre for Agrobiological Research (CABO), Wageningen
- Prof.Dr. S.B. Kroonenberg, Soil Science Society of the Netherlands, Wageningen
- Prof.Dr. Th.W.M. Levelt, Free University, Amsterdam
- Prof.Dr. J. Sevink, University of Amsterdam
- Prof.Dr. A.W.L. Veen, State University Groningen
- Ir. M.M. Vierhout, Haskoning Royal Dutch Consulting Engineers and Architects, Nijmegen
- Ir. W. van Vuure, Government Service for Agricultural Research, Ministry of Agriculture, Nature Management, and Fisheries, Wageningen
- Drs. R.F. van de Weg, Winand Staring Centre, Wageningen
- Dr.Ir. A.L.M. van Wijk, Winand Staring Centre, Wageningen

7.4 ISRIC STAFF

Staff members of ISRIC on 31 December 1990 were:

Director	:	Dr Ir W.G. Sombroek
Deputy Director	:	Drs J.H.V. van Baren

Section on Education and Information

Head; Scientific documentation	:	Drs J.H.V. van Baren
Educational matters, visitors servicing	:	Drs D. Creutzberg
Computer systems and database	:	Ing A.B. Bos
	:	Ir N. Manuchehri
Graphical design, photography	:	W.C.W.A. Bomer
Monolith preparation	:	Ing A.B. Bos
	:	Vacancy
Administration*)	:	J. Brussen
Secretarial services	:	Ms M-B.B.J. Clabaut
Library assistant	:	Ms J.C. Jonker-Verbiesen
Map documentation	:	Vacancy

Section on Research and Laboratory

Head; Soil forming processes	:	Dr Ir L.P. van Reeuwijk, M.Sc.
Lab. information and management systems	:	Ir J. Brunt
Micromorphology	:	Drs D. Creutzberg
	:	Ing R.O. Bleijert
Laboratory analysts	:	J.R.M. Huting
	:	R.A. Smaal
Senior laboratory analyst	:	Ing A.J.M. van Oostrum
Soil classification	:	Dr N.M. Pons-Ghitulescu

Section on Programmes and Projects

Head; Soter programme	:	Dr Ir R.L. Oldeman
Nasrec programme	:	Ir J.H. Kauffman
Labex programme	:	Ir J. Brunt
Corlat programme	:	Dr G.J.J. Aleva (guest)
Soil pollution/vulnerability	:	Ir N.H. Batjes
Glasod/Soter programme	:	Drs V.W.P. van Engelen
	:	Ir J.H.M. Pulles
Soil emissions		Vacancy

*) External administration by ITC, Enschede

itc

ISRIC

CERTIFICATE

This is to certify that the

SOIL LABORATORY OF THE FACULTY OF AGRICULTURE

UNIVERSITY OF PATTIMURA

AMBON - INDONESIA

has been equipped and instructed to perform routine soil analysis according to standards accepted by

International Soil Reference and Information Centre (ISRIC)

under the authority of

International Institute for Aerospace Survey and Earth Sciences (ITC)

as part of the Maluku Land Evaluation Project

MAY 1991, The Netherlands

Enschede,
ITC Project Supervisor

J. de Vos tot Nederveen Cappel
Associate Professor

Wageningen,
ISRIC Consultant

J. Huting
Technical Chemist

7.5 GUEST RESEARCHERS

Soil and other scientists working at ISRIC during (part of) 1990 as guest researchers were:

- Dr. G.J.J. Aleva, the Netherlands
- Dr. E.M. Bridges, United Kingdom
- Ir. G.R. Hennemann, the Netherlands
- Prof. W.L. Peters, Venezuela
- Dr. N.M. Pons-Ghitulescu, the Netherlands

Wouter Bomer, graphical designer, preparing nearly one hundred posters for Indonesia

APPENDIX 1 GROUP VISITS IN 1990 (approximate number of persons)

Belgium
- Dept. of Agric. Science, University of Ghent 10
- International Training Centre for Post-graduate Soil Scientists, Ghent 25

Fed. Rep. of Germany
- University of Hamburg 30
- Fachhochschule Osnabrück (2 visits) 40
- University of Oldenburg 25
- Technische Hochschule Aachen 20

Italy
- FAO, Rome; participants training project China 5
- FAO, Rome; participants Training AEZ Methodology for Land Resources Inventory and Crop Suitability 15

The Netherlands
- Free University, Amsterdam 15
- University of Amsterdam (2 visits) 40
- University of Utrecht (2 visits) 50
- University of Groningen 12
- Wageningen Agricultural University (11 visits) 265
- International Institute of Hydrologic and Environmental Engineering, IHE, Delft 20
- Agricultural College Van Hall, Groningen 10
- National Agricultural College, Deventer (3 visits) 60
- International Institute for Aerospace Survey and Earth Sciences (ITC), Enschede 28
- Horticultural College Warmonderhof, Kerk Avezaat 35
- Horticultural College Huis te Lande, Rijswijk 30
- College for Forestry and Land and Water Management, Velp (6 visits) 130
- International Course for Development oriented Research in Agriculture (ICRA), Wageningen 30
- International Soil Tillage Research Organisation, Haren 12
- International Institute for Land Reclamation and Improvement (ILRI), Wageningen 30

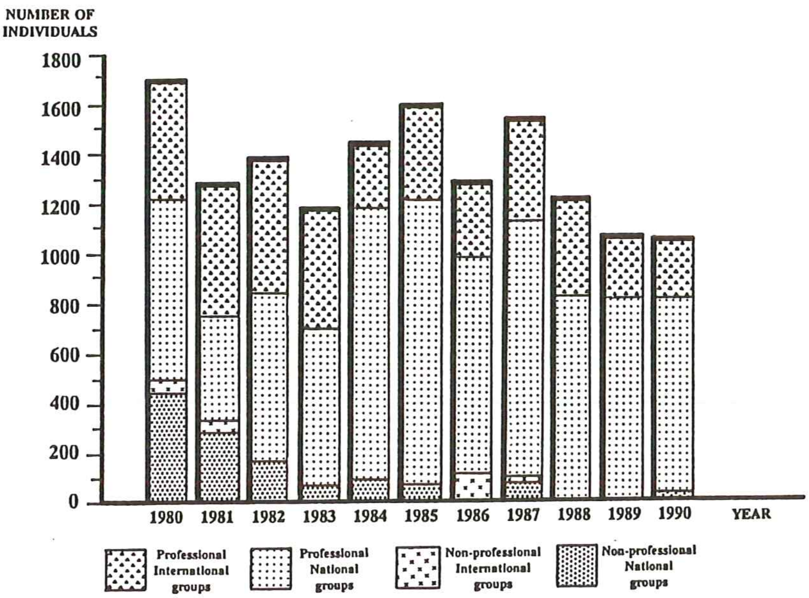
Sweden
- Swedish University of Agricultural Sciences, Uppsala (2 visits) 22

United Kingdom
- Portsmouth Polytechnic, Portsmouth (3 visits) 30
- University of Wales 20

Lecture rooms and other facilities used by:
- Wageningen Agricultural University 19x
- International Agricultural Centre 1x
- International Course for development oriented Research in Agriculture (ICRA) .. 3x
- Post-graduate Course on Soil and Plant Analysis 8x

Number of visitors from 1980 till 1990

Year	Professional International groups	Number of individuals in groups	Professional National groups	Number of individuals in groups	Non-professional International groups	Number of individuals in groups	Non-professional National groups	Number of individuals in groups	Total number of individuals in groups
1980	18	440	18	440	1	94	9	450	1694
1981	18	419	27	529	3	56	11	274	1278
1982	27	558	30	671	1	4	7	165	1398
1983	27	506	27	625	0	0	2	60	1191
1984	12	272	40	1098	0	0	3	81	1451
1985	16	358	48	1138	0	0	3	72	1568
1986	14	308	39	869	3	103	0	0	1280
1987	16	422	43	1022	1	17	1	70	1531
1988	17	397	37	815	0	0	0	0	1212
1989	12	247	33	816	0	0	0	0	1063
1990	16	242	36	787	0	0	1	15	1044
Total:	193	4169	378	9080	9	274	37	1187	14710
Average per year	17	379	34	825	0.8	25	3	108	1337



APPENDIX 2 LABORATORIES PARTICIPATING IN THE LABORATORY METHODS AND DATA EXCHANGE PROGRAMME (LABEX)

Inst. de Investig. Agronomica
C.P. 406
Huambo
ANGOLA

Inst. de Evaluacion de Tierras
Lab. de Suelos CIRN-INTA
1708 Castelar-Pcia Buenos Aires
ARGENTINA

Dept. of Primary Industries
Meiers Road
QLD 4068 Indooroopilly
AUSTRALIA

Div. of Trop. Crops and Pastures
306 Carmody Road
QLD 4067 St. Lucia
AUSTRALIA

CSIRO Division of Soils
Private Bag no. 2
SA 5064 Glen Osmond
AUSTRALIA

Institut für Bodenforschung
Gregor Mendelstrasse 33
A 1180 Wien
AUSTRIA

Dept. of Soil Science
Bangladesh Agric. Univ.
2202 Mymensingh
BANGLADESH

Bodemkundige Dienst van Belgie
De Croylaan 48
B-3030 Leuven-Heverlee
BELGIUM

Mision Brit. en Agricult. Trop.
Casilla 359
Santa Cruz
BOLIVIA

LaboratorioAgrícolaCORDECH
P.O. Box 156
Sucre
BOLIVIA

Soil Mapping and Advisory Unit
P.O.B. 54
Gaborone
BOTSWANA

SNLCS-EMBRAPA
Rua Jardim Botanico 1024 Gavea
22.460 RJ Rio de Janeiro
BRAZIL

Departamento de Solos
Fac. Agronomia, UFRGS
P.O. Box 776
90.001 RS Porto Alegre
BRAZIL

Bureau National des Sols
B.P. 7028
Ouagadougou
BURKINA FASO

IRA/CNS Ekona
PMB 25
Buea
CAMEROON

Canadian Forestry Service
5320 122 Street
Alberta T6H 3S5 Edmonton
CANADA

Land Resource Research Centre
Neatby Bldg. Centr. Exp. Farm
Ontario K1A 0C6 Ottawa
CANADA

Direction de la Recherche
2700, rue Einstein
Quebec G1P 3W8 Sainte Foy
CANADA

Soil, Plant & Feed Laboratory
P.O. Box 8700, Brookfield Road
St John's, NFLD
CANADA A1B 4J6

Universidad de Chile
Depto. Ingeniera Y Suelos
Casilla 1004 Santiago
CHILE

INIA
Casilla 439/3
Santiago
CHILE

Institute of Soil Science
P.O. Box 821
Nanjing
CHINA

Instituto 'Agustin Codazzi'
Apartado Aereo 6721
Bogota
COLOMBIA

C.I.A.T.
Apartado Aereo 6713
Cali
COLOMBIA

CATIE
Apt. Postal 187
7150 Turrialba
COSTA RICA

Instituto de Suelos
Apartado 8022
Ciudad - 8 Habana
CUBA

Soil & Water Science Dept.
Fac. Agric., Alexandria Univ.
Alexandria
EGYPT

Faculty of Agriculture
P.O. Box 281
Cairo
EGYPT

Soil Science Department
El Minia University
El Minia
EGYPT

Faculty of Agriculture
University of Cairo
Giza
EGYPT

ILCAF
P.O. Box 5689
Addis Ababa
ETHIOPIA

National Soil Service Project
c/o FAOR Office P.O.Box 5536
Addis Abeba
ETHIOPIA

Koronivia Research Station
P.O. Box 77
Nausori
FIJI

Institute of Natural Resources
P.O. Box 1168
Suva
FIJI

ORSTOM
70-74, Route d'Aulnay
93143 Bondy
FRANCE

Bundesanst. Geowissenschaften
Postfach 510 153
3000 51 Hannover
GERMANY Fed. Rep.

Soil Research Institute
Academy Post Office
Kumasi Kwadaso
GHANA

Agricultural Research Service
Land Reclamation Institute
547 00 Sindos
GREECE

Plant Protec. and Agric. Centre
Pf.127
H-1502 Budapest
HUNGARY

Nat. Bureau of Soil Survey
Regional Centre, Hebbal
560 024 Bangalore
INDIA

Pusat Penelitian Tanah
Jalan Ir.H. Juanda 98
Bogor 16123
INDONESIA

Brawijaya Univ. Dept. Soil Sc.
Jalan Majen Haryono 169
Malang
INDONESIA

Soil Institute of Iran
North Kargar Avenue
Teheran
IRAN

Ist. Sup. Latt. Caseario
Via L. Pilla 25/B
46100 Mantova
ITALY

Direction de Grand Traveaux
01 BP 1395
01 Bouake
IVORY COAST

Nat. Agric. Res. Laboratories
P.O. Box 14733
Nairobi
KENYA

SRCVO Laboratoire des Sols
Sotuba B.P. 438
Bamako
MALI

Centro de Edafologia
Colegio de Postgraduados
56230 Chapingo
MEXICO

Soil Survey and Land Eval.Proj.
Caixa Postal 3658
Maputo
MOZAMBIQUE

Forestry Research Division
P.O. Box 106
Kathmandu
NEPAL

Pakhribas Agricultural Centre
BTCO P.O. Box 106
Kathmandu
NEPAL

Jamaica Soil Survey Project
P.O.B. 20061
2500 EB Den Haag
NETHERLANDS

Dept. Soil Science and Geology
Postbus 37
6700 AA Wageningen
NETHERLANDS

ISRIC
P.O. Box 353
6700 AJ Wageningen
NETHERLANDS

Lab. Soil Science Plant Nutrit.
De Dreyen 3
6703 BC Wageningen
NETHERLANDS

DSIR Land Resources
Private bag
Lower Hutt
NEW ZEALAND

Forest Research Institute
Private bag 3020
Rotorua
NEW ZEALAND

LABOSOL ICRISAT CENTRE
SAHELIEN
B.P. 12404 Niamey
NIGER

Nigerian Inst. Oil Palm Research
P.M.B. 1030
Benin City
NIGERIA

Cocoa Research Inst. of Nigeria
P.M.B. 5244
Ibadan
NIGERIA

I.I.T.A.-NIGERIA
PMB 5320
Ibadan
NIGERIA

University of Ibadan
Department of Agronomy
Ibadan
NIGERIA

Soil Survey of Pakistan
P.O. Shahnoor Multan Road
54570 Lahore
PAKISTAN

Agricultural Chemistry Section
P.O. Box 2141
N.C.D. Boroko
PAPUA NEW GUINEA

EEA San Camilo - INIAA
Tupac Amaru 312 Cerro
Colorado, Arequipa
PERU

Soil Research Division
P.O. Box 1848
Ermita Manila
PHILIPPINES

Dole Philippines INC.
P.O. Box 362, CCPO, MM
Manila
PHILIPPINES

Centro de Estudos Pedologia
Tapada da Ajuda
1399 Lisboa
PORTUGAL

Labor. de Solos y Fertilidade
U.T.A.D.
5001 Vila Real
PORTUGAL

Institute of Tropical Forestry
P.O. Box 2500
00928 Rio Piedras
PUERTO RICO

Bureau National de Pedologie
B.P. 1374
Bangui
REP. CENTRAFRICAINE

Ministry of Agriculture & Water
Land Management Department
Riyadh
SAUDI ARABIA

Compagnie Sucriere Senegalaise
B.P. 2031
Dakar
SENEGAL

ORSTOM
B.P. 1386
Dakar
SENEGAL

Rice Research Station
P.M.B. 736
Freetown
SIERRA LEONE

Dodo Creek Research Station
P.O. Box G13
Honiara
SOLOMON ISLANDS

Laboratorio de Agric. y Aliment.
Apartado de Correos 1265
26080 Logrono (La Rioja)
SPAIN

Departamento de Edafologia
La Laguna Tenerife
Islas Canarias
SPAIN

Land Use Division
P.O.B. 1138
7 Colombo
SRI LANKA

Land Use Division
P.O. Box 1138
7 Colombo
SRI LANKA

Rubber Research Institute
Dartonfield
Agalawatta
SRI LANKA

Soil Survey Administration
P.O.Box 388
Wad Medani
SUDAN

Dienst Bodemkartering
Coppenamestr./Duisburg
Paramaribo
SURINAME

Swedish University Agric. Sci.
Box 7014
S-750 07 Uppsala
SWEDEN

Nat. Lab. Agric. Chemistry
Box 7004
S-750 07 Uppsala
SWEDEN

ICARDA
P.O. Box 5466
Aleppo
SYRIA

A.C.S.A.D.
P.O. Box 2440
Damascus
SYRIA

SELIAN Agric. Res. Inst.
P.O. Box 6160
Arusha
TANZANIA

TANZANIA-CANADA Wheat
Project
P.O. Box 6160 Arusha
TANZANIA

National Soil Service
P.O. BOX 5088
Tanga
TANZANIA

Dept. of Land Development
Phahonyothin Road, Bangkhen
10900 Bangkok
THAILAND

IBSRAM
P.O. Box 9-109
Bangkhen 10900 Bangkok
THAILAND

Institut National des Sols
B.P. 1026
Lome
TOGO

Direction des Sols
B.P. 96
6018 Gabes
TUNESIA

Direction des Sols
7050 Avenue de l'Independance
2080 Ariana
TUNISIA

PETTIET Agric. Services, Inc.
P.O. Box 838
38756 Leland, Mississippi
U.S.A.

California Growers Lab. Inc.
4630 W. Jennifer, Suite 104
CA 93722 Fresno
U.S.A.

Dellavalle Laboratory Inc.
1910 W. McKinley, Suite 110
CA 93728-1298 Fresno
U.S.A.

IBSNAT/Trop. Soils Projects
2500 Dole Street Krauss Hall 22
Honolulu 96822 Hawaii
U.S.A.

N.C.S.U. / Tropsoils Program
Box 7619
NC 27695-7619 Raleigh
U.S.A.

Soil Conservation Service/NSSL
100 Centennial Mall North
NE 68508-3866 Lincoln
U.S.A.

Trop. Soils Analysis Unit ODNRI
Central Ave., Chatham Maritime
Chatham, ME4 4TB Kent
UNITED KINGDOM

Caleb Brett International Ltd.
Lancots Lane
St. Helens WA9 3ES Merseyside
UNITED KINGDOM

Dirección de Suelos
Av. E. Garzón 456
Montevideo
URUGUAY

FONAI CENIAP
Apdo. 4653
2101 Maracay
VENEZUELA

Mt. Makulu Research Station
P.O. Box 7
Chilanga
ZAMBIA

Chem. and Soil Research Inst.
P.O.Box 8100
Causeway, Harare
ZIMBABWE

APPENDIX 3 ACRONYMS USED IN ANNUAL REPORT 1990

ACSAD	Arab Centre for the Studies of Arid Zones and Dry Lands, Syria
ALES	Automated land evaluation system
BAMEZ	Brazilian Amazon (agro)ecologic and (socio)economic zoning project
BRASOTER	SOTER Project, Brazil
CABO	Centre for Agrobiological Research, the Netherlands
CASOTER	SOTER Project, Central America
CASREC	Central American Soil Reference Collection
CATIE	Centro Agronomico Tropical de Investigación y Ensenanza, Costa Rica
CTB	Chemical Time Bombs project, the Netherlands
CESOTER	SOTER Project, Central Europe
CGIAR	Consultative Group of International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical, Colombia
CORLAT	International Collection of Reference Laterite Profiles, ISRIC
CSR	Centre for Soil Research, Indonesia
CSRI	Chemistry and Soil Research Institute, Zimbabwe
CTA	Centre Technique de Cooperation Agricole et Rurale, the Netherlands
DGIS	Directorate-General for International Cooperation, Ministry of Foreign Affairs,
DHV	DHV Consultants, the Netherlands
DLO	Government Service for Agricultural Research, Ministry of Agriculture, Nature Management and Fisheries, the Netherlands
EASOTER	SOTER Project, East Africa
EEC/EC	European Economic Community
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuaria, Brazil
FAO	Food and Agriculture Organization of the United Nations
FOFIFA	Centre National de la Recherche Appliqué au Developpement Rural, Madagascar
GEPLACEA	Group of Latin American and Caribbean Sugar Exporting Countries, Cuba
GIS	Geographic Information System
GLASOD	Global Assessment of Soil Degradation project, ISRIC
GLP	Good Laboratory Practice
IAC	International Agricultural Centre, the Netherlands
IAP	International Advisory Panel of ISRIC
IB	Institute for Soil Fertility, Haren
IBSNAT	International Benchmark Sites Network for Agrotechnology Transfer, U.S.A.
IBSRAM	International Board for Soil Research and Management, Thailand
ICARDA	International Center for Agricultural Research in the Dry Areas, Syria
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics, India
ICSU	International Council of Scientific Unions
IFIAS	International Federation of Institutes for Advanced Study
IGAC	International Global Atmosphere Chemistry programme, IGBP
IGBP	International Geosphere-Biosphere Programme, Sweden
IHSS	International Humic Substances Society, the Netherlands
IITA	International Institute of Tropical Agriculture, Nigeria
ILRI	International Institute for Land Reclamation and Improvement, the Netherlands
IMADOC	International Map Documentation, ISRIC
INIAA	Instituto Nacional de Investigación Agraria y Agro-industriaal, Peru
INICA	Instituto Nacional de Investigación de Cana de la Azucar, Cuba
INTECOL	International Congress of Ecology
IRB	International Reference Base for soil classification, ISSS
IRRI	International Rice Research Institute, The Philippines

ISE	International Soil Exchange programme, WAU
ISEC	Soils and the Greenhouse Effect, ISRIC
ISIS	ISRIC Soil Information System
ISNAR	International Service for National Agricultural Research, the Netherlands
ISRA	Institut Senegalais de Recherches Agricoles, Senegal
ISSS	International Society of Soil Science
ITC	International Institute for Aerospace Survey and Earth Sciences, the Netherlands
IUBS	International Union of Biological Sciences
KEMA	Research and Development, Testing and Certification, and Consultancy Services for the Electric Power Industry, the Netherlands
KNAW	Royal Netherlands Academy of Arts and Sciences
LABEX	Laboratory Methods and Data Exchange Programme, ISRIC
LCC	Land Cover Change
LIMS	Laboratory Information Management System
LASOTER	SOTER Project, Latin America
LRRC	Land Resources Research Centre, Canada
MAB	Man and the Biosphere Programme, Unesco
MARNR	Ministerio del Ambiente y de los Recursos Naturales Renovables, Venezuela
MOW-WB	Department of Science Policy, Ministry of Education and Sciences, the Netherlands
NAC	Netherlands Advisory Council for ISRIC
NASOTER	SOTER project, North America
NASREC	National Soil Reference Collections, ISRIC
NASRIC	National Soil Reference and Information Centre
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
PUDOC	Centre for Agricultural Publishing and Documentation, the Netherlands
SCOPE	Scientific Committee on Problems of the Environment, ICSU
SCS	Soil Conservation Service, USDA, U.S.A.
SDB	FAO-ISRIC Soil Database
SMSS	Soil Management Support Services, SCS, U.S.A.
SOBIN	Annotated bibliography of pre-Independence literature of soils in Indonesia
SOTER	World Soils and Terrain Digital Database, ISSS
SSD, LDD	Soil Survey Division, Land Development Department, Thailand
SOVEUR	Soil and Terrain Vulnerability mapping, ISRIC
SWASOTER	SOTER Project, South-West Asia
TSBF	Tropical Soil Biology and Fertility Programme, IUBS/Unesco
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
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
UZ	University of Zimbabwe
VROM	Ministry of Housing, Physical Planning and the Environment, the Netherlands
WASOTER	SOTER Project, West Africa
WAU	Wageningen Agricultural University
WDC	World Data Centre of ICSU
WG/RB	ISSS Working Group on International Reference Base for soil classification

WG/DM	ISSS Working Group on World Soils and Terrain Digital Data Base
WG/HP	ISSS Working Group on the History, Philosophy and Sociology of Soil Science
WOTRO	Netherlands Foundation for the Advancement of Tropical Research
WSC	Winand Staring Centre, the Netherlands
WOFOST	World Food Study model

REQUEST FOR MAPS AND REPORTS ON SOIL RESOURCES

Cartographic materials form an important part of ISRIC's documentation section. Geographic coverage of the collection is the whole world with emphasis on developing countries. The subject emphasis is on soils, but related geographic information on climate, ecology, vegetation, land use, land capability, geology, geomorphology, etc. is also of importance to the collection.

The acquisition policy is to obtain world coverage of maps at reconnaissance and smaller scale; examples of more detailed maps and index maps/lists of soil and related surveys carried out in a country. The selection criteria are relevance of the maps for soil science, agricultural development and environmental issues.

The major purpose of maintaining and enlarging the map collection at ISRIC is its use for the possible updating of the FAO-Unesco Soil Map of the World at scale 1:5 million and the compilation of a new, computerized world soil map at 1:1 million. the map collection serves also as a source of basic information for scientists and students using ISRIC's facilities for guest research or training.

You are kindly requested to send maps and accompanying reports, of the types indicated above, either:

- directly to ISRIC, P.O. Box 353, 6700 AJ Wageningen, the Netherlands
- through the Dutch Embassy or Consulate in your country;
- or through the Regional Office of Unesco or FAO.

PUBLICATIONS

Soil Monolith Papers

1. Thionic Fluvisol (*Sulfic Tropaquept*) Thailand, 1981
5. Humic Acrisol (*Orthoxic Palehumult*) Jamaica, 1982
6. Acri-Orthic Ferralsol (*Haplic Acrorthox*) Jamaica, 1982
7. Chernozem calcique (*Vermustoll Typique*) Romania, 1986

Soil Briefs

EC 06 Haplic Nitisol (*Typic Kandiudult*), Ecuador, 1991

Technical Papers

1. Procedures for the collection and preservation of soil profiles, 1979
2. The photography of soils and associated landscapes, 1981
5. The flat wetlands of the world, 1982
7. Field extract of "classification des sols", 1984
9. Procedures for soil analysis, 1986; 2nd ed., 1987; 3rd ed., 1992
10. Aspects of the exhibition of soil monoliths and relevant information (prov. ed., 1985)
11. A simplified new suction apparatus for the preparation of small-size porous plate clay specimens for X-ray diffraction, 1986
12. Problem soils: their reclamation and management (copied from ILRI Publication 27, 1980, p. 43-72), 1986
13. Proceedings of an international workshop on the Laboratory Methods and Data Exchange Programme: 25-29 August 1986, Wageningen, the Netherlands, 1987
14. Guidelines for the description and coding of soil data, revised ed., 1988
15. ISRIC Soil Information System - user and technical manuals, with computer programme, 1988
16. Comparative classification of some deep, well-drained red clay soils of Mozambique, 1987
17. Soil horizon designation and classification, 1988
18. Historical highlights of soil survey and soil classification with emphasis on the United States, 1899-1970, 1988
19. Soil horizon designations, 1990
20. FAO-Unesco Soil Map of the World. Revised Legend, field edition, 1989
21. Technical Report on Agroclimatic Characterization of Madagascar, 1990
22. Methodological Guidelines for Forecasting the Geochemical Susceptibility of Soils to Technogenic Pollution, 1991

Soil Monographs

1. Podzols and podzolization in temperate regions, 1982
   with wall chart: Podzols and related soils, 1983
2. Clay mineralogy and chemistry of soils formed in volcanic material in diverse climatic regions, 1989
3. Ferralsols and similar soils; characteristics, classification and limitations for land use, in prep.

Wall charts

- Podzols and related soils, 67 x 97 cm, 1983 (see Soil Monograph 1)
- Soils of the World, 85 x 135 cm, 1987 (Elsevier Publ. Company, in cooperation with ISRIC, FAO and Unesco)

AIMS OF ISRIC

* Serve as a documentation centre on land resources through its collectio soil monoliths, reports and maps on soils of the world, with emphasis on developing countries

* Transfer information on soils and land resources; improve methods of analysis and advise on equipping and running soil laboratories; and pron the establishment of soil reference collections and databases

* Stimulate and contribute to developments in soil classification, soil mapp and land evaluation and in the development of a geographically referen world soils and terrain digital database

* Improve the understanding of land resources for sustained utilization changing global environment

ISRIC

International Soil Reference and Information Centre

ISRIC
P.O. Box 353
6700 AJ Wageningen
The Netherlands

phone : +31 (0)8370 19063
fax : +31 (0)8370 24460
E-mail : ISRIC@RCL.WAU.
telex : 45888 intas nl

Visiting address: 9 Duivendaal, Wageningen (near IAC)
Bank account: AMRO-Bank, Churchillweg 4, Wageningen, no. 41.31.03.196

ISBN: 90-6672-047-6