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ANNUAL REPORT 1985

International Soil Reference and Information Centre
Wageningen - The Netherlands

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. It 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 for Education and Sciences, and are accountable to the Directorate-General for International Cooperation (DGIS) of the Ministry of Foreign Affairs.

The constituent members of the Board of ISRIC are the International Institute for Aerospace Survey and Earth Sciences (ITC) in Enschede, the Wageningen Agricultural University (WAU) and the Directorate for Agricultural Research (DLO).

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

The financial-administrative responsibillity for the working funds and for the permanent staff of ISRIC rests formally with the Board of Governors of ITC.

Up to 31 December 1983 the name was International Soil Museum (ISM).

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CONTENTS

1 INSTITUTIONAL DEVELOPMENTS

The year 1985 was characterized by the development of a rolling five-year plan for the Centre, and an internal evaluation of several of its activities, viz. the publication programme, the annual training course, and the educational functions.

In the five-year plan, a systematic distinction was made between core-funded activities (soil monolith collection; exhibition and publication; research on individual monoliths and on groups of soils; training and education; map collection; and library), non-core activities with assured project financing (LABEX and NASREC programmes); bilateral cooperation arrangements, and non-core activities for which finances are still being procured.

The yearly six-weeks training course for scientists from developing countries on the establishment and managing of national soil reference collections, or soil musea, takes up substantial manpower in preparation, running and follow-up, considering that only about six trainees can be accommodated per course. It is however an essential training component of the NASREC programme, and often results in obtaining additional representative soil monoliths for the Centre's world collection (the "pedonarium") through the efforts of former trainees. The course is now officially recognized as a Unesco course.

Many groups of European students and scientists continue to include a one-or-two days visit to ISRIC's exhibition and other facilities in their training programme. Consolidation and further improvement upon such educational functions of the Centre is highly desirable. With the enthusiastic support of 20 departments of soil science and/or physical geography of West European universities, an application was submitted for financial support for this function to the Directorate for Cooperation in Higher Education of the Commission of the European Communities in Brussels.

The evaluation of the publication programme resulted in a decision to give less attention to the series "Soil Monolith Papers", because of the limited interest shown by developing-country scientists, notwithstanding the low pricing. Henceforward, more effort will be put into building up the incipient series "Soil Monographs". They encompass a comparative study of a substantial number of soil monoliths and other well-documented soil profiles that belong to a major group of the world's soils (Podzols, Andosols, Ferralsols, Vertisols, etc.). The catalytic force to prepare these publications is the presence of one or two senior foreign guest researchers at the Centre. Their subject of study moreover gives a yearly focal point to the limited amount of research that can be carried out by the permanent staff of the various sections.

The scientific backstopping, over the past five years, of the work of three Unesco associate experts in ecology/soil science has resulted in a MAB Technical Note entitled "Guidelines for soil survey and land evaluation in ecological research", now being distributed by Unesco to its MAB correspondents the world over. ISRIC staff was also engaged in the establishment of methods of chemical laboratory analysis and site characterization of soils for the Tropical Soil Biology and Fertility network research programme, planned by the International Council of Scientific Unions. The Director was involved in the planning of an interdisciplinary programme on ecological research in tropical lowland forests (Tropenbos), initiated by the Dutch Ministry of Education and

Sciences.

The Centre's programme on comparison of methods, procedures and results of laboratory analysis for soil characterization (LABEX) could enlarge its circle of participants to over 80 laboratories, mainly from developing countries, thanks to project funding by the Dutch Directorate-General for International Cooperation (DGIS). Towards the end of the year also another special programme, viz. the effective promotion of the establishment of national soil reference collections in a number of developing countries (NASREC) was started, thanks to a project grant from the UNEP/DGIS "Clearing House" facility. Under this programme, three countries will receive major support for establishing such a collection, and three or four others a more limited support.

ISRIC gladly accepted an invitation by FAO to cooperate in a revision and detailing of the soil classification terminology of the Legend for the FAO-Unesco Soil Map of the World. A small experts group met alternatively in Wageningen and Rome for the purpose. The resulting draft revision is to be submitted for technical comments to soil surveyors in many countries and to the 13th International Congress of Soil Science in Hamburg, Fed. Rep. of Germany, in 1986, before finalization and joint publication by FAO, Unesco and ISRIC.

The collection of generalized soil maps and related documentation is regularly expanding, and is becoming a valuable tool for any international programme on global soil resources assessment. Preparations were made, through the compiling of a background document and the creation of a provisional ISSS Working Group, for a programme of digitized soil and physical land resources inventory and assessment at 1:1 million scale and associated computerized database. ISRIC is to be the host of an international workshop on the subject early 1986.

Thanks to the availability of temporary staff, a good start was made with computerising the Centre's soil pedon data (ISIS) after a scrutiny of compatibility and transferability to national systems as regards both hard- and software.

The efforts to build up a small interdisciplinary reference collection of whole laterite profiles (CORLAT) were hampered by lack of funds for the actual sampling and forwarding of representative bulk material. A literature study of engineering properties of such materials and adapted methods of suitability testing was however carried out through the temporary seconding of a specialist by the Fund for Wageningen graduates (MPW).

Preparations continued to make ISRIC a separate foundation, with international representation on its Board of Management, and a management contract for financial and personnel administration with a major research or educational institution in Wageningen or elsewhere in The Netherlands.

NOTICE
For changes of address, requests for the exchange of publications, etc. please see the form on page 73.

2 REVIEWS AND ARTICLES

SOIL SURVEY AND LANDSCAPE ECOLOGICAL SURVEY

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Abstract

The roots of modern physiographic soil surveys lie in nineteenth century Agrogeology and in the work of V.V. Dokuchaev. Soil surveys are well-suited for the inventory of land resources for intensive land uses such as arable land farming and horticulture, in particular in areas which are more or less stable from the geomorphological viewpoint. They are less applicable for forestry and rangeland and for agriculture in hilly and mountainous areas. Development projects and also land use planning in fragile or vulnerable areas demand additional information. For these and similar purposes ''integrated multidisciplinary surveys of the natural environment'' and landscape ecological surveys (ecological land surveys) were developed. Soil surveys remain of considerable importance in stable areas for planning of intensive land uses; they are also an indispensable tool for pedological investigations.
Landscape ecology was developed by Carl Troll around 1938; it has later also been called ''geo-ecology'' (Fr. ''géo-écologie''). It is a means of combining the surveys of abiotic and biotic components of the landscape in one holistic survey method. This was aided by the development of airphoto-interpretation as a survey tool. Where relevant these surveys also include the climatic aspects of ''life-zones'' and the slope aspect. On detailed and semi-detailed maps in mountainous areas, altitude and aspect are used to indicate ecoclimatic zones of primary importance. In all cases, the essential data about the soils, and all soil differences of ecological influence, have to be mapped also in landscape ecological surveys. An example of a landscape ecological map on scale 1:50,000 of an area in Tuscany, Central Italy, is given. Some indications are provided on the conditions in which landscape ecological surveys are a more useful tool than soil surveys.

Land evaluation based on landscape ecological maps obtains a wider scope than is possible on the basis of soil maps.

Introduction

The need for a good knowledge of soil and land resources is as old as agriculture itself. In particular in periods of extension of land use over new surfaces and of reorganisation of existing agriculture, a systematic knowledge of these resources is essential. This knowledge has not always been collected in the shape of the soil surveys as we know them today. In the nineteenth century there were already in Western Europe schools of what was then called ''Agrogeology'', in France represented by E. Risler and in The Netherlands by W.C.H. Staring. Agrogeology was a means of using data on surface geology, largely geology of the Quaternary, for agricultural and related purposes.

Modern soil survey developed gradually on the basis of the work of V.V. Dokuchaev, who recognized the influence of pedogenesis and established the basic ideas for soil classification into what we now call the ''Soil Groups'', or in East-Central European nomenclature the ''Soil Types''. In the first instance these were used for soil differences over very large areas, for example continents, on very small scale maps, such as 1:20 million. The U.S.A. was one of the first countries of the world where soil maps were made with the specific objective of providing useful knowledge to the farming community (C.F. Marbut, C.E. Kellogg). The scale of 1 inch to 1 mile (approx. 1:63,000) and the development of the soil series as the main unit for mapping and classifying soil units, made this possible. During the same period E.C.J. Mohr studies the soils of

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Indonesia and made the first soil maps in that country.

Between 1920 and 1940 soil surveys were carried out in several other countries, e.g. Germany (H. Stremme) and in several British colonies (e.g. Kenya, G. Milne).

In 1950 Edelman published the results of his physiographic approach to soil surveys, in which emphasis was put on the soil as part of the landscape. A similar approach is now standard procedure in many countries (Sombroek and Van de Weg, 1980).

Soil surveys for forestry purposes had only limited use in most countries and forestry for a long time was more interested in vegetation surveys. A certain competition was sometimes felt between soil surveyors and vegetation surveyors, but also attempts were made to compare, and where possible combine, these two ways of approach to mapping of land resources (Zonneveld, 1960). Since 1950 soil surveys have however become a regular, and extremely useful, tool for research purposes, as well as for land development and land use planning. This is testified by the many soil maps which are extensively used in many countries as well as for projects of global dimensions (FAO-Unesco, 1974). Soil surveyors also developed land evaluation in order to systematize the application of their maps to land use planning (Vink, 1975; FAO, 1976; Beek, 1978; Laban Ed., 1981).

Soil mapping in the traditional sense never gained firm footing in forestry. For agricultural purposes in mostly hilly or mountainous countries it was also rarely applied. Furthermore, many development projects need additional information to what is provided by soil surveys (Van der Meer, 1962). This was one of the reasons for studying the possibilities of "integrated surveys of the natural environment" (Rey Ed., 1968). A new tool was developed, based on a more holistic philosophy, today called "landscape ecological surveys" or "ecological land surveys" (Zonneveld, 1979; Vink, 1983; Bennema, 1985). In this method the many essential aspects of soil surveys can be incorporated within a wider system. Soil surveys and landscape ecological surveys together will be able to meet the many challenges of coming decades.

Soil surveys for research and for practical uses

Perhaps the oldest examples of soil maps to be used as a research tool are the maps indicating zonal soils in relation to climatic and vegetation zones. Soil surveys on large scales, for example 1:50,000, are useful for detecting and indicating relationships between pedogenesis and various soil forming factors such as parent materials, topography, vegetation, land use and time. Some examples are found in recent publications (Sevink et al., 1984).

Modern soil classifications such as the USDA Soil Taxonomy show perhaps the clearest results of the use of soil surveys for scientific purposes. None of the modern soil classifications could have been made without the existence of a huge body of maps and other data provided by the soil surveys made in the previous decades. Soil classification has to be based on an extensive knowledge of data and these can only be provided in a systematic and coherent manner by soil surveys, whether they have originally been made for practical purposes or with special research objectives. Soil survey is always a method of research, and apart from its many other uses, it will always remain essential for soil science itself.

This may be summed up in the following points:

1. soil survey is the only means to provide a complete inventory of the soils in an area;
2. based on this inventory, and during its survey, three-dimensional relationships within the area are found, e.g. between soils, geomorphology, and parent materials;
3. in many cases the fourth dimension, time, may also be studied in the same manner, e.g. soils on terraces of different ages in parent materials of similar origin and composition;
4. the survey produces a large amount of "analogous series"; genetical and ecological sequences of geogenetic as well as pedogenetic processes;
5. soil maps are "visual models" of soil relationships within the landscape and as such they are tools comparable to mathematical and electrical analogous models, including the availability of many quantitative data such as: surface area, altitude, intensity and surface area of erosion, mass wasting, etc.;
6. the soil map is the only efficient means for taking representative samples of soils for laboratory investigations as well as for field measurements, for example of physical data.

Soil surveys in unstable and in stable areas

It is difficult to estimate the total surface area of the world of which soil surveys on various scales have been made between 1950 and today. Two things may be stated however;

1. the largest development of soil surveys took place between 1950 and 1970,
2. most of the objectives of these soil surveys were connected with changes in agricultural use or with development of land use for agricultural purposes; most of these had to do with arable farming.

The selection of the areas to be surveyed was therefore in general based on the knowledge or the likelihood that arable farming would in some manner be practicable in a large part of the area to be surveyed. In a geomorphological sense this selection was therefore directed towards rather stable surfaces: areas where a sustained production of arable crops was likely to be feasible. Such areas have in general a level to rolling topography and rather deep soils, often with a more or less clear horizon differentiation. In arid areas, if no irrigation projects were considered, sometimes vegetation surveys were preferred with rangeland use as their main objective (Vinogradov, 1967; Thalen, 1979).

In other not so stable and sometimes very unstable areas development of arable land use was less likely to occur. These are often mountainous and have more or less shallow soils on, locally very steep, slopes. An exception should be made for areas with volcanic parent materials. The age-old paddy system on steeply sloping hills even in some non-volcanic areas is another exception. On the whole it may be said however that a much smaller surface area of unstable land surfaces has been mapped. Even on small-scale national soil maps these areas are often shown with a reduced soil map legend; on medium-scale maps they are often depicted as "miscellaneous land types".

The development of national soil survey organisations has had a number of different incentives. Economic needs of agriculture have played an important role, for example in the 1930's in the U.S.A. when agriculture was reorganising and starting to combat soil erosion. During the same period in the Dutch East Indies (Indonesia) the first transmigration projects for Javanese to settle on other islands were made. In the period 1945 to 1960 in The Netherlands horticulture -always an important activity- developed into the nation's foremost export industry. The influence of very active soil scientists must also be noted: Marbut and Kellogg in the U.S.A., Edelman in The Netherlands and Tavernier in Belgium and in other parts of Europe. But it still seems a fair proposition that soil survey developed better in countries which have a large surface area of good arable soils, for example Belgium and The Netherlands, and less in mountainous countries such as Norway and Switzerland. In the latter countries other landscape factors are often more decisive: altitude and the resulting temperature regimes, exposition ("site") for orchards and vineyards (see e.g. Schreiber, 1968; Schreiber et al., 1967), stoniness and texture of parent materials. The latter may be found on geological maps such as have been made in Sweden and Denmark, where the surface (Quaternary) geology plays a predominant role and where most surfaces are relatively young due to the ice-covers in the Last Glacial Age.

The need for additional data: integrated surveys

If the 1950's is the decade of the first expansion of soil surveys in developing countries, the 1960's might be indicated by the expansion of activities by consulting engineers in land development projects in these areas. Very often these were irrigation and drainage projects and here it was found that data on climate, hydrology and topography are often even more essential than soil surveys (Van der Meer, 1962). In addition, the development of scientific methods for the interpretation of aerial photographs (Buringh, 1960; Edelman et al, 1962), brought an awareness among scientists from various disciplines (photogrammetry, geology, soil science, geomorphology, plant ecology, forestry) that a combined use of the same stereoscopic photo-images might produce better applicable results.

The use of "Integrated Surveys of the Natural Environment" had in fact already started in the 1940's in Australia where the Land Research Division of CSIRO, under the leadership of C.S. Christian, made integrated reconnaissance surveys of the Australian continent, and after 1950 also of Papua New Guinea. The Unesco Conference on Aerial Surveys and Integrated Studies (Toulouse, France, 1964) provided an excellent platform for discussing these various aspects (Rey Ed., 1968).

Integrated surveys are multidisciplinary surveys of the natural environment in which the participating disciplines are selected according to their relevance for the development of the area concerned. They have a maximum relevance for planning and for land management including a coherent presentation of the results of the survey. In the CSIRO surveys this was done by formulating the Land Systems (on maps at scales 1:250,000 to 1:1 million). Gradually methods were developed to produce integrated surveys at large scales, for example by the Land Resources Development Centre (London), by the Service de la Carte de Végétation CNRS (Toulouse) and by the ITC/Unesco Centre for Integrated Surveys (Delft, now the Survey Integration Group of ITC, Enschede). At the latter institute also integration of data on the natural environment with those from the social sciences was aimed at (Nossin et al., 1977; Luning, 1986).

Integration of multidisciplinary data can be done from different viewpoints: the agronomic, the engineering, the socio-economic, and the ecological viewpoint. Each has its own merit. The agronomic viewpoint aims at the best way of producing crops. The engineering viewpoint aims at the best ratio between the investments for and the results of a given project. The socio-economic viewpoint tries to indicate the best future social and economic results for the region concerned. The ecological viewpoint aims at producing and managing cultural ecosystems in order to reduce as far as possible ecological instability; where feasible it also indicates the needs and possibilities for the conservation of (semi-)natural ecosystems. The four viewpoints are not inconsistent, although differences in emphasis tend to exist. The ultimate aim is however to integrate these viewpoints as far as possible within each project for land use planning, whether for large-scale development with concurrent investments or for small-scale developments within existing social and ecological systems (Soemarwoto, 1977). Some of the answers to this may be found in the new discipline of landscape ecology.

Development of the concept of landscape ecology

The term ''landscape ecology'' was introduced by the German geographer Carl Troll in 1938, who later (1970) also used the term ''geo-ecology'' (French: ''géo-écologie'') for the same purpose. It is meant to produce the synthesis between abiotic and biotic components of the landscape. Several definitions have been given. One of these is: ''Landscape ecology is an approach to the study of the landscape which interprets it as supporting natural and cultural ecosystems'' (Vink, 1983). Within this context, the approach may be differentiated depending on the organisms to which emphasis is given. The following are of particular importance (Vink, 1982):

1. the phytocentric approach in which plants and vegetation play the central role;
2. the zoöcentric approach in which animal communities and their relationships with the landscape are given emphasis;
3. the anthropocentric approach in which emphasis is given on the relationships within the landscape as seen from the human viewpoint.

The latter approach provides the best basis for land use planning in its widest sense, including the conservation and management of nature reserves. It embraces not only the needs of man, but also human responsibilities with regard to other organisms as well as towards future human generations.

Landscape ecology tends to view the landscape as a whole, without neglecting the precise data of different land factors which are necessary for practical use (Zonneveld, 1979). This holistic approach to the landscape gives a more balanced result, for example in integrated multidisciplinary surveys, than would otherwise be obtainable.

Landscape ecological investigations provide comprehensive data for land evaluation. In particular the anthropocentric approach shows many similarities to the viewpoints given in the FAO Framework for Land Evaluation (FAO, 1976), where the definition of ''land'' reads: ''An area of the earth's surface, the characteristics of which embrace all reasonably stable, or predictably cyclic, attributes of the biosphere vertically above and below this area including those of the atmosphere, the soil and underlying geology, the hydrology, the plant and animal populations, and the results of past and present human activity, to the extent that these attributes exert a significant influence on present and future uses of the land by man''.

Taking into account that land uses include nature conservation and related activities, ''landscape'' in the sense of anthropocentric landscape ecology may be defined as: ''A natural arrangement of mutually related tracts of land with a structure which is characterized by certain internal processes'' (Vink, 1983). With regard to forestry land evaluation, Bailey (in Laban Ed., 1981) writes of ''integrated approaches to classifying land as ecosystem''. Wiken and Ironside (1977) use the terms: ''biophysical land classification'' and ''ecological land classification''. Bennema (1985) writes: ''From the physiographic (soil) mapping methodology and its applications a number of disciplines have sprung in which integration has a central position, e.g. ecological land evaluation, integrated surveys and landscape ecology'' (translation by the present author: see also Beek, 1978).

Landscape ecological surveys often use more geomorphological and vegetation characteristics as differentiating criteria, but this does not mean that the use of soils as differentiating criteria may not be the best survey method in some ''major landscapes''. Legends of landscape ecological maps distinguish ''major landscapes'', ''sublandscapes'' and ''land units'' which may also be indicated with other terms (Vinogradov, 1967; Jurdant et al., 1977; Bailey in Laban Ed., 1981). The legend of each major landscape has to be adapted to the specific characteristics found within that landscape (Vink, 1983). An example of a landscape ecological map map (scale 1:50,000) is given in Figure 1 and Table 1 (Westerveld et al., 1984).

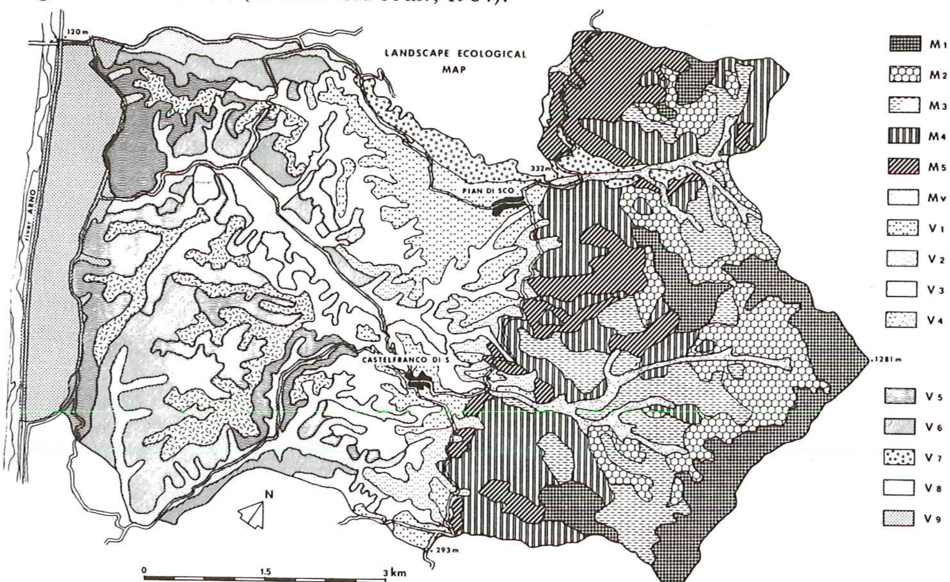

Fig. 1. Landscape ecological map of an area in Tuscany, Central Italy, with two major landscapes: M - Macino mountainous landscapes; V - Valdarno (valley of the river Arno) landscape. Original scale: 1:50,000. For legend see Table 1 (Westerveld et al., 1984)

Table 1:Legend of the landscape ecological map of an area in Tuscany, Central Italy.
For the sake of brevity the additional diagnostic characteristics have been omitted, including: soil group and drainage phase, and in the case of the M landscape also soil texture, which is very homogeneous (sandy loam).

	M-landscape	differential characteristics							
	land unit	altitude in m	land use	stab-ility*	man-made terrace	vegetation	slope form	pH	nr.of obs.
M1	divides	> 750	wood + shrub	3	absent	shrubland	(--)	4.5-5.0	15
M2	instabilities and associated source areas	--	wood + shrub	3	(absent)	forest	straight + flat	4.5-5.0	18
M3	areas of accumulation below faults	(625-750)	(wood + shrub)	0	(present)	shrubland	(concave)	4.5-5.0	23
M4	slopes with unstable parts	425-525	(wood + shrub)	0	present	arable	convex	(5.5)	27
M5	relatively stable lower slopes and footslopes	325-425	orchards	0	present	arable	convex	(5.5)	19
Mv	valleys	325-700	grassland	0	absent	grassland	concave+ flat	(5.5)	-

( ): class is not significantly characteristic ($ac = 0.1$) for the land unit according to one-sample tests; -- : two modal classes

* : 3 = (very) instable

	V-landscape (> 350 m)	differential characteristics									
	land unit	slope in degrees	slope form	geology	altitude in m	denud-ation	parent material	physiography	land use	texture	gravel content
V1	pianalto	2-8	straight flat	Vcg + Sb	250-350	0	colluvium alluvium	"high plain"	arable land	sand	(slightly gravelly)
V2	slightly eroded pianalto	9-14	(concave)	Vcg + Sb	250-350	(1)	(--)	slopes	(arable land)	(sandy loam)	(gravelly)
V3	cliffs	24	straight flat	Vs	200-250	3	slope dep. colluvium	slopes	wood + shrub	sandy loam	(slightly gravelly)
V4	steep slopes ass. with remnant ridges	24	straight flat	Vag	(200-250)	3	slope dep. colluvium	slopes	grazing land	(--)	absent
V5	upper colluvial slopes	--	complex	Vag	150-175	3	slope dep. colluvium	slopes	--	(loam)	absent
V6	lower colluvial slopes	(9-14)	complex	Vag	150-175	(1)	colluvium alluvium	slopes	arable land	(--)	absent
V7	fluviatile terraces	2-8	straight flat	Q + Qt	(--)	0	colluvium alluvium	fluviatile deposits	(--)	sand	(slightly gravelly)
V8	tributary valley bottom	2-8	valley bottom	Q + Qt	150-175	0	colluvium alluvium	valley bottom	arable land	sandy loam	(absent)
V9	Arno valley bottom	0-1	valley bottom	Q + Qt	100-150	0	colluvium alluvium	fluviatile deposits	arable land	(silt)	absent

( ): class is not significantly characteristic (ac =0.1) for the land unit according to one-sample tests; --: two modal classes

Landscape ecological maps combine as efficiently as possible the data given on physiographic soil maps with those of "ecological" or "life zone" maps (Holdridge, 1967; Tosi, 1983). But, whereas the latter have thusfar been mainly produced on small scales (1:200,000 to 1:10 million), the landscape ecological maps are in particular produced on scales which are suitable to land use planning (1:25,000 to 1:200,000). This is done with methods similar to those of soil surveys. Life zones, or ecological zones, are based on climatological and phytoecological data. These are very relevant on large scale maps of regions where they coincide with differences in altitude and in exposure to sun and for winds. In the example given the altitudes of the land units have been given emphasis in the Macigno (M) landscape, which embraces three ecological zones: Lauretum (below 350 m above sealevel), Castanetum (350 to 750 m) and Fagetum (above 750 m).

Soil surveys compared with landscape ecological surveys

In a soil survey, three basic aspects may be recognized:

1. the soil classification which is used, for example the USDA Soil Taxonomy, or the FAO/Unesco, French, German, or Soviet classifications;
2. the contents of the soil units mapped: the "soil-landscape bodies" (Schelling, 1970), i.e. the legend of the soil map;
3. the delineation of the boundaries between the mapped soil units.

The soil classification used is independent of the map scale; its main function may even be said not to lie within the mapped area itself, but in the possibilities for comparison with other areas. With regard to practical uses, this classification is extremely important for the transfer of knowledge and experience from other areas, for example for land use planning.

The contents of the soil-landscape bodies is very dependent on the map scale, but also depends on the soil pattern in the mapped area, in particular its homogeneity. In standard soil surveys of large areas an estimated average of "impurities" has to be allowed in the order of 15 to 30% of the individual units (Sombroek and Van de Weg, 1980). In special purpose soil surveys the contents of the units in general is more or less pure with regard to those attributes which are throught to be essential for the purpose. To some extent the contents, in particular along the margins of the units, is influenced by the way in which the boundaries are delineated in the field.

In all soil surveys the delineation of boundaries has to be done in such a manner that, given a certain map scale, as far as possible all soils differentiated by the map legend are separated by soil boundaries. This includes soil-profile characteristics (soil group, depth, texture, stoniness, drainage class) as well as soil-landscape characteristics (topography, slope). Apart from soil surveys for research purposes, the usefulness for land use planning will nearly always be an additional criterion. In large-scale surveys (scale more than 1:25,000) there is in general a tendency to use more soil-profile characteristics, whereas in surveys of smaller scale (1:25,000 to 1:250,000) more use is made of soil-landscape characteristics; these are also the scales where physiographic soil surveys, with or without systematic airphoto interpretation (Vink in Rey Ed., 1968), have their highest efficiency. In all cases, soil characteristics provide the "differentiating'' criteria, i.e. those criteria which are used for separating the different map units.

All soil surveys are made in such a manner that, given more or less specific preliminary conditions, the maps produced give as accurately as possible a picture of the soils in the area. As soils, and soil differences, are often the most clearly determining factors for land use, soil maps are extremely valuable for land use planning and land management in large areas of the world.

In preceding sections it has however been stated that there exist also regions where soil maps are less satisfactory. Some important cases are:

1. areas with young soils, where little pedogenetic differentiation exists, but where clear landscape differences (altitude, slope, exposition, stability) have a predominant influence on ecological conditions; nearly level areas are excluded, as Edelman (1950) has already clearly shown that there physiographic soil surveys give optimum results.
2. areas where soil surveys provide in general most data for land uses such as horticulture, arable land and intensive (high-input) pastures, but are not satisfactory for other land uses such as forestry, extensive grazing, open-air recreation and nature conservation.

The first case includes good arable land areas as well as mountainous areas suited for forestry and nature conservation, but also lands suitable for special crops such as vineyards. The main difference between landscape ecological surveys, or ''ecological land surveys'', and soil surveys is found in the choice of the principal differentiating characteristics, for example altitude (including temperature regime) and geomorphology instead of soil characteristics. Soil characteristics, including all data found on a soil map, are given in the map legend as ''other diagnostic characteristics'', but the homogeneity of the mapping units with regard to soils is often less than on a normal soil map. This is allowable from an ecological (including ''crop ecological'') viewpoint as most soils are marginal cases with regard to soil groups, for example: Regosols, Regosols to Cambisols, Cambisols, Cambisols to Gleysols, Cambisols to Luvisols, Gleysols (soil units of the Legend of the FAO/Unesco Soil Map of the World). The soil units are however systematically indicated in the legend in order to facilitate transfer of knowledge and experience. In addition, also some biotic characteristics of the map units are given and these are often used as a low-level differentiating criterion (Kwakernaak, 1982; Westerveld et al., 1984). The detail of the data on biotic characteristics depends very much on the map scale and on the kind of area mapped. In practice, it also depends on the knowledge of the surveyor. Basically, a landscape ecological survey should be a multidisciplinary survey, although a team of a plant ecologist and a physical geographer/soil surveyor has proved to be satisfactory in many cases. In areas where hydrology is of crucial importance, a hydrologist is an essential member of the team (Bakker et al., 1981). For semi-detailed surveys, surveys by one-person teams (physical geographers with ecological knowledge or plant ecologists with sufficient knowledge of soils and landscapes) have produced good results.

The second case embraces areas where soil surveys are satisfactory for arable land and comparable land uses but where additional information is needed for many other purposes. Forest areas, in particular in the tropics but also in many other parts of the world, are of predominant importance in this respect. This starts already with the definition of ''Land'', where the land attributes are mentioned as being ''reasonably stable or predictably cyclic''. Individual trees in general have a lifespan of more than 80 years and forests in general should be ''reasonably permanent'' under any criterion. Forests, more than agricultural lands, have characteristic and often very complicated ecosystems, and ecosystems management is one of the essential parts of scientific forest management. Also forest soils have their own characteristics, in particular with regard to litter- and A-horizons, which disappear when the forest disappears. The land resources in forestry therefore include not only the soils but also the trees, the lower vegetation and the litter layer (O horizon).

In addition, many large forest areas are found in mountainous regions as discussed above. With regard to forest exploitation and timber harvesting, in particular in areas with a mountainous topography, slope and hydrology (e.g. for logging operations) are crucial attributes. Integrated approaches to classifying land as ecosystems in the Rocky Mountains area of the U.S.A. were already mentioned (Bailey in Laban Ed., 1981). Similar methods from several other countries are mentioned in the same proceedings.

The second case does not only include forestry areas but also other regions where more comprehensive ecological data are required. These are in particular areas where extensive grazing, nature conservation, wildlife management and recreation planning are relevant and foreseeable land uses. In the Soviet Union a system of landscape surveys for grassland areas has been developed (Vinogradov, 1967). An outstanding example is also given by the ''biophysical'' or ''ecological'' land surveys in Canada (Wiken and Ironside, 1977): very small scale surveys (1:250,000 to 1:1 million) of large areas of Northern Canada as well as more detailed surveys in densely populated regions (Jurdant et al., 1977). In particular the latter kind is of growing importance in industrialized as well as in some other parts of the world. They are of special relevance in areas with ''fragile'' or ''vulnerable'' lands, i.e. lands with particularly serious degradation hazards (Vink and Van de Weg, 1982).

The problem is in general one of encroachment of higher-input land utilization types on lower-input types or on more natural ecosystems. The impact also on adjoining lands can only be studied if comprehensive landscape ecological surveys are made. These may be partly based on available soil maps of suitable scales, but they also have to include data on geomorphology, hydrology, land use, vegetation and wildlife. The use of computerized databanks has proved to be very efficient in such a case. Currently in The Netherlands the first steps are being taken which hopefully will lead to a national landscape ecological map on scale 1:200,000 (Veelenturf Ed., 1985).

Summary and Conclusions

Soil surveys will always remain an important tool for investigations on soil patterns and their relationships with other landscape components, for the purpose of obtaining a better knowledge on the geogenetical and the pedogenetical aspects of soil formation. Soil surveys will also remain the best tool for the systematic inventory of those areas where soils provide the best differentiating criteria; these are in particular geomorphologically stable regions in areas where intensive agricultural land use is of predominant importance, and where no specific ecological problems have to be considered. In all these cases, which cover a large part of the world, a good combination of pedology and physiography produces the best results. Where possible these results should be produced on maps as well as stored in databanks, the latter for further research including land evaluation and possibly later integration in a landscape ecological survey.

Landscape ecological surveys are comprehensive surveys of land units as carriers of ecosystems. They are more comprehensive than soil surveys but high-quality soil data are among their essential components. The landscape ecological surveys should preferably be carried out by small multidisciplinary teams, e.g. consisting of a plant ecologist and a physical geographer/soil surveyor. Teams should never be larger than strictly necessary to avoid lack of integration and of efficiency. For reconnaissance and semi-detailed surveys ''one-man-teams'' are often satisfactory if the surveyor has a very good knowledge of either the biotic or the abiotic components and a satisfactory working knowledge of the other.

Landscape ecological surveys are particularly useful in: (1) geomorphologically unstable areas, (2) areas which have been deglaciated during the last phases of the Last Glaciation, in both cases also if more or less intensive agricultural land utilization types are relevant or foreseeable. They are essential in: (3) forest areas with the possible exception of short-cycle timber plantations, (4) rangeland areas, (5) areas for nature conservation, wildlife management or open-air recreation, (6) ''fragile'' or ''vulnerable'' lands, (7) all areas where high-input land utilization types are encroaching on low-input types or more natural ecosystems and thus provide ecological problems of land use planning and land management.

Land evaluation has thusfar mainly been practised on the basis of soil maps. If landscape ecological maps are used, the land evaluation obtains a much wider scope. This includes for example various kinds of management to be applied to nature reserves (Bakker et al., 1981) and the sensitivity and vulnerability of natural and seminatural ecosystems to changes of their environment (Vink, 1982; Veelenturf, 1985). Land evaluation for forestry has its own particular modifications; see for example Bennema et al. (1981) and Andel et al. (1981). A good methodology for these various purposes can be developed with the use of the basic concepts, and of most of the methods, proposed in the Framework for Land Evaluation (FAO, 1976).

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ENHANCEMENT OF TROPICAL SOIL FERTILITY;

THE ROLE OF BIOLOGICAL RESEARCH

*M.J. Swift**

The productivity of the natural forests and grasslands of the world is maintained by biological processes acting within the physical matrix of soil under the influence of climate. The intimate relationship between climate, vegetation, soil organisms and mineral resources is relatively minor in many traditional farming practices such as shifting cultivation, but as intensification develops so does man's intervention and greater corrective measures have to be employed to maintain productivity. With the realisation of the mounting economic and ecological cost of intensive chemical and mechanical farming, interest is turning back to potential bio-technological solutions to the maintenance of soil fertility. This change in focus has a particular importance in the tropics, where the major demand for increased and sustained efficiency in food production exists. In order to achieve the goals of low-input, biologically sustained farming systems however, more fundamental research is required.

Modification of soil physical properties by biological activity

Soil fertility is the ability of the soil to satisfy plant demands for nutrients, water and an adequately aerated physical matrix for the growth of roots. It is often thought that biological aspects of soil fertility are solely concerned with nutrient supply but this is not so. The activities of a wide range of organisms affect physical properties of the soil they inhabit.

For instance, although the original size and composition of soil particles is determined by parent material, the degree of aggregation and the spatial distribution (both vertical and horizontal) of different size fractions is strongly influenced by soil organisms (such as earthworms and termites). In particular the amount, type and distribution of the clay fraction of the soil may be particularly influenced by the transport activities of the termites. This is of course important in determing nutrient availability through exchange phenomena. The proportion of different clay minerals can also be modified by the activity of specific microbial groups, and the absorption characteristics can be masked by organic complexing as a result of biological activity. Fungi may also play an important role in binding together soil particles with their hyphae. Changes in the aggregation and size distribution of soil particles affect water content and movement, pore space, aeration and hence the retention and supply of nutrients, water and oxygen to the plants as well as affecting the activities of the soil biota.

Many biological effects are mediated through their effect on the water regime of soil.

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Water is essential for soil organisms, for plant growth, and as a medium for nutrient transport. In the humid tropics it is largely the movement of nutrients which is of concern, apart from soils where water-logging is a problem. In the drier tropics available soil water is generally the major determinant of ecosystem structure and function. For any particular rainfall pattern the soil water regime is determined by the infiltration rate, the water holding capacity of the soil, soil water conductance, and soil depth.

The distribution and rate of decomposition of soil organic matter is under the primary control of the soil biota and is critical in the recycling of nutrients. Thus the effects of soil biota on water dynamics operate mainly through the increase in water holding capacity associated with soil organic matter accumulation. This is of particular importance in sandy soils in the sub-humid tropics. The main direct biotic effect on the water dynamics is the uptake of water by plant roots. Uptake of water by roots in non-saturated soil is determined by the amount and distribution of roots and their ability to absorb water against the retention characteristics of the soil. Mycorrhizal hyphae extend root contact with soil and may increase water uptake. In very dry soil roots may exude water into the soil, which facilitates nutrient uptake. The greater the uptake the less the risk of leaching, or in soil with impeded drainage the less the likelihood of water-logging. Although most natural ecosystems show very little loss of nutrients through leaching, disturbance of the plant cover can lead to increased losses, particularly of nitrate, because this ion is not retained by the ion exchange complex in most soils. In agro-ecosystems the plant cover may be intermittent, leading to increased risk of this type of loss.

Biological regulation of nutrient cycling in soils

The soil is the habitat for a very diverse range of living organisms including fungi, bacteria and invertebrate animals. The food resource which supports these organisms is the dead plant material (plant litter) shed by the vegetation. Conversely the soil organisms in utilising many of the mineral elements on which plants depend for growth can only be taken up when they are in inorganic form (e.g. nitrogen as ammonium or nitrate). These forms of the elements may be in short supply in the soil but abundant organic-nitrogen may be present in the plant litter. It is during the decomposition of the plant litter by soil organisms that the organic-N is converted to inorganic-N thus replenishing the supply in the soil. The same argument may apply to other elements such as phosphorus and sulphur.

A second effect of decomposition is that linked to this degradative process is an important synthesis process - that of humus formation. As already mentioned an increase in the humus content of soil improves its physical quality and its nutritional status. In coarse-textured soils, or those in which the clays have a low cation exchange capacity, nutrient retention and availability to plants is strongly dependent on the maintenance of organic colloids. Conditions which favour the formation of soil organic matter, particularly the stable fractions, are thus an advantage. Seasonal hydrogen ion equilibria are also affected by both decomposition processes and plant nutrient uptake mechanisms. Many biological processes affect the ionic balance of soil in the same way. This may result, under different circumstances, in changes in nutrient availability, including the creation of limiting conditions or the accumulation of toxic levels, for specific ions.

The rate at which plant litter is decomposed is closely regulated by the climate and other environmental factors. Rates of decomposition are highest under warm wet conditions and are totally inhibited when litter is in a dessicated state. In strongly seasonal environments a major regulator of decomposer activity is therefore the rainfall pattern. Most frequently the dry season is the time when plants in natural ecosystems such as forest shed their leaves. The dry hot conditions, however, prevent any decomposition and a large accumulation of dead leaf litter builds up on the forest floor. At the onset of the rains however, a dramatic change takes place. Within a very short time conditions are established which are favourable for the decomposition of the leaf litter and the 'standing crop' (the accumulated mass) of leaves rapidly declines (Fig 1).

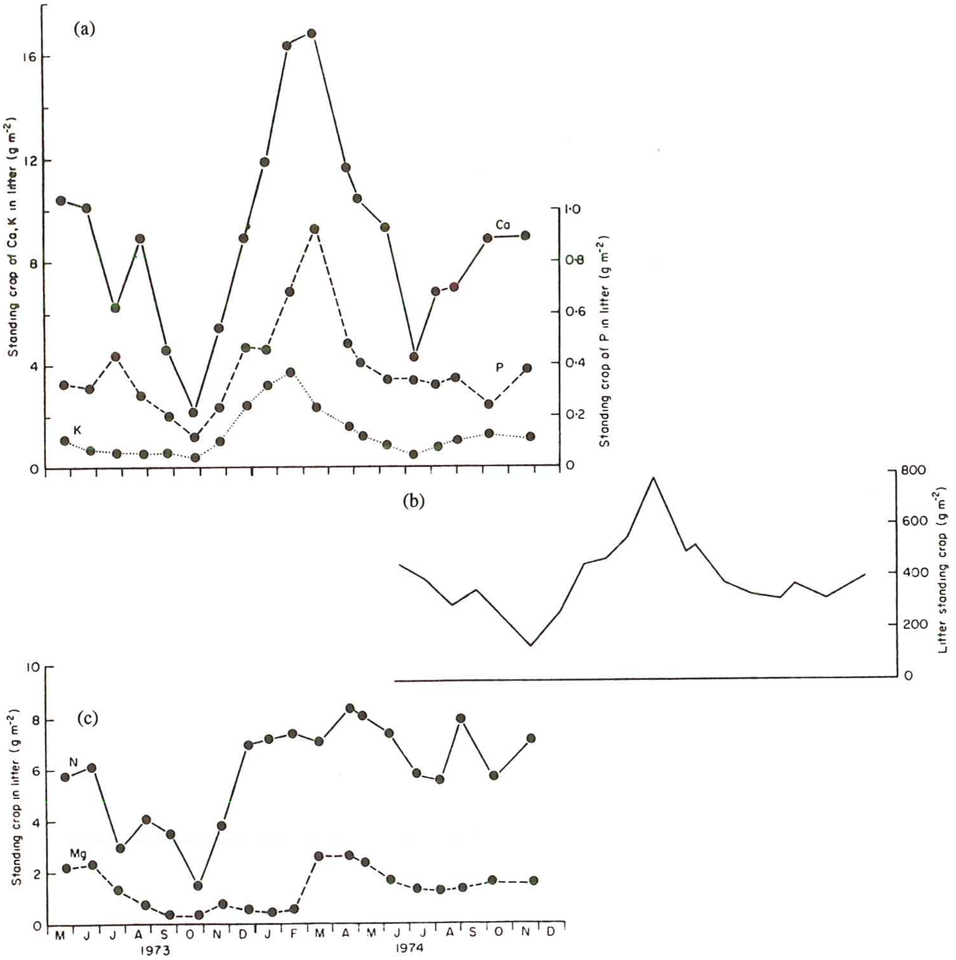

Fig 1: Nutrient dynamics in leaf litter in the floor of a secondary forest in Nigeria. Changes in the standing crop of leaf litter (Fig 1b) are shown together with the equivalent standing crop of component elements of Ca, P and K (Fig 1a) and N and Mg (Fig 1c). Major rainfalls were found between May and October in both 1973 and 1974 with a short dry spell in August 1974 (Swift, Russell-Smith and Perfect, 1981)

Decomposition of the leaf litter results in the dissipation of carbon as carbon dioxide and thence a loss in weight. The pattern of weight loss varies but a frequent pattern is as follows: a rapid initial loss over the first four weeks followed by a stage of slower decomposition (Fig 2). Most importantly the pattern of release of mineral nutrient elements such as nitrogen, phosphorus and magnesium very clearly parallels the weight loss. Interestingly, potassium and calcium behave a little differently, the former being released more quickly and the latter more slowly, than the other elements. The consequence of this process can be seen in Table 1. In this particular example practically the

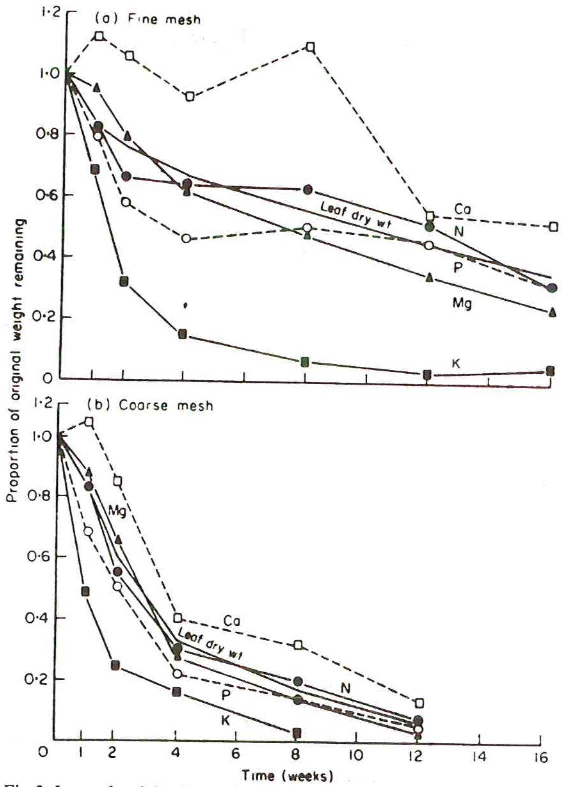

Fig 2: Loss of weight due to decomposition of leaf litter in secondary rainforest in Nigeria. The curve for weight is shown together with the change in fractional content of a number of mineral elements (Swift, Russell-Smith and Perfect, 1981)

Table 1:The accumulation and release of mineral nutrient elements from the standing crop of leaf litter in secondary rainforests in Nigeria during the four weeks after the onset of rain (Swift, Russell-Smith and Perfect 1981).

Element	Maximum standing crop (gm-2)	Initial loss after four weeks (%)	Amount released (gm-2)
N	8,3	60	5,0
P	0,93	67	0,6
K	3,7	95	3,5
Ca	16,9	35	5,9
Mg	2,5	67	1,7

entire reservoir of nutrients that had built up in the accumulated leaf litter on the forest floor was released to the soil within four weeks of the onset of the rains.

The period at which this nutrient release occurs is of course the period of maximum flushing of new leaves in the perennial vegetation of the forest. We can thus see a very close relationship between the activity of the decomposer system and the productivity of the vegetation. The 'tightness' of this relationship has been demonstrated by workers in South America who have shown that the root mat of tropical forest trees is a very different 'sink' for any nutrient in ionic form (Herrera et al., 1978). The root mat is extensive and thousands of fine feeding roots can be found in a dense layer at the base of the carpet of litter right at the site of release.

The process of decomposition

How is this pattern of decomposition and nutrient release brought about? The initial rapid loss, both of organic material and of mineral elements, is due to leaching. The heavy rainfall washing through the litter at the soil surface is able to effectively remove all soluble components within a period of a few days. This may account for the loss of up to fifteen percent of the weight of the forest litter. In particular leaching probably accounts for the very rapid initial decline in the potassium content of the leaves. This element is known to be highly mobile and is largely accumulated in the vacuolar sap in the leaves - a site from which it may be readily lost. The remainder of the action is biological and divided between that of animals and micro-organisms.

It is the latter, a complex community of fungi and bacteria, that are responsible for the major chemical transformations in decomposition: dissipating the plant polysaccharides as carbon dioxide and, most importantly, converting the proteins to ammonium. They are also responsible for the mineralisation of other elements - for instance converting organic-phosphorus to inorganic phosphate. The release of these and other mineral ions (calcium and magnesium) from both the plant tissue and from the microbial tissues in which they may initially become accumulated is, however, stimulated by the action of the invertebrate animals of the soil and litter.

The invertebrate community is a very diverse one with practically every major group of terrestrial invertebrates represented, ranging (in size) from protozoa to earthworms. What is of particular interest however is not so much their taxonomic diversity as the variety of feeding activities they display. Some, such as certain termites, millipedes and earthworms, feed directly on plant litter. Other, including some protozoa and nematodes feed on bacteria. Many groups, particularly some taxa of collembombola (spring-tails) and mites feed on fungi. Representatives of nearly all these groups also feed on particulate organic matter. This is the detritus formed from initial decomposer action - partially chewed leaves, faecal pellets and proto-humus (Lavelle, 1983, 1984).

Animal activity is usually delayed until some microbial decomposition has taken place. The initial effect of the animal-feeding is thus to bring about further decomposition. The secondary effects of animal action are, however, probably more significant to the overall process. Firstly, amongst these is the breaking open of plant and microbial cells which results in the release of the mineral elements mentioned earlier (Anderson and Ineson, 1983). Secondly, the animal activity stimulates secondary waves of microbial action by breaking up the litter into smaller particles, increasing the surface area for microbial colonisation and exposing new surfaces for enzymatic action.

The pattern described above is one commonly observed in soft leaf litters. Other types of litter or crop residues may however show a different pattern. The decomposition rates of different litters is often markedly divergent even under identical environmental conditions and when exposed to the same decomposer microflora (Table 2).

These differences in 'decomposability' are attributable to differences in the intrinsic characters of the materials. High 'quality' litters, those which are rapidly decomposed, have high N and P contents, high concentrations of readily metabolised sugars and low lignin contents. Low quality materials are characterised by the inverse state of these variables. They also often carry biologically active contents of allelopathic compounds (i.e. molecules which are inhibitors of biological activity).

The accumulation of surface and soil organic matter in tropical ecosystems is a balance of the rates of inputs and decomposition (Anderson and Swift, 1983). The potentially high rate of decomposition associated with high temperature and rainfall is modified locally by resource quality as well as by seasonal drought, moisture holding characteristics of the soils and soil chemistry. The quality and quantity of input also varies. Hence surface and soil organic accumulation varies considerably within the tropics (Sanchez, Gichura and Katz, 1962).

The time over which mineral nutrients are released from a resource occurs is largely regulated by its rate of decomposition (Fig 2). The efficiency of transfer of nutrients from the plant litter soil to the plants is at a maximum when the timing of nutrient release is synchronized with that of plant uptake. Variation of any of the factors that affect decomposition rate (e.g. the spectrum of quality in mixed litter or climatic change) may cause an uncoupling of decomposition and plant nutrient uptake.

Soil organic matter

Soil organic matter is an important source of nutrients in addition to those released by the decomposition of plant litter or crop residues. Soil organic matter is not one well-characterized soil component but can be regarded as a series of more or less well-defined fractions with different qualities. These fractions form a continuum which can be subdivided into three main categories.

The first, which is the most easily decomposable, has a half-life of less than two years. It consists of dead microbial and animal cells and their metabolites (e.g. mucus, exudates). The second fraction consists of stabilized organic matter and has a half-life in the order of ten years. It is synthesized from fresh organic matter by soil organisms and extracellular chemical condensation reactions. Part of it becomes complexed with clay minerals, which make it less susceptible to decomposition and mineralization.

The third fraction is formed in a similar manner but is very recalcitrant to microbial attack with a half-life typically more than a hundred years. Although the rate of nutrient release may be very slow this organic matter component can be quantatively important, as a nutrient reservoir.

These organic fractions release nutrients at different rates. Thus the relative amounts of the fractions in soil is another determinant of nutrient availability.

The effects of cultivation on biological processes

The brief description given above reveals a highly integrated system of regulation of nutrient flow within the plant-litter-soil system of natural ecosystems. It has been postulated that nutrient cycling is stabilised in part because of the diversity of decomposition patterns. The combination of slow and fast release rates and variation in the timing of nutrient availability from different components of the litter and soil organic matter ensure availability to the plant at all times of the growing season. The tight coupling in space and time of nutrient demand and availability is emphasised as an essential feature of the sustained productivity of natural ecosystems. Conversion of natural ecosystems such as forests to agricultural land may disrupt this system by altering the regulatory controls on the processes of decomposition.

Firstly, there is a dramatic change in the environment within which decomposition takes place. The clearing of forest and the preparation of land for cultivation modifies both the macro-climate and micro-climate of the soil and brings about environmental changes which affect the activities of decomposer organisms. For instance the removal of vegetational cover results in a greatly increased daily amplitude in the soil temperature. Correspondingly, the surface soil has a greater tendency to dessication. The process of ploughing or hoeing alters the soil structure and chemistry. Aeration is increased, particle size is reduced and pore volume is increased (although the latter may be offset by a subsequent increase in compaction). As a result the drainage and aeration characteristics of the soil are altered and the chemistry changed by accelerated oxidative breakdown of the humus. Even more significantly the practice of cultivation may alter both the site and physical state of litter decomposition. In particular, ploughing reduces the particle size of litter and buries it within the soil. This process enhances decomposition and results in accelerated nutrient release. The burning of litter is another practice that profoundly affects the activity of soil organisms both by removing potential food resources and by changing the pH and other factors in the soil environment.

A major consequence of these changes is that the abundance and diversity of composition of the decomposer community of the soil is markedly lowered. The major effects are on the soil animals, the micro-organisms seeming to be far more resilient. One result of this may be that decomposition is shifted to a more microbially-dominated system. What the implications of this shift are for soil fertility is unclear. They are probably not severe as far as the rate of mineralisation is concerned; the effect on soil humus formation is, however, totally unknown and likely to be quite significant.

Perhaps the most profound effects on decomposition processes are, however, those due to changes in the nature of the litter input itself, In this respect not only the amount of litter but its composition, and the timing of its incorporation are affected by agricultural practice. The most obvious differences between the cultivated and forest system is the decreased amount of plant litter input in the former (Table 3). The above-ground litter production in a Nigerian forest over the one year period November 1973 to November 1974 was estimated as 855 gm^{-2}. This input to the decomposers was composed of leaves, twigs, small branches, palm fronds and a variety of hard and soft fruits. Large branches, roots, root exudates and above-ground leachates were not investigated but were important additional components. In contrast the measured input from a neighbouring field of cowpea, which included the entire vegetative growth (leaves, stems and roots) which

Table 3:The annual input of mineral nutrient elements to the soil from plant litter in two different but neighbouring ecosystems in Nigeria. N.B. The cowpea input is total litter; the forest is above ground litter only

	Elemental input (gm-2 y-1)				
	N	P	K	Ca	Mg
Forest	9,2	0,60	3,0	14,0	2,7
Cowpea	4,1	0,47	3,1	2,1	0,9

was ploughed back into the soil after harvest amounted to only 197 gm^{-2}. These quantitative differences have an obvious significance with regard to the nutrient reservoir of plant litter at any one time (Table 3) and the amount of carbon and energy to fuel decomposition. Cultivation not only stimulates the rate of decomposition of soil organic matter but also diminishes the extent to which it can be replaced by the activity of decomposers.

The cowpea litter is clearly different in character to that of the forest; in particular it lacks the hard, woody materials which decompose more slowly. This may have two important effects. Firstly, it is generally thought that this lignified component is the main source of the molecules from which the soil humus is synthesised by microbial enzymes during decomposition. Secondly, it means that the overall rate of mineral element release is accelerated and reduced to a short time period following the onset of the rains. In the forest this is characteristic of leaf litter - as illustrated earlier. But the woody material decomposes much more slowly and provides a slow trickle of nutrients in the later weeks of the rainy season. All the cowpea litter has the characteristics of the forest leaves - in consequence all the nutrient eggs are in one basket. The timing of litter input to the decomposers in agricultural systems is also commonly dictated by management practices particularly the cutting and ploughing-in of standing residues.

The latter practice also changes the context in which decomposition takes place. Like the other changes mentioned earlier it can result in an accelerated rate of decomposition because of the more stable environment within the soil as compared with the surface and the readier accessibility of the litter to the soil organisms.

Yet further changes may be brought about in the decomposer environment by the introduction of fertilizer chemicals and pesticides. The application of fertilizers may contribute to increased rates of soil organic matter decomposition, though this effect has not been clearly distinguished from those associated with tillage practices. Since humus is the main cation exchange site in acid soils, an understanding of this process is critical. Crop plants, particularly fertilized crops, have high resource quality characteristics and generally decompose faster than natural vegetation under comparable conditions. Grain crops differ from fodder or root and tuber crops in the distribution of resource qualities in different parts of the plants. Hence the consequences of harvest for the nutrient balance of the system are different for different crops.

Pesticides have direct effect on the soil biota and indirectly modify rates of decomposition in a manner analogous to the antiherbivore defence compounds of natural vegetation. The impacts on non-target organisms and associated processes include reduction of soil fauna, litter comminution and changes in soil physical structure, as well as the poorly quantified effect on soil micro-organisms. For example, there is evidence that persistent pesticides, such as DDT, can have long-term effects on soil fertility (Perfect et al., 1979).

The overall effects on decomposition of the change from a forest to a cultivated ecosystem can be summarised as a lowering of the nutrient input and an acceleration of the rate of mineralisation, coupled with a narrowing of the period in which mineralisation takes place. These latter two effects may have a major consequence for the availability of nutrients to the crop.

The initiation of decomposition will commonly occur before seed planting and it is possible to predict that maximum nutrient release may occur before the crop is sufficiently established to benefit from the availability of nutrients. Under conditions of heavy rainfall and leaching this could result in the loss from the system of a significant component of the nutrient return. This lack of integration between the release of nutrients by decomposition and their uptake by plant roots contrasts strongly with the 'tight' cycling described earlier for the forest ecosystems.

The potential for management of soil fertility through manipulation of biological processes

The demand for increased food productivity in the tropics puts man's ingenuity to the test. Great advances have been made, through the 'Green Revolution' and other programmes, to apply scientific principles to farming in these areas. This spread of high-input farming systems is clearly one direct path to solving the problem. It is also apparent that there are economic, ecological and social limits to the extent to which such high technology systems can be implemented on a permanent basis. Nonetheless it is also clear that the various types of traditional agriculture (e.g. shifting cultivation system) that support the major part of the tropical zone population cannot be indefinitely sustained as population pressures force the shortening of the fallow cycle and eventually impose the practice of continuous cultivation on low fertility soils unable to sustain it.

Solutions must be found to raise fertility which do not lean entirely on the same economic and social base as the high-subsidy, high technology farming characteristics of the temperate zones. One obvious, but hitherto neglected, approach is to utilise the biological mechanisms which regulate the natural fertility of soil. As we have seen above productivity in natural ecosystems is sustained by the tight integration of the vegetative system with the biological system of soil. The capacity of the latter to deliver nutrients to the plant and to maintain a favourable physical condition in soil is furthermore related to a complex interaction between a rich community of organisms and a diverse input of organic materials. These processes may be subject to considerable disruption by the conventional practices of intensive agriculture. Enhancement of natural fertility may be achieved by some of the management practices currently receiving favour in both tropical and temperate agriculture such as minimum tillage and agroforestry combinations. The introduction of perennials into the cropping systems, either as mixtures with the annual crop, or in rotation mimics to some extent at least the perceived value of woody fallows as used in shifting agriculture.

During a fallow period or with the introduction of a tree species there is an increase in the litter input, particularly of woody materials and roots. There is also increased diversity of plant species and phenologies. In consequence, the timing and quality of resource input becomes more variable. This leads to increased formation of soil organic matter (Greenland and Nye, 1959). It is also interesting to speculate that the composition and properties of soil organic matter formed under natural vegetation are modified by the diverse resource quality and different physico-chemical and biotic characteristics of this input.

When a permanent tree cover is established the depleted nutrient capital of the upper soil horizons is replenished through cycling of nutrients from deeper horizons. The diversity of resources leads to a wide range of decomposition rates which spread nutrient release over a longer period of time than during cultivation. Uptake is stabilized by the development of a more or less continuous root mat of plant species with different requirements, mycorrhizal relationships and phenological characteristics. The overall consequences of all these features is a re-integration of the vegetation and soil sub-systems leading to improved conservation of elements. The most critically limiting factor is the time taken for the recovery phase under natural fallow. Managed fallows can dramatically reduce the length of cultivation cycle and provide an intermediate practice between shifting agriculture and continuous cultivation. For instance, fallow under kudzu (Pueria phaseoloides), a nitrogen fixing creeper, for 1-2 years has the same restorative effect as 25 years of forest fallow. Mixed cropping such as alley-cultivation with leguminous trees, may provide another intermediate position with many of the benefits of fallow.

Nonetheless the depth of understanding of the biological processes that maintain the system is still very superficial. Whilst a substantial body of information is now available from natural ecosystems, soil biological processes are rarely investigated by agriculturalists. One of the reasons for this is the success of high-input farming, which effectively bypasses the soil biology through its use of fertilizers, pesticides and mechanized preparation of soil. This success leaves little apparent reason why soil processes should be taken seriously but it is noticeable that the adoption of minimum tillage systems in temperate regions is refocussing attention on soil ecology.

An attempt is now being made to stimulate the basic research needed in this area by the launching of an international programme of collaborative research. The programme, called 'Tropical Soil Biology and Fertility (TSBF)' is sponsored by the International Union of Biological Sciences as part of their 'Decade of the Tropics' (see Solbrig and Golley, 1983; Swift, 1984, 1985; Swift and Sanchez, 1984). UNESCO has provided much support and ISRIC is among the active participants.

The objective of the TSBF programme has been stated as follows;

> "to develop a predictive understanding of the functioning of biological processes in tropical soils, and their role in contributing to sustainable soil fertility; and hence to provide a means for the maintenance and improvement of soil fertility by influencing these processes through management practices" (Swift, 1985).

In approaching this target the TSBF scientists have postulated four experimental principles (see Annex 1) which are derived from the understanding of the functioning of soil biological processes in the maintenance of soil fertility outlined briefly in previous paragraphs. From these principles specific hypotheses, testable by experiment can be derived. It is proposed that these hypotheses be tested by collaborating scientists in a network of research sites round the tropics.

The ultimate aim of the programme is an improvement in management practices to increase the efficiency of nutrient cycling and the sustainability of favourable physical conditions on tropical soils. The management practices envisaged are largely of a low-input technology kind - e.g. manipulation of organic inputs - but are important features of the programme design in its capacity to embrace a wide range of farming systems. Higher input systems are not excluded; indeed the investigation of ways in which the efficiency of fertilizer use can be enhanced by means of biological manipulation, may turn out to be one of the most significant components of the research programme.

Acknowledgement

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Annex 1: THE TSBF EXPERIMENTAL PRINCIPLES

The list of principles is not exhaustive and every statement is clearly challengeable; the intention is to provide the basis for rigorous experimental testing of a range of assumptions concerning the biological basis of soil fertility, most of which carry direct implications for the management of tropical soils under low-input conditions. The management proposals are simple and are largely concerned with manipulation of the quality, quantity, timing and location of organic inputs to the soil.

P1. The release of nutrients (N, P) from above- and below-ground litter can be synchronised with plant growth demands.

The decomposition of litter leads, over the course of time, to the release of nutrient elements (N, P) in plant-available form. The rate of decomposition, and hence the time to nutrient release, is regulated by climate (P, particularly rainfall) and resource quality (Q). Definition of the relationship of P and Q to the time course of nutrient release, coupled with knowledge of the time course of demand by the plant for nutrients, provides a basis for maximising the efficiency of nutrient transfer. In natural ecosystems this efficiency will be high, whereas in agricultural systems it will commonly be very low.
The efficiency of nutrient availability to the plant can be manipulated by varying the quantity and quality of litter (e.g. crop residues, manures etc.) and the time of its input in relation to the onset of rain.

P2. Soil organic matter constitutes both a sink and a source of plant nutrients (N, P) and hence acts as a regulator of temporal and spatial patterns of nutrient availability. The quantity and quality of soil organic matter is influenced by the nature of the above- and below-ground litter input.

Soil organic matter (SOM) is formed as a product of the decomposition of litter, above- and below-ground. Nutrients (N, P) are transferred to SOM during the process of synthesis. SOM is a continuum of fractions differing in their physical and chemical properties (including their N and P contents) but particularly in their susceptibility to decomposition. The light fractions (including the microbial biomass of soil) represent a relatively labile pool of nutrients (N, P) with a rapid nett mineralisation rate under favourable conditions. The heavier fractions are more recalcitrant and release nutrients at very slow fractional rates. The amount released annually may nonetheless be quantitatively significant because of the potentially high standing crop of these components. Recalcitrant SOM fractions may moreover constitute an important stabilising influence in nutrient cycling. SOM pools in different soils vary quantitatively and qualitatively in relation to the nature and quantity of the litter input from which they are derived and the conditions under which it is decomposed.
The quality and quantity of SOM, and thence the timing, location and magnitude of nutrient availability can be regulated by management of litter inputs.

P3. The pattern of root growth in time and space acts as a regulator of the availability of nutrients to plants in present and future seasons.

The time course of current root growth determines the timing of nutrient uptake by plants. The spatial distribution of the roots determines the sources of nutrients that may be tapped. The distribution of roots in the current season determines the pattern of input of root litter in the next season (although this may be altered by management practice). Such below-ground litter, because it is located within the rooting zone, provides the most direct source of nutrient for the next generation of plants. Below-ground litter may also provide a greater contribution than above-ground litter to SOM synthesis. Root litter may also contribute directly to the improvement of soil physical structure, e.g. by providing the basis for macropore formation during its decomposition.
Management practices which retain root litter in the rooting zone and relate new plantings to the location of previous ones will improve soil fertility.

P4. Surface litter and soil organic matter influence soil water fluxes and moisture regimes.

The presence of litter at the soil surface improves water infiltration and diminishes run-off and evaporation. Below-ground litter and soil organic matter improve water infiltration rates and water-holding capacity and reduce the susceptibility to compaction. The nature of the soil fauna is influenced by the quantity and quality of above- and below-ground litter inputs. The soil fauna influences soil water characteristics by their physical effects on soil such as the creation of macropores, effects on aggregate formation, comminution of organic fractions and transport of mineral particles.
The soil water regime may be improved by management of litter inputs both through direct effects and by indirect influence on the soil fauna.

3 ACTIVITIES OF THE SECTIONS

3.1 SOIL MONOLITH COLLECTION

During the reporting period the number of soil monoliths increased with 25 to 660 (see table below).

Acquisitions in 1985

Monolith collection, December 1985
Within parentheses: acquisitions in 1985

Australia	33	Mozambique	8
Belgium	4	Namibia	11
Botswana	7	Netherlands	24
Brazil	14	New Zealand	5
Cameroon	1	Nigeria	14
Canada	21	Norway	3
People's Rep. of China	16 (8)	Oman	4
Colombia	19	Peru	1 (1)
Czechoslovakia	8	Philippines	6
Denmark (Greenland)	6	Romania	11
Finland	5	Rep. of South Africa	20
France	12 (1)	Spain	20
Fed. Rep. of Germany	17	Sri Lanka	4
Ghana	4	Sweden	17
Gabon	6	Switzerland	1 (1)
Greece	15 (1)	Syria	4
Hungary	20	Thailand	13
India	30	Turkey	13
Indonesia	25	United Kingdom	11
Ireland	11	U.S.A.	25 (4)
Italy	17	U.S.S.R.	62
Ivory Coast	7 (7)	Uruguay	6
Jamaica	3	West Samoa	5
Japan	4	Yugoslavia	3
Kenya	33	Zaire	2 (2)
Malaysia (East)	11	Zambia	10
Malaysia (West)	7		
Mali	1	Total	660 (25)

Acquisitions in 1985

People's Republic of China: ISRIC soil scientist J.H. Kauffman collected in cooperation

with Nanjing Institute of Soil Science 8 soil profiles in an east-west climatological sequence in Shaanxi, Gansu and Xinjian Provinces. Soils collected are mainly Regosols, Xerosols and Yermosols, part of these soils are irrigated (see also Chapter 5).
France: Within the framework of an overall study of red Mediterranean soils, organized by Dr. E.A. FitzPatrick, Aberdeen, Scotland, ISRIC's guest researcher Dr. N. Pons-Ghitulescu collected a Chromic Luvisol in southern France
Greece: M.Sc. course participant Mr. N. Danalatos collected a Calcaric Fluvisol, representative for large areas in his home country. His M.Sc. thesis was partly based on the study of this profile.
Ivory Coast: Mr. A.J. van Kekem, Unesco-MAB soil scientist, Abidjan, Ivory Coast, collected 7 profiles, mainly Ferralsols, in the Taï National Park.
Peru: Messrs. M.H.P. Schreurs and N. van Gelderen, students of Wageningen Agricultural University, collected an Orthic Acrisol in the Amazone region during their stay in Yurimaguas.
Switzerland: Dr. B. Buchter, ETH, Zürich, sent us a Rendzina monolith. This soil is extensively discussed in his Ph.D. thesis.
U.S.A.: Dr. J.M. Kimble, National Soil Survey Laboratory, Lincoln, Nebrasca, who coordinates the collection of about 30 profiles all over the country, forwarded another 4 profiles.
Zaire: Mr. A.J. van Kekem, Unesco-MAB soil scientist, Abidjan, Ivory Coast, collected 2 profiles of a Xanthic Ferralsol.

General

Arrangements for collecting soil profiles have been made with institutions and individuals in a number of countries. Some of these have plans for the establishment or enlargement of soil reference collections for their own purpose.

In the coming two to three years a part of the profiles-to-be-collected will come from the countries included in the National Soil Reference Collection (NASREC) programme (see item 3.7).

Furthermore, the countries with which ISRIC is in contact include: Brazil, Burundi, People's Republic of China, Ecuador, Indonesia, Israel, Kenya, Mali, Mexico, Pakistan, Poland, Portugal, Rwanda, Spain (Canary Islands), Sri Lanka, Sudan, Tanzania, U.S.A., Venezuela, Vietnam and several countries in North Africa and the Near East.

Most of the sampling will be carried out by non-ISRIC soil scientists, part of whom are participants of the annual training course.

Preparation of monoliths

During the reporting period about 40 profiles have been impregnated and five monoliths have been re-impregnated/repaired. During the annual training course about 12 profiles have been taken and treated as an exercise. Furthermore, the technician gave short courses in impregnation techniques to participants of the M.Sc. Course in Soil Science and Water Management of Wageningen Agricultural University and to two technicians from France and Portugal.

3.2 LABORATORY AND LABEX PROGRAMME

Regular analytical work, related to the collection

The laboratory work this year was concentrated on the Ferralsol/Oxisol project (see Chapter 4). Some sixty monoliths of Ferralsols/Oxisols and related soils from all over the world were included in the programme. About half of them were recently acquired profiles, the other half was longer present and had been, at least partly, analyzed at an earlier stage. This situation clearly brought to light a major problem in reference work namely the changes introduced in analytical procedures in the course of time. Often such changes go beyond minor adaptations and unintentionally may influence the results. Direct comparison or correlation with older data in some cases proved to be difficult, particularly the determination of the cation exchange capacity (CEC) is very sensitive in this respect and many samples had to be re-analyzed. Also the determination of "free iron" offered problems of this type.

The recently acquired new computer facilities at ISRIC proved to be very useful in a better and more rapid treatment of the wealth of data obtained on the Ferralsols than could have been done before.

For the CORLAT, the Trombetas laterite profile from Brazil was also analyzed.

Non-regular work

On consultancy basis, the laboratory carried out a number of special analyses on usually small series of problem soils (salinity problems, X-ray diffraction, soil moisture characteristics). Some 200 samples were received this year from LABEX participants for reference purposes of which about a hundred were analyzed on key parameters for soil classification (CEC, exchangeable bases, texture, organic carbon, X-ray diffraction).

As usual, for different departments of ITC analytical work was carried out related to research and student field work.

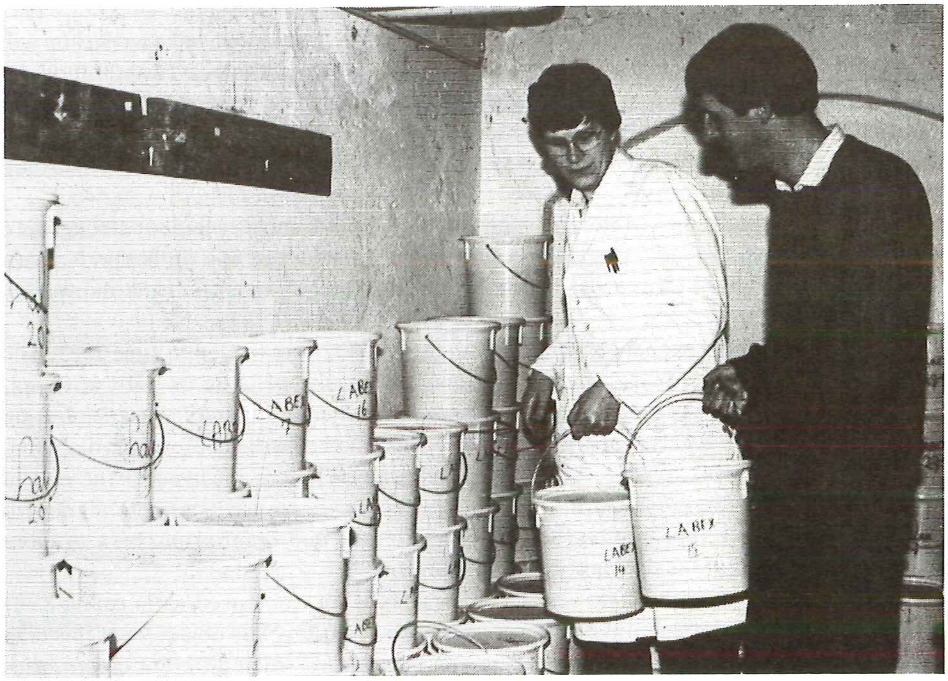
Two technicians of the laboratory were charged with equipping and putting into operation a soils laboratory at Ambon, Indonesia as part of a consultancy project of ITC, By the end of the year the containers with equipment had arrived at the site and preparations were made for the technicians to leave for Indonesia.

As participant of LABEX, the laboratory analyzed the 15 reference samples on the prescribed parameters (CEC, exchangeable bases, exchangeable acidity, texture, pH, organic carbon).

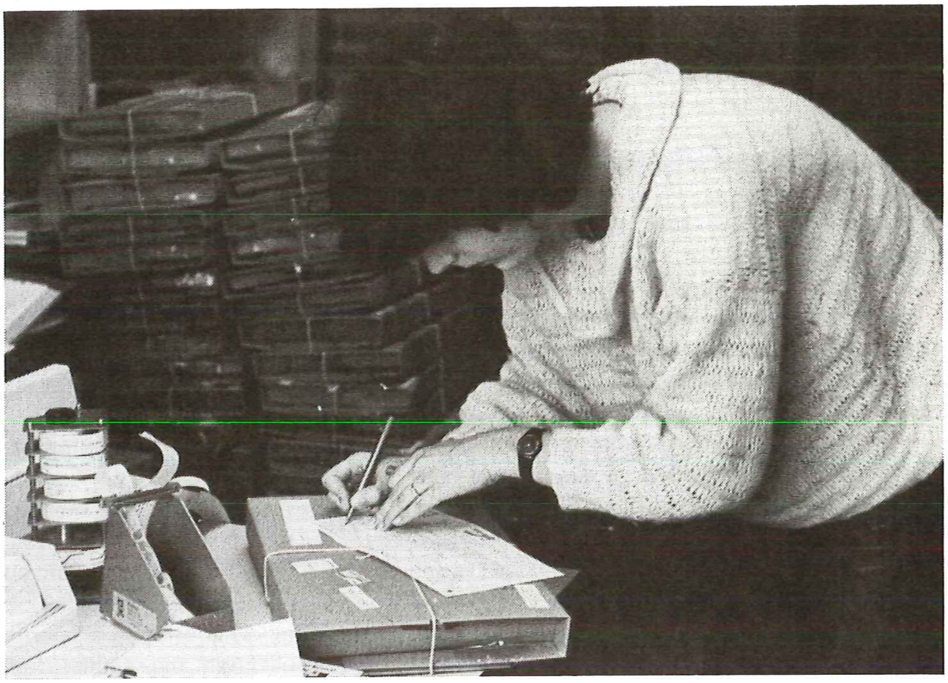
The Laboratory Methods and Data Exchange Programme (LABEX)

In 1984 the Dutch Directorate-General for International Cooperation (DGIS) granted a fund for a 2½-year programme on the comparison of methods, procedures, and results of laboratory analyses for classification purposes.

At the start of the year a full-time programme secretary was appointed. This marked



Storing and mailing of reference samples.



the transition from the pilot stage of the project to a full scale programme. Up to July 1987 it is envisaged that 4 soil sample exchange rounds will be conducted and a workshop will be organized. In the pilot stage the number of participating laboratories was 20. Following the publication of the results of this pilot stage another 20 laboratories volunteered to cooperate. Additionally 67 soil institutes were invited to join in the programme. From 45 a positive reaction was received which makes the number of participants to 85. They are listed in Appendix 2.

For the preparation of reference soil samples, bulk samples of about 100 kg were collected in Brazil, Canada, France, Hungary, Kenya, Malaysia, The Netherlands, Syria and the U.S.A. These were dried, ground, sieved to pass a 2 mm sieve and thoroughly mixed.

For the first new exchange round 85-1, soil samples were mailed in June 1985. The soil parameters to be analysed were texture, pH-water, pH-KCl or pH-$CaCl_2$, exchangeable cations, exchangeable acidity, cation exchange capacity, base saturation and organic carbon. Analytical procedures to be applied had to be conform participants' usually applied methods. The results of 55 laboratories were received at the end of October. These were compiled into an interim report which was mailed to all contribuants. This report appeared as ISRIC Working Paper and Preprint no. 85/4. A more in-depth treatment of the data will appear in due course.

In exchange round 85-2 the same soil samples were to be used as in round 85-1. However, the analytical methods are prescribed by LABEX. The objective of this is to observe how far the variation in the data can be reduced when different laboratories apply a uniform method. The methods prescribed in round 85-2 are by no means 'standard methods'. Modifications, as proposed by the participants, are to be considered for use in the next round. 'Standard methods' will be drafted at a workshop, which is envisaged to take place at ISRIC in August 1986. Results of the analyses in round 85-2 will only be known in 1986.

3.3 MICROMORPHOLOGY

Technical work

The treatment of undisturbed soil samples and the subsequent preparation of thin sections is carried out by the technician of ISRIC at the laboratory of the Netherlands Soil Survey Institute (Stiboka) at Wageningen. There is a close cooperation with the technician of Stiboka and there are material contributions to the laboratory.

In 1985, 189 samples were received for treatment from the following countries: Brazil, Gabon, Greece, Ivory Coast, Malaysia, U.S.A. and Zaire.

In the same year approximately 240 thin sections were prepared. 131 thin sections were made for the regular soil collection of ISRIC. These concerned soil profiles from Brazil (13), China (5), Ghana (1), Greece (1), Indonesia (3), Spain (2), Uruguay (2) and U.S.A. (1).

Thin sections for special projects totalled 45, including samples from a laterite profile from Brazil (Trombetas) belonging to the CORLAT collection, and samples from study areas of ITC in Greece and Sri Lanka.

A financial arrangement was made for the preparation of 65 thin sections for a special project of the Netherlands Soil Survey Institute.

Investigations

The regular description of thin sections is now well under way since the adoption of the system as proposed in het Handbook for Soil Thin Section Description. The text of this Handbook, which was published in 1985 under the auspices of the ISSS, is considered as the first approximation to arrive at an internationally acceptable system for description. ISRIC has given its promise to support the Handbook by extensive testing and making suggestions for improvement through the description of thin sections of a wide variety of soils.

ISRIC participates in a Working Group, including micromorphologists of Wageningen Agricultural University; The University of Amsterdam; the Free University, Amsterdam; and the Netherlands Soil Survey Institute. The aim is to further standardize the procedure to make brief and comprehensive descriptions.

Thin section descriptions, prepared according to the Handbook include soil profiles of the ISRIC collection from the following countries: Brazil (5), Greece (1), Hungary (1), Kenya (3), Namibia (2), Nigeria (1), South Africa (1), Spain (2), Sweden (1).

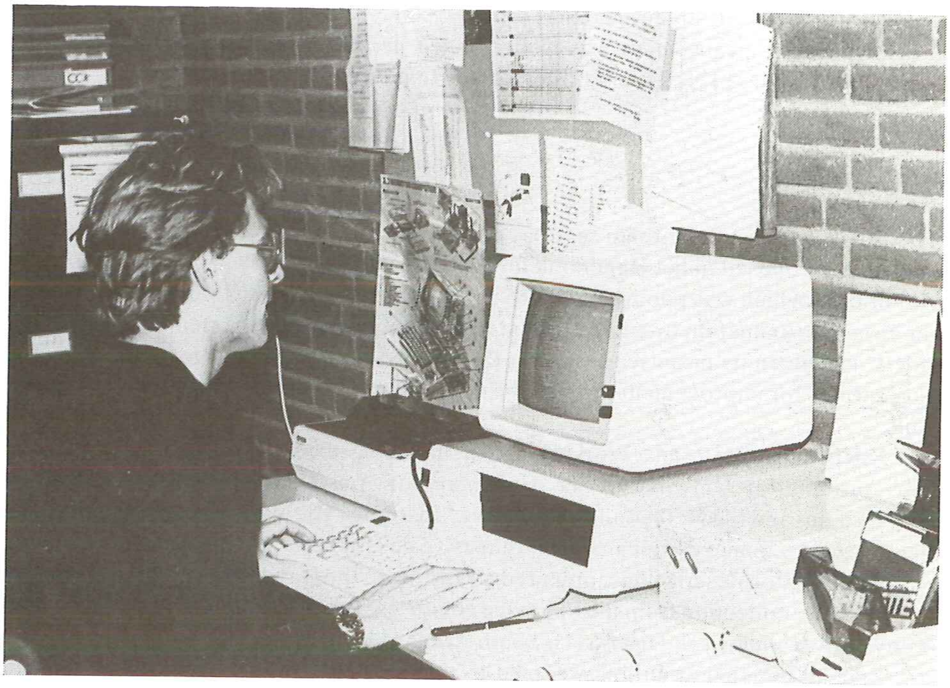
Special detailed attention was paid to thin sections of soils from Ghana, Greece, Spain, and Brazil. The study of thin sections of soils from Ghana, Greece and Spain formed part of a thesis of participants of the M.Sc. Course in Soil Science and Water Management of the Agricultural University and the soils of Brazil are under study by Prof. E. Klamt, guest researcher at ISRIC. In all cases photomicrographs were made to illustrate relevant features.

Thin sections of 21 Nitosols of the ISRIC collection, occurring in 15 different countries, were investigated. It was attempted to establish a set of criteria that can be used for a more precise characterization and classification of these soils.

3.4 DOCUMENTATION

ISRIC Soil Information System (ISIS)

In order to improve storage, retrieval and selection out of the information files of the soil monoliths, a proposal for a computerized soil information system was made. To cope with international developments in soil information systems, available expertise and financial possibilities, it was decided to develop ISIS on a micro-computer with a standard data base management system. To guarantee optimal conditions for transferring information, a questionnaire concerning hard- and software was sent to 45 soil institutes. Based on the results of the questionnaire an IBM PC-XT with a 20 Mb harddisc was selected. The available application programmes are (December 1985):
Database management: dBASE III; Statistics: SPSS/PC; and Pascal compiler.



Entering soil data into ISIS.

During the last quarter of the year the site- and profile descriptions and physical, chemical and mineralogical data of 60 Ferralsols/Oxisols and related soils were stored. These belong to the study carried out by Prof. E. Klamt. The data are primarily stored for research purposes (especially statistical analysis), but will subsequently be used for the development of a first ISIS version.

A draft version of ISIS, including a limited amount of data, will be ready mid 1986. For the completion of ISIS a project proposal was presented to the Ministry of Education and Sciences for special funding.

Map collection and library

Maps and publications form an important part of the Centre's documentation. The coverage is the whole world with 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 4000 sheets and some 600 photonegatives and transparencies.

The acquisition policy is to obtain world coverage of soil maps at reconnaissance and smaller scale, examples of more detailed soil maps and index maps/lists of all soil surveys carried out in a country. Other thematic maps are collected mainly if they complement soil information. The selection criteria are the relevance of the maps for soil science, agricultural development and environmental issues.

One of the purposes of maintaining the map collection is its use for the possible updating of the 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 library collection includes about 4300 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 atlases. There is an annual increase of two to three hundred publications. ISRIC has subscriptions to about 35 journals. The map and book collection increasingly serves as a source of basic information for use by scientists, students and consultants in soil correlation studies and in the preparation of missions abroad. There is especially an increase in its use by students of Wageningen Agricultural University and participants of the M.Sc. Course in Soil Science and Water Management and the International Course for development-oriented Research in Agriculture (ICRA).

The further development and day-to-day running of the administration is seriously hampered by the lack of a qualified librarian. Also, the linkage of the library with Agralin and/or other computerized library systems would increase the usefulness of the collection. This can, however, only be implemented if ISRIC can employ a librarian.

3.5 SOIL CLASSIFICATION AND CORRELATION, SMALL-SCALE SOIL MAPPING

At the initiative of FAO's Land and Water Development Division, a joint working group of FAO, Unesco and ISRIC (Dr. W.G. Sombroek and others) is working on a substantial revision of the FAO-Unesco Soil Map of the World Legend. It includes also proposals for third-level subdivision of the Legend units. After three working meetings, alternatively in Wageningen and Rome, a third draft was prepared by FAO as an issue in its World Soil Resources Report series. This was presented for discussion at two African regional soil correlation meetings during the latter part of the year, and will be circulated for further comments early 1986. A final version of the Revised Legend will be presented at the ISSS Congress in Hamburg, Fed. Rep. of Germany, in August 1986.

Progress at the elaboration of an International Reference Base for soil classification (ISSS Working Group IRB), which ISRIC is actively supporting, has been slow in the past year. This was due to continued non-availability of funds, notwithstanding promises for a two-year's project supported by UNEP.

The programme on the establishment of a reference base for red clay soils in Mozambique has been outlined in Annual Report 1983. The results of a soil classification exercise by an international group of soil scientists have been issued as a working paper. After the incorporation of suggestions and improvements by this group, this study will be published as an ISRIC Technical Paper (see also Chapter 4)

3.6 EDUCATION AND INFORMATION

In 1985 the number of visitors was about 2000.

Group visits

About 1700 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 exhibition hall has been incorporated in the courses on regional soil science of Wageningen Agricultural University and its M.Sc. Course on Soil Science and Water Management, of the Tropical Section of the National Agricultural College, Deventer, and of other courses held in The Netherlands, e.g. at ITC, Enschede.

In addition, groups of students came from Belgium, the Federal Republic of Germany, Sweden and the United Kingdom. See also Appendix 1.

Individual visits

The number of people coming individually or in small groups amounts to about 300. Most visitors are professional soil scientists, and two-third of them coming from abroad. They usually visit ISRIC for discussions with staff members or for consulting the collection, the library and the map collection.

Lectures by guests

In 1985 two guests have presented lectures on topics related to their research. The lectures were held at the premises of ISRIC, staff members of various institutes were invited to attend.

- Dr. G. Irion (Senckenberg Institute for Sea-geology and Sea-biology, Wilhelmshaven, Fed. Rep. of Germany): Landforms and clay Mineralogy of the Amazon Basin.
- Dr. P.F. Farres (Portsmouth Polytechnic, U.K.): Relationship between indices of individual soil aggregate stability and rainsplash erosion for some soils from Mozambique.

Extramural lectures

As in the previous years, staff members of ISRIC participated in the Standard course Soil Survey of ITC, Enschede, The Netherlands by giving lectures on special topics of soil genesis and classification, mineralogy and soil chemistry. Both the FAO-Unesco Soil Map of the World and the USDA Soil Taxonomy were discussed. These lectures are illustrated with slides, hand-outs, lecture notes and other materials derived from the

ISRIC collection.

A series of lectures was given at the Department of Soil Science and Geology of Wageningen Agricultural University, by ISRIC staff members and by its guest researcher Prof.Dr. E. Klamt. Lectured was also at the International Centre for Theoretical Physics, Trieste, Italy and at several soil science institutions in Moscow, U.S.S.R. (see Chapter 6).

3.7 TRAINING

Course on the Establishment and Use of National Soil Reference Collections

The fifth international training Course on the Establishment and Use of National Soil Reference Collections was held at ISRIC from 20 May to 28 June 1985 under the direction of Ir. R.F. Breimer - replaced by Ir. J.H. Kauffman for one week - and aided by A.B. Bos, technician.

The objective of this Unesco-recognized course is to train soil scientists, in particular from developing countries, in all aspects related to national soil reference collections (NASREC).

The course was attended by four participants from Africa. Two were sponsored by Unesco; one was financed by the Directorate-General for International Cooperation (DGIS), and one by NORAD, Oslo, Norway. Unfortunately, a participant from Mali, to be financed by Unesco, was unable to attend.

The participants were:

- Dr.Ivara E. Esu, Department of Soil Science, Ahmadu Bello University, Zaria, Nigeria
- M. Jean-Bernard Moutsinga, Institut des Recherches d'Agronomie et Forestière (IRAF), Libréville, Gabon
- Mr. Samweli E. Mugogo, National Soil Service of the Tanzanian Agricultural Research Organization (TARO), Tanga, Tanzania
- Mr. Michael M. Sishwashwa, Soil Survey Section, Mt. Makulu Central Research Station, Chilanga, Zambia.

The course activities can be broadly categorized as follows:

- Fieldwork: sampling soil profiles and making lacquer peels, soil and landscape description and photography;
- Workshop: preparation of soil monoliths;
- Lectures/exercises: soil classification, micromorphology, laboratory, land evaluation, soil reference collections with regards to users, exhibition aspects;
- Excursions: exhibition techniques, soil and landscape, several agricultural research institutes;
- Final presentation: preparation, display and presentation of a small monolith exhibition (monoliths made during the course)
- Follow-up discussions.

Training course activities.

At the coming two annual courses it is intended to have the majority of the participants from countries included in the National Soil Reference Collection (NASREC) programme, which will officially start in 1986 for a period of 2½ years. Funds for this activity will be provided by the Dutch Directorate-General for International Cooperation (DGIS) in the framework of UNEP's Clearing House Facility.

Course on Soil Classification

As in the previous years, ISRIC was requested by the National Agricultural College, Deventer to organize a Course on Soil Classification for a selected number of students of this College. The course was held at the premises of ISRIC and included lectures, slide shows, demonstrations, discussions and exercises on the USDA Soil Taxonomy and on the soil units of the FAO-Unesco Soil Map of the World. It was also attended by staff members of 4 other Dutch Agricultural Colleges.

REQUEST FOR INFORMATION ON VISUAL TRAINING AIDS

During the last decade a large increase in the use of films, slides and videotapes and other training aids can be noticed at universities, agricultural highschools, training institutes, etc. This will also apply to soil science. Unfortunately, there is no central listing of the available material.

In cooperation with the Secretariat of the ISSS a register of such visual aids is now being made. It will, in due course, appear in the Bulletin of the ISSS.

We would be grateful if recipients of the Annual Report could send to the Secretary-General of the ISSS, P.O. Box 353, 6700 AJ Wageningen, the Netherlands a listing of available films, slides or slide sets, and videotapes on soil science *sensu largo.*

Please supply information on:

- title and main contents,
- level of audience,
- size and length of film,
- type of sound track,
- video system type,
- year of preparation,
- availability and price,
- ordering/contact address.

4 GUEST RESEARCH

Establishment of a reference base for red clay soils in Mozambique

Ir. J.H. Kauffman

The programme has already been outlined in Annual Report 1983. During two months in 1985 the following activities were carried out:

- A working paper on a soil classification exercise was prepared (see also 3.5)
- Analyses of soil moisture retention characteristics, physiographic analysis of the soil sites from aerial photographs, comparison of CEC results as determined with different methods, including the silver thiourea method.
- The reporting of the latter activities as well as of those carried out in 1984 was partly realized in 1985 and will be finished shortly.

Ferralsols and similar soils. Characteristics, classification and limitations for land use

Prof.Dr. E. Klamt, Soil Science Department of UFRGS, Porto Alegre, Brazil.
Period: 25 January 1985 - 30 January 1986.
Funding: Federal University of Rio Grande do Sul (UFRGS)/Conselho Nacional de Pesquisa (CNPq).

The broad aims of this research project are to evaluate the variability of properties of Ferralsols and similar soils, such as low activity clay Nitosols, Acrisols, Cambisols and Luvisols, in order to support taxonomic and capability classification and land evaluation for agricultural development.

Fifty-eight monoliths of the ISRIC collection, described and sampled in eighteen countries, were selected for this study. Besides the morphological properties and environmental informations described in the field, physical, chemical and mineralogical characteristics have been determined in the laboratory, using a uniform methodology. The data are analyzed statistically to assess their variability, correlation and clustering. The research is carried out in close cooperation with ISRIC staff.

The results will be published as Soil Monograph 3.

The application of lateritic materials in civil engineering

Ir. F.A.J. van den Steen van Ommeren

Period: March 1985 - June 1986
Funding: Ministry of Social Affairs, The Hague, through the Stichting MPW

The research project was set up in the CORLAT framework and is carried out in cooperation with DHV Consulting Engineers at Amersfoort and the Department of Civil Engineering and Irrigation of Wageningen Agricultural University.

The project has the aim to develop a practical classification system of lateritic materials, to assess their engineering properties, especially for road construction and to develop methods for understanding and predicting their behaviour in road constructions. The relationship with pedological, morphological and geological aspects forms an important part of the study.

Activities:

- In the first phase, relevant literature and information have been collected and studied. About 150 articles and reports were reviewed on identification and classification methods, test procedures, mechanical and physical characteristics and the application of laterites in road construction.
- A bulk sample of lateritic material was collected in Guinea-Bissau. The material will be tested on various aspects. The development of a newly designed plate bearing laboratory test is an important part of the research.
- For the description of a sample site and profile, a draft manual was prepared. It is based on the profile description form developed by ISRIC.
- A report on the conclusions of the literature review is in preparation. Main items are: the suitability of present classification systems and identification and performance tests for lateritic materials.

ISRIC's guest researcher Prof. E. Klamt (centre), Ir. H. Rogaar of the Wageningen Agricultural University and Dr. I.E. Esu from Nigeria studying a Dutch soil profile.

5 PROJECTS

5.1 SOIL STUDIES IN 'MAN AND THE BIOSPHERE' (MAB) SITES

The programme of support to soil studies in 'Man and the Biosphere' (MAB) biosphere reserves and other research sites in developing countries, through the back-stopping of three associate experts employed by Unesco through DGIS, continued during the year.

The cooperative programme between ISRIC and Unesco started in 1980 and was finished in May 1985 when Mr. A.J. van Kekem terminated his Unesco assignment after five years in Africa. His two colleagues Messrs. H. van Reuler (S.E. Asia) and R.F. Breimer (Latin America) had finished their duties earlier, in August 1984 and February 1985 respectively.

Initiated in 1980 as an ambitious programme to characterize the soils of MAB biosphere reserves and other research sites in three tropical continents (see Annual Report 1980), the programme has accomplished many tasks during the years of its existence. The three associate experts have been made available to Unesco by the Netherlands' Directorate-General for International Cooperation (DGIS). For an over-view of the main accomplishments under the MAB soils programme, reference is made to former Annual Reports and to Appendix 3.

An important result of the programme is the publication of a volume in the Unesco-MAB Technical Note series. Entitled ''Guidelines for soil survey and land evaluation in ecological research'' it gives a comprehensive over-view of the soil survey methodology employed by the three MAB soil scientists in their respective regions. The last chapter of the Technical Note deals with case studies, summarizing the results of nine soil surveys and special studies carried out in the tropics between 1980 and 1985.

A positive side-effect of the MAB soils programme for ISRIC was the collection of 30 soil profiles form 7 countries, enriching and complementing the world soil monolith collection. The build-up of national soil reference collections, such as the one in Uruguay, which was officially opened in June 1985, was also actively supported by the MAB soil scientists.

It is hoped that follow-up activities can be arranged in one way or another, possibly by a support from Unesco Headquarters, to field staff.

5.2 COOPERATION WITH THE PEOPLE'S REPUBLIC OF CHINA

Since 1980 a cooperative programme has been developed between the Nanjing Institute of Soil Science, Academia Sinica, and ISRIC, for strengthening scientific relations and exchanges. This programme is jointly funded by the Academia Sinica (Chinese Academy of Sciences) and the Royal Netherlands Academy of Arts and Sciences (KNAW). The programme includes exchange visits by soil scientists.

In 1983 Dr. O.C. Spaargaren made a two-months soil study tour through southeast

China. In 1984 Mr. Xu Li-yu attended the training course on the establishment and use of national soil reference collections at ISRIC.

From 31 July to 27 September 1985 Ir. J.H. Kauffman made a study tour through northwestern China for the following purposes:

- to study soils and agricultural practices, including collection of representative soil monoliths with accompanying documentation, to be incorporated in the ISRIC soil monolith collection
- To evaluate and advise on updating of the existing soil monolith collection at the Nanjing Institute of Soil Science
- to give lectures at the Nanjing Institute of Soil Science on soil classification, remote sensing and computerized data handling
- to train Chinese counterparts in the sampling of soil monoliths, using materials provided by ISRIC.

After preparatory discussions at the host Institute and its various Departments, including an inspection of the existing soil monolith collection, a one-month field tour was made in an east-west climatological transect. Eight soil profiles were taken for the world soil collection of ISRIC. These profiles represent three major soil types of the loess area in Shaanxi and Gansu Provinces, and five major soil types from the desert areas in Xinjian autonomous region. Two profiles were collected from irrigated areas to characterize effects of long term irrigation practices.

The discussions focussed on the cooperative programme, soil classification, the distribution and characteristics of primary and secondary loess, and the establishment of soil reference collections. During the past 2 years the Nanjing soil reference collection has been enlarged with twelve new soil monoliths, prepared with modern conservation techniques. These monoliths show well the natural soil morphological features, such as structure, porosity, etc. Exhibition and information aspects of soil reference collections were discussed.

In addition, lectures were given on the FAO-Unesco Soil Map of the World legend, problems related to the classification of red clayey soils in East Africa, computer-assisted data handling in soil science, and the use of satellite images especially for soil mapping purposes. The latter lecture was also given to the Xinjiang Institute of Biology, Pedology and Psammology in Urumqi.

Academia Sinica - KNAW
1985
Soils Expedition

国际土壤参比情报中心

J.H. 考夫曼博士

土壤学家

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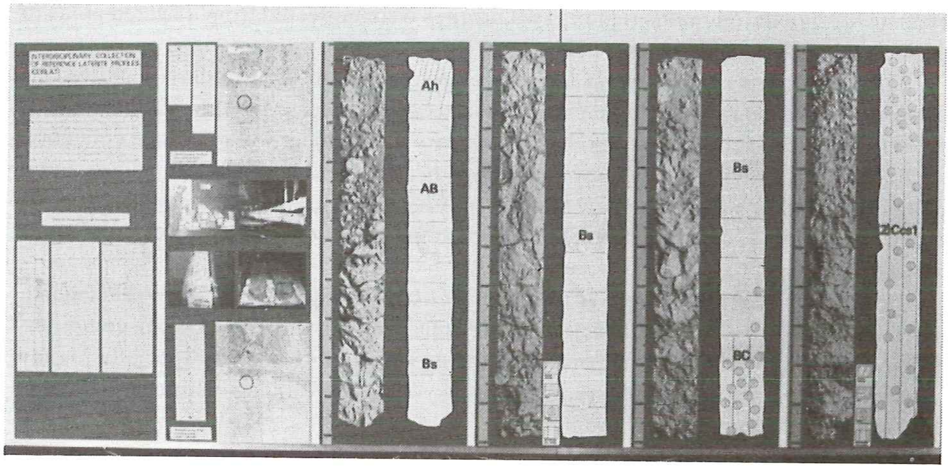
How to get around in China.

5.3 INTERNATIONAL COLLECTION OF REFERENCE LATERITE PROFILES (CORLAT)

The programme to support the establishment of interdisciplinary laterite collection was continued in 1985. Most attention was paid to promote the project and to sollicit the participation of more counsellors. These counsellors will function as regional representatives, thereby keeping the Working Party in touch with the needs and interests of institutes and individuals, concerned with laterites in the region.

The research on the first laterite profile (Trombetas-bauxite) was continued: chemical, mineralogical and micromorphological analyses on 27 samples of this profile were carried out at ISRIC and at the University of Utrecht, The Netherlands (trace elements by ICP-analyses; Prof. R.D. Schuiling) and the Senckenberg Institute for Sea-geology and Sea-biology in Wilhelmshaven, Fed. Rep. of Germany (clay mineralogy, texture; Dr. G. Irion).

The analytical results and the information on the first reference profile and the programme were presented at the First International Conference on Geomorphology, held in Manchester, U.K., in September (see also Chapter 6).



Poster on Trombetas bauxite profile at Conference in Manchester.

It has to be repeated that the effective realization of the project is dependent on external funding. For this purpose, contacts with the EUROLAT-group are continuing to study the possibilities of funding by the EEC.

Further activities will be concentrated on the administration of the Secretary correspondence, and stimulation of contacts between disciplines. It is hoped to involve scientists from laboratories of institutions which have facilities within the programme. These scientists will be involved in advisory and service capacities, as well as in the collection and transport of the future reference profiles.

5.4 'SOILS OF THE WORLD' WALL CHART

This cooperation project of Elsevier Publishing Company and ISRIC, and supported by FAO and Unesco, embraces the production of a wall chart of about 110 x 160 cm. It shows 106 colour photographs of soils illustrating the units of the FAO-Unesco Soil Map of the World legend and enlists eight soil classification systems (from Australia (2 systems), Brazil, Canada, England and Wales, France, Fed. Rep. of Germany, and the United States of America). All the soils will be correlated in these systems, as far as this is feasible. The chart will become available early 1987.

5.5 SPECIAL PROJECTS

In the course of the year instruction on the impregnation of soil profiles was given to soil scientists from France and Portugal.

Indonesia. East Java, 5 samples analyzed on basic parameters and P-Olsen (for Marif, ATA 272)

Kenya. Lake Basin, 29 samples analyzed on basic parameters (for Stiboka).

Nigeria. 21 pF curves (for ILRI)

Saudi Arabia. 59 samples analyzed on salinity aspects (for Thumama Nature Park Consultants).

Spain. 19 samples analyzed on basic parameters, and 59 water samples on pH, electrical conductivity and ionic content (for ITC).

Tanzania. 20 pF-curves and 5 samples analyzed on basic and some special parameters (for Stiboka).

Laboratory exchange programme (LABEX). About a hundred samples analyzed on texture, CEC and exchangeable cations, organic carbon and pH. 10 samples on clay mineralogy.

Logos of the Laboratory Methods and Data Exchange Programme LABEX, the Collection of Reference Laterite Profiles CORLAT, and the National Soil Reference Collection programme NASREC.

6 TRAVEL AND MISSIONS

(85/1) Première Table Ronde Franco-Marocaine ''Quaternaire et Préhistorie du Maroc'', Bordeaux, France, February 1985. *Participant: N.M. Pons-Ghitulescu.*

The main aim of participation was the collection of documentation on Red Mediterranean Soils (mainly Chromic Luvisols) and the exchange of information of these soils. Mrs. Pons is a member of the Working Group on Red Mediterranean Soils, headed by Dr. E.A. FitzPatrick.

(85/2) College on Soil Physics, International Centre for Theoretical Physics, Trieste, Italy, May 1985. *Participant: J.H.V. van Baren.*

To give lectures on soil genesis, classification and geography of the world's soils. Two films by Shell, London and the Soil Conservation Service, USDA, Washington, were also shown. The college was attended by about 100 persons from developing countries.

(85/3) Visit to INRA, Montpellier, France, May 1985. *Participant: N.M. Pons-Ghitulescu.*

To take a profile of a Chromic Luvisol and collect information and soils documentation on these soils.

(85/4) Second Workshop on Tropical Soil Biology and Fertility, Ury, France, May 1985, sponsored by International Union of Biological Sciences (IUBS) and Unesco. *Participants: W.G. Sombroek and R.F. Breimer.*

The framework of a collaborative research programme on maintaining soil fertility under cropping, by biological means, was discussed and adopted. ISRIC is responsible for some sections in a Methods Handbook, to be published in 1986.

(85/5a) Primero Seminario Cientifico de Pedologia de America Central y los Caribes, Havana, Cuba, April 1985, organized by the Soil Science Society of the Academy of Sciences of Cuba and ORSTOM. *Participant: W.G. Sombroek.*

Attendance of meeting and presentation of paper ''Estado actual y tendencias de la pedologia en el plano internacional; hacia una base internacional de referencia para la classificacion de suelos''. Establishing contacts with the Instituto de Suelos, Havana.

(85/5b) Visit to Bogota and CIAT, Cali, Colombia, April 1985. *Participant: W.G. Sombroek.*

Follow-up discussions on the 'Tropenbos' research site in the Colombian Amazone region. Visit to CIAT to study the computerized soils and agroclimatological data information system.

(85/5c) Visit of several institutions and sites in Peru, April 1985. *Participant: W.G. Sombroek.*

As member of a four-person mission for establishing one or more UNEP-proposed projects in the High Selva region on environmental management. Also contacts with La

Molina Agricultural University on LABEX; ONERN for maps; and sampling of soils in Yurimaguas experimental station, from where a soil monolith has also been collected.

(85/5d) IBSRAM inaugural Workshop on "Acid Tropical Soils Management Network", Brasilia, Brazil, April-May 1985. *Participant: W.G. Sombroek.*

To take part in the Workshop and discussion on effectuation of the research programme within the network. Furthermore contacts on LABEX; Tropenbos research site in Brazil; second phase soil profile collection trip in 1986; visit to Cerrado Soil Research Institute, Planaltina.

(85/6) FAO, Rome, Italy, June 1985. *Participant: W.G. Sombroek.*

To participe in discussions on improvement and detailing of the FAO-Unesco Soil Map of the World legend, for application at updating of the existing 1:5 million map, and for use at a larger scale at country level. Final proposals, after a meeting in August 1985 at ISRIC, and two regional soil correlation meetings in Africa, will be available at the beginning of 1986.

(85/7) Visit to Kumasi, Ghana. *Participant: F.A.J. van den Steen van Ommeren.*

Within the framework of research project "Lateritic materials in civil engineering" visits were made to the Soil Research Institute and the Building and Road Research Institute in Kumasi. Main aims were to introduce the project and investigate possible cooperation, and to collect informaiton.

(85/8) Course on Iron in Soils and Clay Minerals. NATO Advanced Study Institute, Bad Windsheim, Federal Republic of Germany, July 1985. *Participants: L.P. van Reeuwijk and ISRIC guest researcher Prof.Dr. E. Klamt.*

Participation in course.

(85/9) 7th International Working Meeting on Soil Micromorphology, Paris, France, July 1985, organized by the Subcommission on Soil Micromorphology of the ISSS. *Participants: D. Creutzberg and W.G. Sombroek (opening session).*

To participate in the workshop and presentation of a poster "Micromorphology of Nitosols" by Creutzberg and Sombroek. Creutzberg was also co-author of a paper presented by Dr. G.W.W. Elbersen: "Mechanical and chemical transport processes in calcic horizons".

(85/10) Annual Meeting of CASAFA, Wageningen, The Netherlands, September 1985. *Participant: W.G. Sombroek (as Secretary-General of the ISSS).*

To discuss the on-going programme and future orientation of activities of the ICSU Inter-union Commission on the Application of Science to Agriculture, Forestry and Aquaculture (CASAFA). Presentation of paper: "Identification and Management of Problem Soils in the Tropics and Subtropics".

Installation of the Netherlands CASAFA Committee, under the umbrella of the Royal Netherlands Academy of Arts and Sciences (KNAW). W.G. Sombroek was elected as a member of the Dutch Committee.

Participants Annual Meeting of CASAFA at ISRIC.

(85/11) Annual Meeting of the Deutsche Bodenkundliche Gesellschafft and working meeting of the Organizing Committee for the 13th International Congress of Soil Science, Göttingen, September 1985. *Participant: W.G. Sombroek.*

To attend part of the annual meeting of the DBG. To discuss Congress programme, especially opening and closing sessions.

(85/12) First International Conference of Geomorphology, Manchester, England, September 1985. *Participant: W.G. Sombroek.*

The main aim was to present a poster, prepared by ISRIC guest researcher Drs. M.L. Moura, ''Interdisciplinary Collection of Reference Laterite Profiles (CORLAT); Chemical Progressions in the Trombetas Profile''. Cooperation was sought with persons interested in participating in the CORLAT programme, especially for sampling of laterites in Australia, Nigeria and Venezuela.

(85/13) International Symposium on the Assessment of Soil Surface Sealing and Crusting, Gent, Belgium, September 1985. *Participant: W.G. Sombroek (as Secretary-General of the ISSS).*

Introduction to the symposium on the problem of sealing and crusting, with special reference to the Sudano-Sahelian zone in West Africa. The importance of standardization in nomenclature was stressed.

(85/14) Soil study tour and profile collection trip to the People's Republic of China, July-September 1985. *Participant: J.H. Kauffman.*

During the second visit in the framework of the ISRIC-KNAW and Nanjing Institute of Soil Science - Academia Sinica cooperative programme eight soil profiles were collected and a number of other activities executed. For details see Chapter 5.

(85/15) SCOPE/INTECOL/ICSU Workshop on Spatial and Temporal Variablity in Biospheric and Geospheric Processes, St. Petersburg, Florida, U.S.A., October-November 1985. *Participant: W.G. Sombroek (as Secretary-General of the ISSS).*

The Workshop was one of several, dealing with planning of an ICSU-proposed International Geosphere-Biosphere Programme; a study of Global Change (IGBP). Key issue was the harmonizing of spatial and temporal scales of research to be undertaken within the various disciplines.

(85/16) Visits to several institutions dealing with soil science in Moscow and Puschino, U.S.S.R., November 1985. *Participant: W.G. Sombroek, at invitation of USSR Academy of Sciences.*

Visits were brought to Moscow State University, Dokuchaev Institute of Soil Science, V.V. Williams Soil Museum of Timiriazev Academy of Agriculture, all in Moscow; the Institute of Soil Science and Photosynthesis, Academy of Sciences' Centre for Biological Sciences, Puschino, for establishing and renewing of contacts and discussions on ISSS matters, LABEX, Glinka Memorial Collection at ISRIC. Some lectures on trends in classification of tropical soils.

7 RELATIONS WITH OTHER INSTITUTIONS

7.1 INTERNATIONAL RELATIONS AND ACTIVITIES

Contacts and activities with international institutions included the following:

Food and Agricultural Organization of the United Nations (FAO, Rome and Regional Offices).
- Development of an improved legend for small-scale mapping, as a successor to the FAO-Unesco Soil Map of the World legend
- Map collection for the updating of the FAO-Unesco Soil Map of the World
- Elaboration of an International Reference Base for soil classification (IRB)
- Exchange of publications and documentation, on soils and their management, agro-climatic zones, and potential population supporting capacities
- FAO advice to ISRIC on the preparation of a Soils of the World chart.

United Nations Educational, Scientific and Cultural Organization (Unesco, Paris and Regional Offices)
- Unesco-ISRIC cooperative programme for soil studies in project areas of Unesco's "Man and the Biosphere" (MAB) programme, including the preparation of a MAB Technical Note
- Unesco financial support for ISRIC's International Course on the Establishment and Use of National Soil Reference Collections
- Establishment of an International Collection of Reference Laterite Profiles (CORLAT) at ISRIC
- Unesco advice to ISRIC on the preparation of a Soils of the World chart.

United Nations Environment Programme (UNEP, Nairobi)
- Advice on the promotion of UNEP's World Soils Policy and the elements of its Plan-of-Action
- UNEP financial support for the elaboration of an International Reference Base for soil classification (IRB)
- ISRIC participation in UNEP-GEMS Global Resources Information Data base (GRID)
- UNEP possible financial support of an ISRIC programme to assist in the establishment of national soil reference collections in a number of developing countries, through UNEP/DGIS "Clearing House Facility".

International Society of Soil Science (ISSS)
- Administrative assistance to the Secretariat-General of ISSS, housed at ISRIC
- 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

- Establishment of a reference collection of soil thin sections for the ISSS Subcommission of Soil Micromorphology
- 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 international contacts

- Commission of the European Communities (EEG, 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
- International Development Research Centre (IDRC, Ottawa); support soil data centres
- Institut français de recherche scientifique pour le développement en coopération (OSTROM, Paris); exchange of information; proposal for joint documentation in the field of land resources
- Centre Technique de Coopération Agricole et Rurale (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; request for financial support
- Several of the International Agricultural Research Centres of the Consultative Group on International Agricultural Research (IITA, IRRI, CIAT); exchange of information
- International Union of Biological Sciences (IUBS); cooperation on formulation of a proposal for network research on Tropical Soil Biology and Fertility (TSBF), and preparation of a manual for the project (items of site selection and characterization; methods for chemical analysis of soil and water samples)
- National Soil Survey and Soil Research Institutes in many countries.

7.2 NATIONAL RELATIONS AND ACTIVITIES

- National Unesco Committee for MAB/SCOPE (Amsterdam); cooperation on organization of a Seminar on Tropical Forest Ecosystems.
- 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 CASAFA.
- 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 data base development; map preparation for MAB soil scientist.
- Department of Science Policy ot the Dutch Ministry of Education of Sciences (MOW-WB, The Hague); cooperation on the elaboration of a multidisciplinary research programme on tropical forests (Tropenbos).
- Centre for World Food Studies (SOW, Wageningen/Amsterdam); exchange of information.
- Department of Soil Science and Geology of Wageningen Agricultural University;

cooperation 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 three students at thesis work.
- Netherlands Soil Survey Institute (Stiboka, Wageningen); cooperation micromorphology, including methodology of descriptions; exchange of information; representation at international meetings.

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 Offices of Unesco and FAO.

8 PUBLICATIONS

8.1 SOIL MONOLITH PAPERS

The actual situation with regard to SMP's is as follows:

1, 5 and 6. Published.

2. Orthic Ferralsol (Typic Haplustox) Zambia. J.H.V. van Baren and L. van Sleen, in preparation.
3. Placic Podzol (Placaquod), Ireland. D. Creutzberg, J. Kiely and J. Diamond, draft nearly completed.
4. Humic Nitosol (Oxic Paleustalf), Kenya. H. Lips and W. Siderius, draft nearly completed.
7. Calcic Chernozem (Vermic Haplustoll), Romania. N.M. Pons-Ghitulescu, text completed.
8. Ferric Luvisol (Oxic Paleustalf), Nigeria. T. Loran and F.R. Moormann, in preparation.
9. Ferric Acrisol (Oxic Paleustult), Ghana. P. Derigubaa and R. Asiamah, in preparation.
10. Eutric Planosol (Typic Albaqualf), Uruguay. Chr. Angueira and W.G. Sombroek, in preparation.
11. Calcaric Fluvisol (Typic Xerofluvent), Greece. N. Danalatos and D. Creutzberg, in preparation.
12. Calcic Cambisol (2x, Calcixerollic/Petrocalcic Xerochrept), Spain. J. Boixadera and W.G. Sombroek, in preparation.
13. Chromic Luvisol (Typic Vermustoll), France. N.M. Pons-Ghitulescu, in early stage of preparation.

8.2 SOIL MONOGRAPHS

The text of SM 2, 'Clay Mineralogy and Chemistry of Andisols and related soils from diverse climatic regions', by C. Mizota and L.P. van Reeuwijk is being finalized. For the preparation of SM 3, see Chapter 4.

8.3 TECHNICAL PAPERS

The following Technical Papers were issued or completed in 1985:

Technical Paper 9. Procedures for soil analysis. L.P. van Reeuwijk (ed.)

Technical Paper 10. Aspects of the exhibition of soil monoliths and relevant information (provisional edition). W.C.W.A. Bomer and J.H.V. van Baren

Technical Paper 11. A simplified new suction apparatus for the preparation of small-size porous plate clay specimens for X-ray diffraction. J.R.M. Huting and L.P. van Reeuwijk.

8.4 ANNUAL REPORT

Annual Report 1984 was published in 1985. In contains one scientific article, viz: 'Soil Classification in the Past --- Roots and Philosophies', by Roy W. Simonson.

8.5 MISCELLANEOUS

In 1985 the following article was published:

- Van Reeuwijk, L.P. & J.M. de Villiers (1985) The origin of textural lamellae in Quaternary coast sands of Natal. S.A.J. Plant Soil 2:38-44.

The following poster presentations took place:

- M. Moura: "Interdisciplinary Collection of Reference Laterite Profiles (CORLAT); Chemical Progressions in the Trombetas profile". First International Conference of Geomorphology, Manchester, England.
- A poster on the aim and activites of ISRIC was presented at the jubilee meeting of the Soil Science Society of The Netherlands, Wageningen.

In the series 'Working Paper and Preprint' the following was issued:

- (85/1) Towards an International Reference Base for soil classification, W.G. Sombroek
- (85/2) Report on the classification exercise of some deep well drained red clay soils of Mozambique, J.H. Kauffman
- (85/3) Identification and Management of Problem Soils of the Tropics and Subtropics. ICSU-CASAFA Meeting, Wageningen, September 1985, W.G. Sombroek
- (85/4) The Laboratory Methods and Data Exchange Programme. Interim Report on the exchange round 85-1, L.K. Pleijsier

Consultancy/Mission Reports:

- (85/1) Report on a consultancy travel to Brazil and Colombia, 10 November-2 December 1984, for the preparation of an international research programme called Tropenbos, W.G. Sombroek.
- (85/2) Chemical, physical and mineralogical analyses of 59 soil samples from Saudi Arabia, Laboratory staff.
- (85/3) Travel Report to Colombia (Choco Department), November 1985, L.R. Oldeman.

9 PERSONNEL

9.1 BOARD OF MANAGEMENT

Members of the Board of Management on 31 December 1985 were:

- Prof.Dr. Ir. F.R. Moormann, Chairman Netherlands Advisory Council
- Prof.Dr. L. van der Plas, Wageningen Agricultural University
- Ir. P. van der Schans, International Institute for Aerospace Survey and Earth Sciences (ITC), Enschede
- Dr.Ir. F. Sonneveld, Directorate for Agricultural Research, Ministry of Agriculture and Fisheries, Wageningen (Chairman)
- Prof.Dr.Ir. T. Wormer (personal member).

9.2 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)
- Mr. 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)
- Prof.Dr. G. Varallyay, Research Institute for Soil Science and Agricultural Chemistry, Budapest, Hungary (for Eastern Europe).

9.3 NETHERLANDS ADVISORY COUNCIL

Members of the NAC on 31 December 1985 were:

- Ir. J.G. van Alphen, International Institute for Land Reclamation and Improvement, Wageningen

- Dr. J.P. Andriesse, Royal Tropical Institute, Amsterdam
- Prof.Dr.Ir. G.H. Bolt, Department of Soils and Fertilizers, Wageningen Agricultural University
- Dr.Ir. J. Bouma, Soil Science Society of The Netherlands
- Prof.Dr.Ir. A. van Diest, Royal Netherlands Society of Agriculture, Wageningen
- Dr.Ir. P.M. Driessen, Centre for World Food Studies, Amsterdam-Wageningen
- Dr.Ir. J.C. Dijkerman, M.Sc. Course in Soil Science and Water Management, Wageningen Agricultural University
- 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
- Dr. F. Kadijk, Laboratory for Soil and Crop Testing, Oosterbeek
- Dr.Ir. T. de Meester, Department of Soil Science and Geology, Wageningen Agricultural University
- Prof.Dr.Ir. F.R. Moormann, State University Utrecht (Chairman)
- Dr. F.W.T. Penning de Vries, Centre for Agrobiological Research, Wageningen
- Dr. J.F.Th. Schoute, Free University, Amsterdam
- Dr. J. Sevink, University of Amsterdam
- Dr.Ir. P.K.J. van der Voorde, Euroconsult, Arnhem
- Ir. W. van Vuure, Directorate for Agricultural Research, Ministry of Agriculture and Fisheries, Wageningen
- Drs. R.F. van de Weg, Soil Survey Institute, Wageningen
- Dr.Ir. A.L.M. van Wijk, Institute for Land and Water Management Research (ICW), Wageningen.

Prof.Dr.Ir. J. Bennema. From 1966 to 1985 associated with ISRIC

Mutations: It is with great regret that the passing away of Prof.Dr.Ir. J. Bennema and Dr.Ir. G.P. Wind have to be mentioned. Prof. Bennema had been actively pursuing the cause of ISRIC, even from before its establishment in 1966. Dr. Wind was a member of the Netherlands Advisory Council since its establishment. He represented the Institute for Land and Water Management Research (ICW), Wageningen. Dr. Wind is succeeded by Dr.Ir. A.L.M. van Wijk.

9.4 ISRIC STAFF

Staff members of ISRIC on 31 December 1985 were:

Dr.Ir. W.G. Sombroek	: Director, soil classification and correlation, soil ecology
Drs. J.H.V. van Baren	: Curator, documentation
Drs. D. Creutzberg	: Soil micromorphology, educational affairs
Ir. J.H. Kauffman	: Senior soil scientist
Dr.Ir. L.R. Oldeman	: Publications, agricultural applications
Ir. L.K. Pleijsier	: LABEX programme secretary
Dr.Ir. L.P. van Reeuwijk, M.Sc	: Soil chemistry, mineralogy and physics
Drs. E.J. van Waveren	: Soil documentation
Ing. R.O. Bleyert	: Soil micromorphology, map documentation
W.C.W.A. Bomer	: Technician, photography and drawing
Ing. A.B. Bos	: Monolith preparation, technical services
J. Brussen	: Internal administration*
J.R.M. Huting	: Laboratory analyst
B. van Lagen	: Laboratory analyst
A.J.M. van Oostrum	: Senior laboratory analyst
J.D. Scheiber	: Technician, thin-section preparation
R.A. Smaal	: Laboratory analyst
Ms. M.B. Clabaut	: Clerical services
Ms. Y.G.L. Karpes-Liem	:
Ms. J.C. Jonker-Verbiesen	: Library assistant

* External administration by ITC, Enschede.

Persons working at ISRIC during (part of) 1985 were:

Ir. R.F. Breimer	: Training course leader
Drs. M.L. Moura	: Geochemist
J.G. ten Bokkel	: Laboratory analyst
W.C.A. Oostrom	: Library assistant (volunteer)

9.5 GUEST RESEARCHERS

Soil and other scientists working at ISRIC during (part of) 1985 as guest researchers were:

- Ir. W.P. Groeneveld
- Ir. P. Kiepe
- Prof.Dr. E. Klamt
- N. Lauv, M.Sc.
- Dr. N.M. Pons-Ghitulescu
- Ir. F.A.J. van den Steen van Ommeren

APPENDIX 1 - GROUP VISITS IN 1985

Professional

Institutions	Approximate number of persons
Belgium	
University of Ghent	2 visits of 18
University of Leuven	2 visits of 20
Foundation Universitaire Luxembourgeoise	25
Fed. Rep. of Germany	
University of Bonn	7
University of Aachen	15
University of Hamburg	25
University of Kiel	20
University of Bochum	22
Fachhochschule Osnabrück	25
The Netherlands	
International Institute of Hydrologic and Environmental Engineering, Delft	2 visits of 32
International Institute for Aerospace Survey and Earth Sciences (ITC), Enschede	2 visits of 34
International Agricultural Centre (Fertility Programme)	18
International Institute for Land Reclamation and Improvement (ILRI)	28
ILRI Course on Land Drainage	25
University of Amsterdam	2 visits of 15
Free University, Amsterdam	15
University of Utrecht	20
Wageningen Agricultural University	16 visits of 24
Agricultural University, M.Sc. course	6 visits of 24
ICRA International Course for Development Oriented Research in Agriculture, Wageningen	25
National Agricultural College, Deventer	3 visits of 24
Agricultural College, Den Bosch	19
Agricultural College, Dronten	14
Agricultural College, Groningen	15
College for Forestry and Land and Water Management, Velp	22
Horticultural School, Frederiksoord	37
Agromisa International Course, Wageningen	20
Participants Symposium on Remote Sensing and Soil Survey	35
Post-graduate Course Agronomists (BLOS)	22
Netherlands Advisory Council ISRIC	18
CASAFA meeting	23
Eurolat Network - KNGMG	20
Poland	
Agricultural College, Krakov	45
Sweden	
University of Uppsala	12
United Kingdom	
Portsmouth Polytechnic	16
Meeting of Association for Environmental Archeology	35
Yugoslavia	
Excursion of Yugoslavian soil scientists	35

Non-Professional

Ladies programmes	17 + 40
Rijksscholengemeenschap Wageningen	15

APPENDIX 2 - LABORATORIES PARTICIPATING IN THE LABORATORY EXCHANGE PROGRAMME (LABEX)

ARGENTINA
Secretaria de Agricultura
INTA
Departamento de Suelos
1712 Castelar F.C.S.

AUSTRALIA
CSIRO Davies Laboratory
Private Bag
Aitkenvale, QLD 4814

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

Dept. of Primary Industries
Meiers Road
Indooroopilly, QLD 4068

AUSTRIA
Institut für Bodenforschung
Gregor-Mendelstrasse 33
A-1180 Wien

BELGIUM
Geological Institute
Krijgslaan 281
B-9000 Gent

BENIN
Centre Nat. d'Agro-Pédologie
B.P. 988
Cotonou

BOLIVIA
CIAT, Bolivia
Casilla 247
Santa Cruz

BOTSWANA
Dept. of Agricultural Research
Private Bag 0033
Gaborone

BRAZIL
SNLCS-EMBRAPA
Rua Jardim Botanico 1024
22460 Rio de Janeiro, RJ

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

CAMEROON
Centre de Recherche d'Ekona
PMB 25
Buea

CANADA
Canadian Forestry Service
Analytical Serv. Laboratory
5320, 122 Street
Edmonton, Alberta T6H 3S5

Land Res. Research Institute
Central Experimental Farm
Neatby Bldg
Ottawa, Ontario K1A OC6

CHILE
INIA
Casilla 5427
Santiago

CHINA, PEOPLE'S REP. OF
Institute of Soil Science
P.O. Box 821
Nanjing

COLOMBIA
CIAT
Apartado Aereo 6713
Cali

Inst. Geogr. 'Agustin Codazzi'
Apartado Aereo 6721
Bogota

COSTA RICA
CATIE
Turrialba

Universidad de Costa Rica
Centro de Inv. Agronomicas
Ciudad Univ. 'Rodrigo Facio'

CUBA
Instituto de Suelos
Apartado 8022
Ciudad Habana 8

ECUADOR
Nat. Soil Dept. PRONAREG
Sancho de la Carrera 285,
CCI No. 11
Quito

EGYPT
Faculty of Agriculture
University of Cairo
Giza

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Koronivia Research Station
P.O. Box 77
Nausori

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70-74, Route d'Aulnay
F-93140 Bondy

GERMANY, FED. REP. OF
Bundesanst. f. Geowissenschaften
Postfach 51 01 53
D-3000 Hannover 51

Universität Hamburg
Von-Melle-Park 10
D-2000 Hamburg 13

GHANA
Soil Research Institute
Academy Post Office
Kwadaso, Kumasi

GREECE
Agricultural Research Service
Land Reclamation Institute
570 00 Sindos

HUNGARY
Plant Protec. and Agric. Station
Fo ut 230
H-2481 Velence

Research Inst. for Soil Science
Herman Otto u. 15
H-1022 Budapest

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

INDONESIA
Centre for Soil Research
Jalan Ir. H. Juanda 98
Bogor

IRAN
Soil Institute of Iran
Kargar Shomali Avenue
Teheran

IRELAND
National Soil Survey
Johnstown Castle
Wexford

JAMAICA
Min. of Agriculture
Soil Survey Unit
Hope Gardens
Kingston 6

JAPAN
Hokkaido University
Faculty of Agriculture
Kita 9, Nishi 9, Kita ku
Sapporo 060

Kyoto University
Laboratory of Soils
Kitashirakawa, Sakyo ku
Kyoto 606

Tropical Agric. Research Centre
1-2 0-washi
Yatabe Tsukaba
Ibaraki 305

JORDAN
Soils Division JVA
P.O. Box 2769
Amman

KENYA
Kenya Soil Survey
P.O. Box 14733
Nairobi

MALAWI
Chitedze Research Station
P.O. Box 158
Lilongwe

MALAYSIA
Soil Management Branch
Jalan Mahameru
Kuala Lumpur 10-02

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

MEXICO
Centro de Edafologia
Colegio de Postgraduados
56230 Chapingo

MOROCCO
Inst. Agron. & Veter. Hassan II
B.P. 6202
Rabat Instituts

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

THE NETHERLANDS

Agricultural University
Dept. of Soil Science & Geology
P.O. Box 37
6700 AA Wageningen

Agricultural University
Dept. of Soil Science and Plant Nutr.
P.O. Box 8005
6700 EC Wageningen

ISRIC
P.O. Box 353
6700 AJ Wageningen

Lab. for Soil and Crop Testing
P.O. Box 115
6860 AC Oosterbeek

Royal Tropical Institute
Mauritskade 63
1092 AD Amsterdam

NEW ZEALAND

Forest Research Institute
Private Bag
Rotorua

Soil Bureau DSIR
Private Bag
Lower Hutt

NIGERIA

Ahmadu Bello University
Dept. of Soil Science
P.M.B. 1044
Samaru, Zaria

IITA
P.M.B. 5320
Ibadan

PAKISTAN

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

PHILIPPINES

Bureau of Soils
Soil Research Division
P.O. Box 1848
Ermita, Manila

IRRI
P.O. Box 933
Manila

PORTUGAL

Centro de Estudos Pedologia
Tapada de Ajuda
1399 Lisboa Codex

SENEGAL

ISRA-CNRA
B.P. 51
Bambey

SIERRA LEONE

Land and Water Develop. Div.
P.M. Bag 187
Freetown

SPAIN

Departamento de Edafologia
La Laguna Tenerife
Islas Canarias

SRI LANKA

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

SUDAN

Soil Survey Administration
P.O. Box 388
Wad Medani

SURINAM

Dept. of Soil Survey
Hoek Coppenamestr./Comm.
Weytingweg
District Wanica

SWEDEN

Swedisch Univ. Agr. Sciences
Dept. of Soil Sciences
Box 7014
S-750 07 Uppsala

SYRIA

ACSAD
P.O. Box 2440
Damascus

TANZANIA

National Soil Service
P.O. Box 5088
Tanga

THAILAND

Soil Analysis Division
Paholyotin Road, Bangkhen
Bangkok 10900

TOGO

Dir. des Etudes Pédologiques
B.P. 1026
Lomé

TUNESIA

Direction des Sols
Route de la Soukra
Ariana

UNITED KINGDOM

Caleb Brett Laboratories Ltd.
Lancots Lane
St. Helens Merseyside WA9 3ES

ICI Jealott's Hill Research St.
Bracknell
Berkshire RG12 6EY

The Macaulay Institute for Soil Res
Craigiebuckler
Aberdeen AB9 2QJ

Rothamsted Experimental Station
Harpenden
Herts. AL5 2JQ

Trop. Soils Analysis Unit, LRDC
Coley Park
Reading RG1 6DT

URUGUAY

Direccion de Suelos
Casilla Correo 14.005 D4
Montevideo

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Univ. of Hawaii
College of Tropical Agriculture
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Honolulu HI 96822

U.S. Dept. of Agriculture
Soil Conservation Service
100 Centennial Mall North
Lincoln NE 68508-3866

U.S.S.R.

Dokuchaev Soil Science Institute
Pyzhevsky Lane 7
Moscow 109017

VENEZUELA

CENIAP, MAC Seccion Suelos
Apdo. 4653
Maracay 2101

ZAMBIA

Mt. Makulu Central Research St.
P.O. Box 7
Chilanga

ZIMBABWE

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

APPENDIX 3 - ACTIVITIES CARRIED OUT DURING UNESCO/MAB-ISRIC COOPERATIVE PROGRAMME, 1980-1985

AFRICA *(Mr. A.J. van Kekem, Nairobi, Kenya and Abidjan, Ivory Coast)*

Soil surveys/studies

Gabon, Makokou

Extent: 10,000 ha; Scale: 1:100,000; and 120 ha; Scale 1:10,000

Report: Soil survey of the M'Passa Biosphere Reserve, Makokou. Unesco, Paris, 1984. 30 pages

Ivory Coast, Taï

Extent: 350,000 ha; Scale: 1:250,000.

Report: Legend for the soil map of Southwest Ivory Coast. Application of the methods used in the MAB soils programme. Unesco, Paris, 1985, 32 pages

Kenya, Kulal-Marsabit

Extent: 1,400,000 ha; Scale: 1:250,000

Report: Soils of the Mount Kulal-Marsabit area. Report R12 of Kenya Soil Survey, Nairobi and Technical Report D1 of Unesco/IPAL, Nairobi, 1986.

Other publications/articles

- The soils of Western Marsabit District. In: Integrated Resource Assessment and Management Plan for Western Marsabit District, Northern Kenya. Technical Report Number A-6, Unesco-IPAL, Nairobi, 1984, pp. 6-31.
- Land evaluation for extensive grazing in the Mount Kulal-Marsabit area. In: Proceedings of Workshop on Land Evaluation for Extensive Grazing, Addis Ababa, November 1983. ILRI publication 36, Wageningen, 1984, pp. 257-274.

Attendance of workshops/meetings/congresses/etc.

- South African Wildlife Conference, Nairobi, Kenya, 14-19 July 1980
- Fourth Annual meeting of the Soil Science Society of East Africa in combination with Fourth FAO Subcommittee meeting on Land Evaluation Arusha, Tanzania, 26 October-3 November 1980
- First OAU Interafrican Soil Science Congress, Accra, Ghana, 10-16 November 1980
- IPAL Scientific Seminar, Nairobi, Kenya, 11-13 August 1981.
- Sixth FAO meeting of the West African Subcommittee on Soil Correlation and Land Evaluation, Lomé, Togo, 6-15 December 1981.
- 12th International Congress of Soil Science, New Delhi, India, 6-25 February 1982
- ISM-Unesco/MAB Workshop on Soil Research in Biosphere Reserves, Wageningen, The Netherlands, 15-18 June 1983.
- Workshop on Land Evaluation for Extensive Grazing, Addis Ababa, Ethiopia, 29 October-10 November 1983
- FAO meeting of the West and Central African Committee for Soil Correlation and Land Evaluation, Niamey, Niger, 4-13 February 1984.

Other activities

- Soil monolith collection in Kenya for ISRIC, Kenya Soil Survey and Unesco-IPAL, 4-12 December 1982
- Soil monolith collection in Gabon for ISRIC and IRAF, 14 August-12 September 1984
- Soil monolith collection for ISRIC in Ivory Coast, 19-31 January 1985
- Soil monolith collection for ISRIC in Zaire, 15 February-16 March 1985
- Some short missions to inquire about possibilities and needs for soil surveys in MAB research programme in Congo, Gabon, Ivory Coast and Zaire, 1980-1983.

LATIN AMERICA AND THE CARIBBEAN *(Mr. R.F. Breimer, Montevideo, Uruguay)*

Soil surveys/studies

Argentina, Cordoba Province

Extent: 70,000 ha; Scale: 1:50,000

Report: Soils of the Pampa de Achala, Cordoba, Argentina, Unesco-ROSTLAC, Montevideo, 1985. Mimeographed. pp. 43 + app.

Chile, 5th Region

Report: Coordination of erosion measurements under different goat-browsing regimes: no final report yet

Mexico, Durango State

Extent: 174,000 ha; Scale: 1:100,000

Report: Soil and landscape survey of the Mapimi Biosphere Reserve, Durango, Mexico, Unesco-ROSTLAC, Montevideo, 1985, pp. 128

Uruguay

Report: Assistance to establishment of National Soil Reference Collection

Venezuela, Amazonas Fed. Territory

Report: Some observations on soil and forest types in San Carlos de Rio Negro, Venezuela (unpublished, 1982).

Other publications/articles

Montana, C. and R. Breimer, 1981. Vegetacion y ambiente de la reserva de la biosfera de Mapimi (Durango). Actas VIII Congreso Mexicano de Botanica, Morelia

Unesco, 1982. Conferencias recibidas de la Reunion de Expertos sobre Procesos de Erosion en los Andes del Norte, Bogota, Colombia, 24-28 de marzo de 1981. Unesco-ROSTLAC, Montevideo (edited by R.F. Breimer)

Soils section of the natural resources chapter in: CONCYTEC, 1983. Ciencia, Technologia y Desarrollo Rural. Proceedings of the First Seminar on Science and Technology and Rural Development of Latin America and the Caribbean, Lima, Peru, 25-29 October 1982

Conservacion de suelos en un contexto ecologico, paper presented at the First Conference on the Environment of the Uruguay River Basin, Salto, Uruguay, 9-11 October 1982

Métodos de evaluacion del estado de los recursos naturales en la cuenca del Rio Uruguay como base para su conservacion, paper prepared for the Second

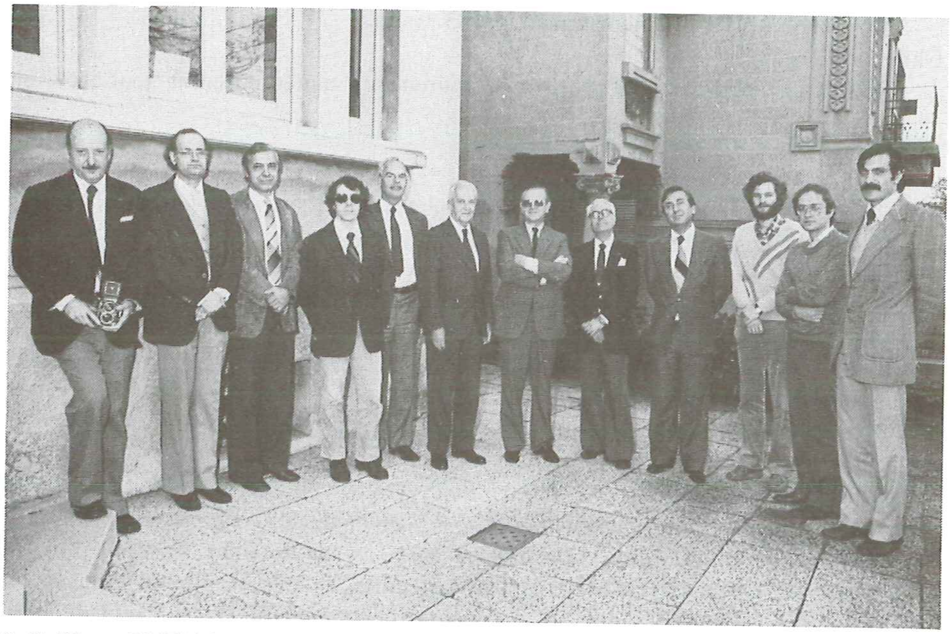
Conference on the Environment of the Uruguay River Basin, Sao Borja (RS), Brazil, 12-13 October 1984

In press:

Cabido, M., R.F. Breimer and G. Vega. Plant communities and associated soil types in a high plateau at Cordoba Mountains, central Argentina (submitted to the journal Mountain Research and Development, Boulder, Colorado).

Co-author of the chapter on soil-forest relationships in: R. Herrera, C. Jordan, H. Klinge and E. Medina (eds.): Structure and functioning of Amazon ecosystems at San Carlos de Rio Negro, Venezuela (to be published by Junk, The Hague)

Montana, C. and R.F. Breimer: Main vegetation and environment units (chapter 3); Breimer, R.F. and J.P. Delhoume: Geomorphology and soils (chapter 4) in: G. Halffter and/or P. Reyes-Castillo (eds.): Vegetation and environment of the Mapimi biosphere reserve, Durango, Mexico (provisional title; to be published by the Institute of Ecology, Mexico).



Staff of Unesco-ROSTLAC, Montevideo, Uruguay, together with Dr. Leloir, Argentinian Nobel Prize laureate in chemistry. Third from right: R.F. Breimer. (photo Hector Devia, Montevideo).

Attendance of workshops/meetings/congresses/etc.

- Seminar on Soil Deterioration and Conservation, Buenos Aires, Argentina, 23 September-7 October 1980
- Experts' meeting on Erosion Processes in the northern Andes, Bogota, Colombia, 24-28 March 1981
- 12th International Congress of Soil Science, New Delhi, India, 6-25 February 1982

- Latin American Regional Conference of I.G.U., Rio de Janeiro, Brazil, 17-20 August 1982
- First Conference on Environment of Uruguay River Basin, Salto, Uruguay, 9-11 October 1982
- Seminar on Environment and Alternative Technologies for Human Settlements in Arid Zones (ECLA), Antofagasta, Chile, 22-23 March 1983
- ISM-Unesco/MAB Workshop on Soil Research in Biosphere Reserves, Wageningen, The Netherlands, 15-18 June 1983
- Seminar on Conservation Policies of Renewable Natural Resources and Soil Resources in Particular, Quito, Ecuador, 11-15 July 1983
- 10th Argentinian and 7th Latin American Congress of Soil Science, Mar del Plata, Argentina, 23-28 October 1983
- National Post-graduate Course on Land Capability Classification (USAID)*, Tarija, Bolivia, 29 October-6 November 1983
- MAB Seminar/Workshop on Research and Management of Reserves in Mountainous, Arid and Semi-arid Zones, San Juan, Argentina, 20-25 November 1983
- Post-graduate Training Course in Rational Use, Management and Conservation of Soil, Water and Forest (UNEP)*, Medellin, Colombia, 20 May-2 June 1984.

Other activities
- Soil monolith collection in Uruguray for ISRIC and Soils Institute
- Promotion of ISSS membership in Latin America (Uruguay and Argentina mainly)
- Writing articles and short notes for the ROSTLAC and ECO bulletins, published at the regional office
- Co-editing of the ECO-bulletin
- Some short mission to enquire about possibilities and needs for soil surveys in MAB Research Programmes in Chile, Colombia, Paraguay, Peru, and Uruguay, 1980-1984.

SOUTHEAST ASIA *(Mr. H. van Reuler, Bogor, Indonesia)*

Soil surveys/studies

Indonesia, Bukit Raya nature reserve, Central Kalimantan Province

Report: Preliminary report on soil studies carried out in the Bukit Raya nature reserve, Central Kalimantan, Unesco, Jakarta, 1984. pp. 14

Indonesia, Ujung Kulon National Park

Extent: 50,000 ha; Scale: 1:75,000

Report: Physiographic soil map of the Ujung Kulon National park (internal document).

Other publications/articles

Chartres C.J. and H. van Reuler. Mineralogical changes with depth in a layered andosol near Bandung, Java, Indonesia. Journal of Soil Science, vol. 36, 1985, pp. 173-186

*) participation as a lecturer

Johanis P. Mogea, Harry Wiridinata and Henk van Reuler - kabar dari Bukit Raya Suara Alam, vol. 31, 1985, pp.28-35

Van Reuler, H. Comparison of the Indonesian soil classification system with the USDA Soil Taxonomy and FAO-Unesco legend of the Soil Map of the World, Unesco, Jakarta, August 1982, pp. 8

Van Reuler, H. and H.P. Nooteboom. Special visit to a big mountain (in Dutch). Panda (magazine of the Dutch branch of the WWF), January 1984, pp. 8-11

Hommel, P.W.F.M. and H. van Reuler. The impact of the 1983 Krakatau eruption on the soils and vegetation of the Ujung Kulon peninsula, West Java, Indonesia, pp. 7. Paper presented at the Centennial Krakatau Commemoration, Jakarta, 1983. Proceedings in press

Diemont, W.H. and H. van Reuler. Physiography and pyrite formation in Berbak, Sumatra, Indonesia. Research Institute for Nature Management, 1984, pp. 34

Sombroek, W.G. and H. van Reuler. The International Soil Reference and Information Centre (ISRIC). Proc. of the 5th ASEAN Soil Conference, 1984, vol. I. J 1.1 -J 1.6

In preparation:

Van Reuler, H. Soil studies in the Bukit Raya nature reserve, Central Kalimantan Province, Indonesia. I Reconnaissance soil studies; II Detailed soil studies of a 2.7 ha plot (submitted to Blumea)

Hommel, P.W.F.M. and H. van Reuler. Soils of the Ujung Kulon peninsula (in preparation).

Attendance of workshops/meeting/congresses/etc.

- International Conference on Phosphorus and Potassium in the Tropics (Phosphotrops), Kuala Lumpur, Malaysia, 17-19 August 1981
- 12th International Congress of Soil Science, New Delhi, India, 8-16 February 1982
- International Symposium on Soil Geology and Landsforms: Impact on Land use planning in developing countries (LANDPLAN I), Bangkok, Thailand, 1-3 April, 1982
- ISM-Unesco/MAB Workshop on Soil Research in Biosphere Reserves, Wageningen, The Netherlands, 15-18 June 1983
- Centennial Krakatau Commemoration, Jakarta, Indonesia, 23-27 August, 1983
- The Fifth ASEAN soil conference, Bangkok, Thailand, 10-23 June 1984.

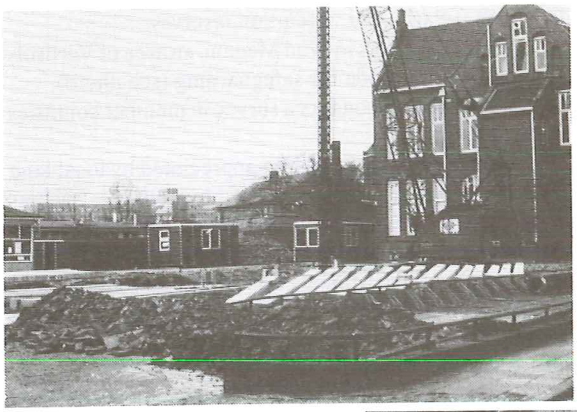
Other activities

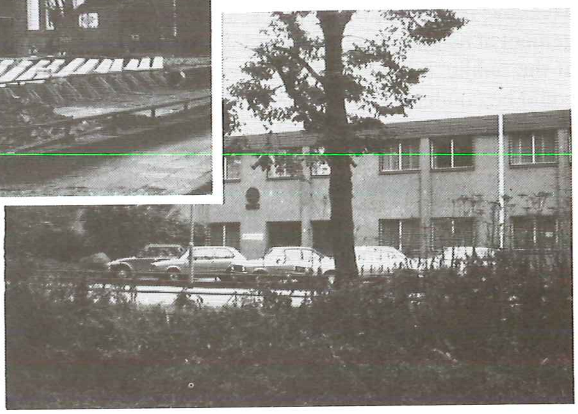
- Soil monolith collection in Indonesia. Monoliths were collected at the Benchmark Soils Project sites in Nakau, Sumatra and Lembang, West Java. Representative soils were also collected in the Ujung Kulon National Park, Java; Krakatau islands group; the Bukit Raya nature reserve, Kalimantan; and the Malang area, Java.
- Soil monolith collection in Sri Lanka was effected in the framework of a study of paddy soils.

ABOUT 10 YEARS AGO

At the location where a wooden building, erected in 1922 for Wageningen Agricultural University, was destroyed by fire at the ende of 1972, the construction of ISRIC (then ISM) was started in 1976, now ten years ago. Up to that time another place in Wageningen was chosen, to house ISM after its transfer from temporary housing at premises of the State University of Utrecht. However, the negotiations on the price were not yet completed, when the opportunity arose to build at the site which had become available after the fire. This convenient place adjoins the Department of Soil Science and Geology of the Agricultural University and is very near to the International Agricultural Centre (IAC).
However, the originally planned building was too large for the area available and too expensive for the funds which had been earmarked for the purpose. More than five hundred square meters had to be cut! To give a few examples: the laboratory space was cut from 395 to 274 m^2, the library from 180 to 103 m^2, the director's room from 30 to 20 m^2 while a garage of 70 m^2 had to be cut altogether. This space of 517 m^2 is now, ten years later, badly needed!
On 5 March 1976 the first concrete pole of 10 m length went into the ground, 50 would follow. It is the basis for a building which is classified as 'semi-permanent', since the area was reserved for the new administrative building of the Agricultural University, a plan which was changed afterwards.

W.C.W.A. Bomer





APPENDIX 4 - PROPOSAL FOR AN INTERNATIONAL REGISTER OF SOIL & VEGETATION RESERVES

Soils that have been largely unmodified by man, together with their indigenous vegetation cover, provide an essential benchmark against which soil scientists can measure man-induced changes of soil biology, chemistry, morphology and physics.

Reserves are most needed on soils of high value for agriculture, horticulture or forestry as it is these soils which have been most modified by land use. In practice, protected areas in the form of National Park, Scenic Reserves, Ecological Areas, Sites of Special Scientific Interest or similarly designated zones are mostly found on land of little economic potential, or are designed to preserve unusual natural features, rather than those which are, or were once, typical. Consequently, mountainous, upland and forested areas are often well represented in reserves, but lowland areas of high agriculture potential, particularly natural grasslands, are under-, or very poorly represented.

Within the circle of the International Society of Soil Science, this matter was brought up by the Polish Society of Soil Science (ISSS Bulletin 51, pages 45-46), in which the usefulness of establishing and preserving soil reserves all over the world was stressed.

To mention a few items:

In Belgium, the 43 km^2 Zonian Forest near Brussels with lowland loessial soils under deciduous forest is preserved.

In Brazil, an area with deep, extremely weathered soils with 'cerrado' vegetation is preserved within the newly established botanical garden near Brasilia (see photo).

In New Zealand, many soil/vegetation associations that were once common have all but disappeared. From the 407,000 ha of lowland yellow-grey earths, only 36 ha of these highly productive soils are preserved in an unmodified state in a single reserve with indigenous forest cover. Compare this with over 1 million ha of protected hill and steepland soils under high rainfall in neighbouring Fiordland National Park.

In Poland, at present 139 sites of 'natural' soils with a total area of 56,529 ha are being preserved. This figure does not include National Parks and vegetation reserves.

In Sudan, near the Soil Survey Administration headquarters in Wad Medani, an area of Vertisols with its original sparse grassy vegetation has been set aside for safeguarding (see photo).

At the request of ISSS/ISRIC, the Council of Europe will conduct a survey in member countries about this matter.

The scientific importance of Soil/Vegetation reserves is seldom appreciated by local land users, or decision makers. Even established reserves may be threatened by activities such as excessive recreational use, roads, and tourist development, or the deleterious effects of management of neighbouring farmland, e.g. drainage. An education and publicity programme aimed at the public, schools, universities and government departments appears to be required and could be conducted as a project in the International Geosphere-Biosphere Programme of the International Council of Scientific Unions (ICSU), possibly in conjunction with the Internatonal Union of Biological Sciences and its 'Decade of the Tropics' (ISSS Bulletin 68, pages 43-44).

The co-ordination of the projects could have three additional aims: (1) the registration of Soil/Vegetation reserves and reference sites of national and international significance; (2) identification of Soil/Vegetation associations inadequately represented in reserves; (3) support of national soil science societies attempting to secure legal protection for key sites.

At the 13th International Congress of Soil Science, which took place in Hamburg, Fed. Rep. of Germany, in August 1986, the Council of the ISSS expressed support for the idea to set up a Working Group on Soil and Vegetation Reserves. Several ideas were put forward on safeguarding 'standard' soils and soil samples, clay mineralogical material, reference sites for field soil physical properties, etc. A network of key soils with their natural vegetation could be entered in a kind of 'heritage site' register.

For general reference see:

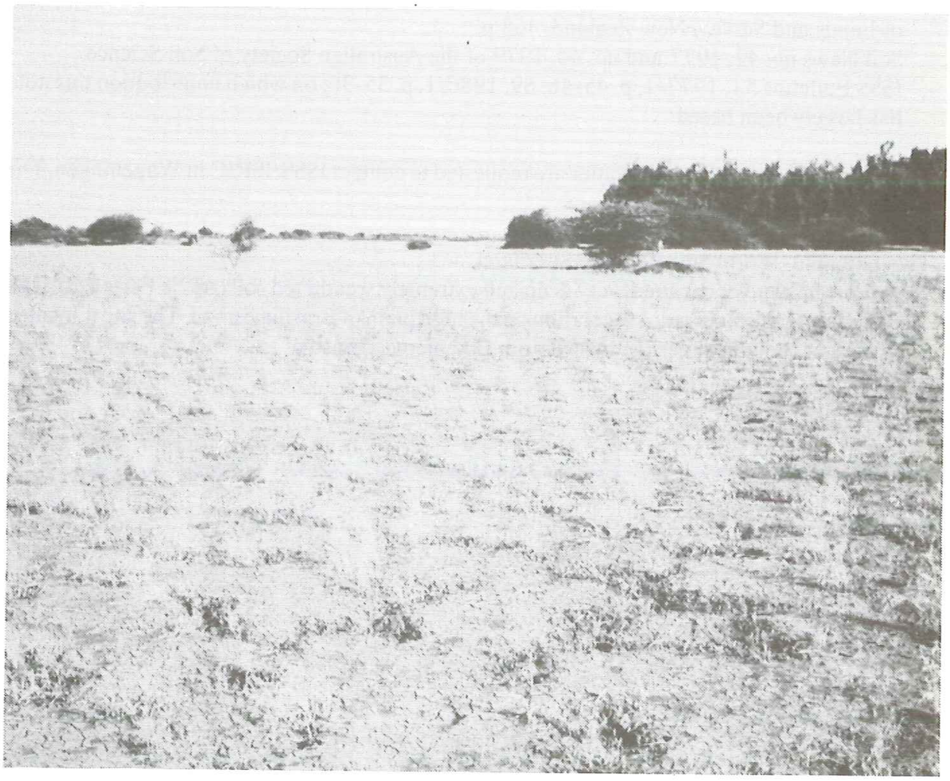
- D.F. Ball and P.A. Stevens 1981. The role of ancient woodlands in conserving 'undisturbed' soils in Britain. Biological Conservation 19:163-176.
- Lands and Survey 1984. Register of Protected Natural Areas in New Zealand. Department of Lands and Survey, New Zealand, 468 p.
- Soil News no. 42, 1977 and no. 44, 1979 of the Australian Society of Soil Science.
- ISSS Bulletins 51, 1977/1, p. 45-46; 69, 1986/1, p. 35-36; on which contribution this note has largely been based.

Persons interested in this matter are requested to contact ISSS/ISRIC in Wageningen, The Netherlands.

Two potential 'World Soil Heritage Sites' are:

1) A protected site of dark red, very deep and extremely weathered soil (Akric Ferralsol), with its characteristic 'cerrado' vegetation on the high plain of Brasilia, Brazil. The site is located in the new botanical garden the "Jardim Botanico de Brasilia".

2) A protected site of dark coloured cracking clay soil (Suleimi series, Chromic Vertisol, sodic phase) with its natural sparse grassy vegetation within the Gezira irrigation scheme, near the headquarters of the Soil Survey Administration in Wad Medani, Sudan. The photograph shows irrigated crops and woodland plots in the background.



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PUBLICATIONS

Soil Monolith Papers

1. Thionic Fluvisol *(Sulfic Tropaquept)* Thailand, 1981
2. Orthic Ferralsol *(Typic Haplustox)* Zambia, in prep.
3. Placic Podzol *(Placaquod)* Ireland, in prep.
4. Humic Nitosol *(Oxic Paleustalf)* Kenya, in prep.
5. Humic Acrisol *(Orthoxic Palehumult)* Jamaica, 1982
6. Acri-Orthic Ferralsol *(Haplic Acrorthox)* Jamaica, 1982
7. Calcic Chernozem *(Vermic Haplustoll)* Romania, 1986
8. Ferric Luvisol *(Oxic Paleustalf)*, Nigeria, in prep.

Technical Papers

1. Procedures for the collection and preservation of soil profiles, 1979
2. The photography of soils and associated landscape, 1981
3. A new suction apparatus for mounting clay specimens on small-size porous plates for X-ray diffraction, 1979 (exhausted, see no. 11)
4. Field extract of "Soil Taxonomy", 1980, 3rd printing 1983
5. The flat wetlands of the world, 1982
6. Laboratory methods and data exchange program for soil characterization. A Report on the pilot round. Part I: CEC and Texture, 1982, 3rd printing 1985
7. Field extract of "classification des sols", 1984
8. Laboratory methods and data exchange program for soil characterization. A report on the pilot round. Part II: Exchangeable bases, base saturation and pH, 1984
9. Procedures for soil analysis, 1986
10. Aspects of the exhibition of soil monoliths and relevant information (provisional edition), 1986
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, pp. 43-72), 1986

Soil Monographs

1. Podzols and podzolization in temperate regions, 1982
   - with wall plate: Podzols and related soils, 1983
2. Clay mineralogy and chemistry of Andisols and related soils from diverse climatic regions, in prep.
3. Ferralsols and similar soil; characteristics, classification and limitations for land use, in prep.

AIMS OF ISRIC

- to serve as a documentation centre on land resources - through its collection of soil monoliths and reports and maps on soils of the world; with emphasis on the developing countries
- to improve methods of soil analysis - through research and international correlation; with emphasis on soil characterization and classification
- to transfer specialized information - by lecturing and by publishing on the collected materials and on research data, and by advising on the establishment of national and regional soil reference collections
- to stimulate and contribute to new developments in soil genesis and classification, soil mapping and land evaluation - through active participation in international scientific working groups

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