ANNUAL REPORT 1980

International Soil Museum - Wageningen - The Netherlands

ISM 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 ISM working funds are provided by the Dutch Ministry for Education and Sciences, and are accountable to the Directorate of Technical Assistance (DTH) of the Ministry of Foreign Affaires.

The constituing members of the Board of ISM are the International Institute for Aerial Survey and Earth Sciences (ITC) in Enschede, the Agricultural University of Wageningen (LH) and the Dutch Directorate of Agricultural Research (DLO).

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

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

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ISM

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CONTENTS

1. INSTITUTIONAL DEVELOPMENTS

Soon after the official opening of the permanent ISM building in March 1979 (see previous Annual Report) the number of visitors increased substantially. Applications for training at ISM or in developing countries multiplied. The demand for formal teaching at the Soils Department of the International Institute for Aerail Survey and Earth Sciences (ITC) in Enschede continued to take up substantial time of the scientific staff. Requests for the hosting of guest researchers became frequent. The amount of documentation, both in the form of soil monoliths/samples and natural resources maps/reports, increased steadily. The programme of inter laboratory cross-checking of analytical methods (LABEX) got well underway, thereby further increasing the tasks of the limited number of laboratory personnel. Also, substantial time had to be devoted to the technical-scientific backstopping of the cooperative programme with Unesco on the pedological characterization of the MAB biosphere reserves in Latin America, Africa and South-East Asia. New developments in international soil classification, soil correlation, soil mapping and soil-based agrotechnology transfer required continuous attention.

In view of the above it became soon evident that a serious shortage of both core personnel and working space was developing. Proposals were therefore submitted to the Dutch Government that the Annual Budget for ISM be increased with a provision of some extra staff establishments and the construction of a topfloor on the ISM building. This would in fact bring ISM to the level of facilities as foreseen back in 1970. At the suggestion of the Directorate-General for International Technical Cooperation (DGIS) the proposals were substantiated in a formal Memorandum on the Relevance of ISM for Development Cooperation. That memorandum subsequently became a focus of discussion between several Dutch Ministries. Towards the end of the year this resulted in a proposal that FAO and Unesco be officially invited to compose a high-level Evaluation Commission that would also recommend on the future orientation and financing of ISM.

From the organizational point of view several items still need to be solved, notably its formal foundation, its relation with UN agencies and the responsibilities and duties of the provisional Board of Management of ISM and of its Director vis-à-vis the Board of Governors and Directorate of ITC which now functions as its mother institute.

At the same time, vigorous efforts were initiated to obtain complementary international financing, both for ad-hoc activities and for the regular ISM programmes. After all, the Centre was conceived by the International Society of Soil Science (ISSS) and adopted by Unesco as one of its activities in the field of earth sciences. International financial support and international staffing, in addition to core funding by the host country is therefore essential if ISM is to live up to its aim of becoming an international centre of reference and information on soils of the world.

One of the potential funding agencies, the United Nations Environment Programme in Nairobi (UNEP) now accepted for processing a request for substantial programme support over several years.

2. REVIEWS AND ARTICLES

2.1. Some considerations on quality and readability of soil maps and their legends

*W. G. Sombroek and R. F. van de Weg**

Abstract

Often modern soil survey reports are lengthy and dull technical documents. The non soil specialist user however wants a quick insight in the soil conditions and use possibilities of a surveyed area. It is therefore imperative that the soil information as contained on a map is readily available to him.

Definitions are given of soil, land, mapping unit, classification unit, and types of soil survey. Also, criteria on quality and reliability of soil mapping and cartographic requirements are outlined.

The importance of landforms and parent materials versus soil taxonomic information is stressed. A methodology of legend construction is then presented, which attempts to visualize the relationship landform - geology - soils for the potential user. Landforms are taken as the first entry of the legend, and the geology/parent material as the second one, each with distinctive symbols. The soil characteristics of the mapping unit are given in a short descriptive terminology, and the soil taxonomic name is only given at the end.

Some examples are given, drawn from recent soil surveys in Kenya.

Introduction

Modern soil survey reports are of necessity rather dull technical documents. They contain scores of comprehensive descriptions of mapping units, individual soil profile descriptions, analytical data sheets, micromorphological data, correlation of soil taxonomic classification, tables and graphs, etc.

The users of the survey - the land use planner, the agronomist or ecologist, and the rural agricultural extension worker - are hardly interested in this technical data. They want a quick insight in the spatial distribution of the main soils, a short description of soil features that can be recognized in the field, and a simple key to the limitations and suitabilities of the mapping units for either one specific or several alternative land uses. Also, there should be an easy cross-referencing with existing information on topography, geology, hydrology, vegetation and present land use or farming systems. After a perfunctory glance through the survey reports, the user therefore turns to the soil map and its legend, hoping to find the above mentioned ready-to-use data.

Alas, he is often disappointed: he cannot recognize from the map the lay of the land; he does not see any relationship with salient non-soil (land) features; he cannot grasp the characteristics and properties of the various soils because the legend contains only technical taxonomic terminology; on field checking he finds discrepancies with the printed soil information; or he can obtain only vague notions on potential land use because of the absence of derived maps or a concise land evaluation key.

As a consequence he tends to dismiss the whole soil survey effort, even though he may realize that an inventory of the soil situation is as important for sound land use and ecological studies as any other base-line study. As a result not only valuable time and effort may be lost, but also wrong decisions on rural land use or conclusions on ecological relationships may be taken, with often disastrous long term consequences for the well-being of the rural population and/or the ecological balance of a region.

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It is the responsibility of the soil surveyor-land evaluator to ensure that the results of his efforts are being used. He should pay, therefore, the utmost attention to a ready-to-use presentation of the technical data on the soil map - as well as on the derived (land evaluation) maps. At the same time the soil map should be comprehensive in the sense that it is a basic scientific document that should still be useable many years hence.

In developing countries trained manpower and working funds for soil surveys are often scarce. In particular in such situations the one-time survey should have a high quality. This not only because often expensive foreign expertise is involved, but also because it is in such countries that the most drastic changes in land use are taking place - accidentally or purposely.

A soil survey should preferably be followed immediately by a land evaluation exercise. Usually this is carried out mainly by the soil surveyor himself. He has first-hand knowledge of all written and unwritten/unmapped relevant field information, and is therefore usually able to give fair estimates of land suitabilities for immediate application. Each land evaluation is however time-bound. Often a renewed assessment has to be carried out a number of years hence when a new development alternative emerges or new management techniques become applicable. The erstwhile soil surveyor may then not anymore be around to contribute his non-documented field information. Therefore, a systematic, ready-to-use annotation of such information on soil maps is imperative.

Essentially, moreover, modern land evaluation is a multidisciplinary effort. The non-soil specialists involved, to appreciate the physical land and soil information in their proper perspective, should be able to read these data as much as possible from the soil map - rather than by verbal elucidation of the soil specialist.

Some definitions and standards

Soil versus land

Soil resources are an essential part of *land* resources. Land is a broader concept than soil because it embraces also the climate, the underlying geology, the hydrology and the results of past and present human activity, etc. (cf. FAO, 1976). Thus in developing interpretative methods based on soil survey data, additional aspects of the natural environment need investigation. Also, the efficiency of a soil survey depends largely on a good understanding of the relationship, between land(scape) and soils.

Mapping unit versus classification unit

A *soil mapping unit* is different from a *soil classification unit,* although the distinction is not always appreciated. Mapping units are units of land which can be separated geographically/spatially in the field, can be shown on maps, and can be used as units for land evaluation purposes. In reconnaissance soil surveys such units rarely comprise one soil only. Either several soils are concerned in about equal proportions, i.e. *combined* mapping units: soil associations or soil complexes; or one main soil with minor associates, i.e. *inclusions* in the mapping unit. A *soil association* is a combined mapping unit in which the composing soil units are regularly geographically associated in a defined proportional pattern; however at the map scale concerned the constituent map units cannot be shown separately. In a *soil complex* the component soils occur in a complicated, not easily recognizable pattern, so that even if they may be geographically associated, they cannot (or only at very detailed scale) be separated individually.

The *soil catena* (a concept developed in East Africa; Milne, 1935 and 1936) is a mapping unit like the soil association. It is used either in its narrow sense ("first class catena"), a regular sequence of soil types down a slope; or in a wider sense ("second class catena"), a regular sequence but derived from different parent materials.

Soil *classification units* on the other hand are abstractions mainly devised for purposes of correlation of soil information between different areas and extrapolation of agronomic research data. They can be defined in many different ways but there are two main internationally known approaches, based either on genetic principles (examples are the USSR classification system and the 1938 USDA classification) or on morphometric principles (US Soil Taxonomy). The legend of the FAO-Unesco Soil Map of the World, though not a classification proper (FAO, 1974) incorporates aspects of both approaches.

Phases are subdivisions of soil units of a special character. They are used as a subdivision of soil classification or soil mapping units according to criteria of practical importance, i.e. based on characteristics which are significant to the use or management of the *land*. Any category of soil units may be subdivided into phases. They can be recognized at any level of generalization.

Types of survey and scale

There is a hierarchy of soil maps and surveys at different scales, each using different methods and intensities of survey and having different purposes (cf. Forbes and Eswaran, 1978).

For the terminology of the different survey "intensities" followed here see table 1.

Quality and reliability of soil mapping

The scale of the map determines the measure of detail at which one can represent the soil conditions of an area. There is a strict relationship between accuracy, scale, and purpose of soil maps. The purpose determines the accuracy, the accuracy determines the scale, and the scale determines the possible uses of the map (i.e. the purpose). Each scale of mapping has its own recommended number of field observations - soil augerings and pits - per unit of surface area. In areas where the soils are relatively homogeneous, usually the surveyor makes fewer observations. Therefore the element of flexibility in deciding on the density of observations is important. This holds the more where a judicious interpretation of aerial photographs and other remote sensing imagery supplants the need for part - but never the whole - of the ground observations.

The size of the mapping units on a map is limited, for technical reasons, to a minimum surface but also in view of the readability. Good use can be made of the concept of the *basic mapping unit* (Vink, 1963), indicating the smallest unit which can still be represented on the map. The size of the basic mapping unit (b.m.u.) is normally taken as 0.25 - 1 cm^2 on the map. It indicates to the map user the measure of detail of the aerial photograph interpretation together with the density of the field observations. The b.m.u. should be printed on the map so that it automatically will be enlarged or reduced together with the map in the same way as a scale indicator on

Table 1. Types of soil surveys

Exploratory survey
Scales : 1:500,000 - 1:1,000,000
Purpose : - establishing major soil regions, for agricultural research, planning, etc. international soil correlation and exchange of research data
Methods : - deductions from existing natural resources maps, geological surveys, etc.
- re-interpretation of existing field data
- study of ERTS + LANDSAT-imagery
- country-wide travelling and sampling

Reconnaissance survey
Scales : 1:100,000 - 1:250,000
Purpose : - systematic inventory of soil and land resources with multi-purpose land evaluation, for planning of various land utilization types
Methods : - aerial photo interpretation
- comprehensive field observations on soils, geology, topography, vegetation, present land use and soil management characteristics
- laboratory analysis of selected soil profiles
- development of land evaluation keys for qualitative assessment of land suitabilities for alternative land uses.

Semi-detailed survey
Sclaes : 1:20,000 - 1:50,000
Purpose : - project feasibility studies
- development of one particular land use (e.g. the promotion of a particular rainfed crop, irrigation schemes, silviculture)
Methods : - aerial photo interpretation
- intensive field observations, mainly on soil; soil management field measurements
- laboratory analysis of selected profiles
- quantitative assessment of land suitabilities

Detailed survey
Scales : 1:10,000 or larger
Purpose : - farm planning
- characterization of research trial sites
Methods : - very intensive soil augering (one or more per ha) in a grid pattern
- laboratory analysis, including soil testing

Site evaluation ("preliminary surveys")
Scales : variable
Purpose : - project identification
- soil problem assessment (e.g. suspected cause of crop failure)
Methods : - aerial photo interpretation
- scattered field observations
- rapid laboratory testing
- rapid reporting

any topographic map. Also the revised US "Soil Survey Manual" (in preparation) indicates "minimum size delineations", a roughly square or circular area approximately 6 mm across.

As for the reliability of the information supplied on the map, one should aim at an average *purity* (or "success percentage") of the mapping units of more than 70% of each mapping unit area. The inclusions in the mapping unit should, however, be mentioned in the descriptions of the units in the report, each preferably with an indication of the percentage involved. If the impurities comprise - according to the soil surveyor - more than 30%, then combined mapping units (associations, complexes) should be indicated.

Cartographic requirements

Reduction of scale is a procedure inherent to the production of the final map. The fieldwork is always performed on base maps which have a scale at least twice the intended scale of the final map. Errors made in plotting of the boundaries are reduced by the process of scale reduction.

With regard to the readability of the map, the map should show sufficient topographic detail for the user to be able to orient himself. The soil boundaries on the map should be as far as possible natural boundaries which one can see in the field, or on the aerial photographs.

In the soil legend, an explanation of the soil mapping units is given. The relationship between the soils and other landscape features should be brought out by a groupwise presentation in the legend, preferably a grouping in such a way that one can find some reflection of the surface features of the terrain (see below). If there is a clear relationship the map user will be able to understand the map and to make the best possible use of it. The connection between the mapping unit and the legend is provided by the letter symbols indicated in each separate portion of the mapping unit, and by means of colours, and/or patterns (graphically distinctive arrangements of marks). Colours are never to be used alone!

The relative importance of landforms, parent material and soil taxonomy

The importance of landforms

The importance of landforms in soil mapping has been stressed by various authors (Soil Survey Staff, 1951; Vink, 1963, 1975; Young, 1976 and others). The spatial distribution of soils is related to landforms at all scales. Soil surveyors make extensive use of landforms and relief as a means of recognizing soil patterns, in particular in aerial photograph interpretation which is nowadays an essential tool in soil surveys. Landforms should, however, also play a major role in the presentation of mapping units, as this facilitates the map user's insight into the spatial variation of the soils and landscape concerned. It also enlarges greatly the readability of the map.

By the systematic use of aerial photo interpretation, the delimitation of the mapping units is done on a physiographic basis, using in particular the characteristics of landforms with some elements of geology, geohydrology, vegetation and land use. It is therefore perfectly logical that these characteristics are reflected in the set-up of the maps, the legend and the mapping symbols. As the soil-landscape relationship is often used in delineating soil mapping units, why not then reflect this in the soil map legend? By not using difficult geomorphological names but rather a physiographic name with a short description it is felt that the map pattern is much easier to understand for the map user, in particular the non-soil specialist. The map reader must be able by using the map in the field to find his way when comparing map patterns with conditions in the field and to grasp the relationship landform-soils(-geology). He then appreciates the differences in soils on the basis of features which he can observe himself in the field without digging or making augerings.

Landform (types) can be described or grouped in many ways. For soil resource inventories, physiography - the scientific description of the physical features; this is more than topography or relief although they are important aspects of it - and the nature, thickness and continuity of the soil cover are the most conspicuous criteria; groupings should be made which are significant in relation to (future) land use. An example may illustrate this:

The landform type "piedmont plains" concerns the broad, continuous gently sloping plains extending along and from the base of a mountain or hill, formed by the lateral coalescence of a series of separate but confluent alluvial fans. Alluvial processes are mainly responsible for the sediments. Often the individual fan cannot be observed anymore and the transversal section does not show the convex shape of the individual fans. Of practical significance are the following characteristics: mostly non to only slightly gravelly soils, which are well drained in the upper and middle part of the plain; in the lower piedmont plain drainage is less good and salinity hazard may occur. The plain surface is smooth, but in places is subject to sheet floods (flash floods). In general the area is irrigable.

The importance of geology/parent material

Rock types and soil parent material are important determinants of soil characteristics. Studies of the relationships between parent material/rock and soils should ideally be based on quantitative chemical and/or mineralogical analysis of rock or sediment composition and their grain size. There are however three main variables in parent material affecting soils: degree of consolidation, grain size, and rock or sediment composition (Young, 1976) of which the latter is fundamental in particular in the tropics as it affects the rates of supply to the soil or soil solution of the products of weathering. The geological formations moreover influence directly the phreatic features of the land, and the soil parent material is often used as a source of construction material for roads, housing, etc.. Both aspects are of importance in comprehensive land evaluation.

Especially in the tropics many soils appear to be alike both in taxonomic classification and in descriptive features. One can at the same time surmise (for instance through differences in vegetation and crop growth) that the soils in reality are different from the point of view of soil fertility, erosion susceptibility, etc.. As field trials ons soil fertility are normally not carried out within the framework of reconnaissance soil surveys, the "richness of parent material" is then a sensible anticipation of more detailed studies and field experiments. In Kenya for instance such a subdivision after having been applied for some years has proven to be relevant. Recent greenhouse testing pointed to important differences in micronutrient content of mollic Nitosols which could not be deducted from the more routine field and laboratory data. Classificationwise the soils appeared completely identical. Only by using lithological differences as an element of separation of mapping units could these differences be indicated. A similar case is the subdivision of pellic Vertisols on the basis of their lithology: lithomorphic and topomorphic phases.

For all these reasons it is sensible to indicate systematically the geology/lithology in soil map legends, grouped according to hardness and richness as soil parent material. This was in fact already done systematically in the legend of the Soil Map of Africa on scale 1:5 million (d'Hoore, 1964). Lithology as one of the main factors responsible for variability of soils in the tropics was also stressed by van Wambeke and Dudal, 1978.

The approach is facilitated by the fact that in many countries, including tropical ones, good coverage of geological maps on various scales already exists, with their data often permeated as common knowledge, before any systematic soil survey is carried out.

The limitations of soil taxonomic systems in soil mapping

Quite a few soil maps show in their legends only a soil taxonomic terminology, without any further information.

Modern morphometric soil classification groups the soils on the basis of observable and measurable characteristics, with pedogenetic principles as a general guideline. The major advantage of such systems (f.i. the US "Soil Taxonomy"; Soil Survey Staff, 1975) is that each soil as found in the field can be placed without any doubt in the system, because the range of characteristics and the boundaries are minutely defined and a major source of misunderstanding at national and international soil correlation is thereby avoided. The disadvantage is that some soils then happen to fall in units where they obviously do not belong in view of the whole complex of their characteristics and their apparent genesis in relation to surrounding soils. Frequently also, the taxonomic classification is based on only one or two fully described and analysed profiles per mapping unit, which may or may not be really representative.

When soil climate is used as a soil classification criterion, then a further source of possible divergence is introduced between the average characteristics of the soil mapping unit and the implied characteristics of the taxonomic naming. Only rarely actual soil climatic data are measured. Usually one goes for an interpretation of the overhead climatic data, which may be sparse and non-representative, while conversion factors to arrive at the soil climate may vary substantially per individual soil in a survey area.

Presentday soil taxonomic systems tend moreover to take insufficient account of a number of soil differences in tropical countries which are relevant to management - and hence land evaluation - for instance inherent nutrient supply and toxicities, structure stability of the topsoil, etc..

Finally, any soil taxonomic system tends to change often the naming of the various units in the course of years. One cannot expect the user to keep up with these developments. For alle these reasons the use of only soil taxonomic terminology in map legends is dissuated. It may be argued that a soil taxonomic terminology can be extended by adding important landform and lithological aspects, as phases (considering "soil" as land rather than as a pedon). This may work in countries with a well-developed agriculture like the US, but becomes awkward in newly developing regions, where the planning of several alternative land uses would require lengthy and multiple phase descriptions, without a systematic overview of these land aspects.

A proposed construction of soil mapping legends

Introduction

The above considerations have led the authors to promote in their respective assignments in Iran, Nigeria, Uruguay and Kenya over the past 15 years the application of a *"physiognomic-lithomorphic" approach* to soil mapping in general and *to the presentation of soil map legends* in particular. This was done in close consultation with national soil scientists and technical assistance personnel so that the resulting schemes differ from country to country. The most recent form was developed by the joint staff of the Kenya Soil Survey in Nairobi, Kenya and therefore reference will be made to its published soil maps and reports.

Table 2: Subdivision of landforms in relation to soil mapping and map legend construction (example from Kenya)

Symbol	Landform	Overall slope class	Relief intensity	Some suggested subdivisions
M	mountains and major scarps	> 30 % (no overall slope direction)	> 300 m	elevation; relief intensity; shape of the summits; shape of the valleys; density drainage pattern; average slope; slope shape; slope pattern; slope length; relief elements
H	hills and minor scarps	8-30 %, max. 40 %, (no overall slope direction)	up to 300 m, in general lower	as for mountains
R	dissected lower slopes of major older volcanoes and mountains	crests: 0-5 %; valley sides: 5-16 % (up to 30 %)	up to 100 m	relief; average slope
F	footslopes (incl. pediments, glacis, coalescing fans)	2-8 % (up to 16 %)	up to 20 m	average slope; position; degree of erosion; weathering depth; thickness accumulation cover
L	plateaus and high-level structural plains	0-8 % (up to 16 %)	< 50 m	position; topography; dissection; origin; altitude
Lc	coastal plateaus			
Lu	plateau/upland transitions			
U	uplands (incl. dissected "peneplains")	2-16 %	< 50 m	elevation; topography; dissection; origin; position; e.g. upper-level, middle-level, lower-level
Uc	coastal uplands			
Up	upland/plain transitional lands			
Y	piedmont plains	0-5 %	< 20 m	topography; type; position; degree of erosion; elements
P	plains	0-5 %	< 10 m	topography; position; dissection
Pn	non-dissected erosional plains			
Pd	dissected erosional plains			
Ps	sedimentary plains ("aggradational plains")			
Pt	sedimentary plains of upper river terraces			
Pf	sedimentary plains of large alluvial fans			
Pc	coastal plains			
Pv	volcanic plains			
Pl	lacustrine plains			
A	flood plains (incl.lower terraces)	0-2 %	< 5 m	origin; type; location; elements
B	bottom lands	0-2 %	< 5 m	origin; location
Miscellaneous landtypes				
D	dunes			
La	(recent) lava flows			
S	swamps			
T	tidel swamps/flats			
V	(minor) valleys			
W	"badlands"			
Z	beach ridges			

The methodology presented here has been primarily developed for reconnaissance surveys at scales of 1:100,00 and 1:250,000 but can be used at any other scale of survey.

In general it attempts to visualize the complex relationship landform-geology-soils. The pragmatic subdivisions devised in Kenya were originally intended to be developed separately for each reconnaissance soil map sheet (van de Weg and Mbuvi, 1975). It was however soon clear that with some additions and adaptations the proposed subdivision and definition of landforms, parent materials, and the descriptive presentation of soil characteristics could be applied systematically over the whole of Kenya, not only for the legends of reconnaissance soil surveys but also for the exploratory soil map of Kenya (Sombroek and van der Pouw, in press) as well as for the more detailed surveys and site evaluations.

The landform entry

Landforms are taken as the *first entry* in the soil map legend because these give the reader a preliminary insight into differences of physiography and altitude. The first element (capital letter) of the mapping symbol indicates the "landform" for example: Y: Piedmont plains
Pv: Volcanic plains
M: Mountains and major scarps, etc..

For each landform a description can be given of overall slope class, relief intensity, suggested subdivisions, while in addition the practical significance of each landform type, e.g. related soil conditions, drainage, conditions, land use possibilities, etc. can be indicated in the accompanying soil report. The scheme developed in Kenya is given summarized in table 2.

The geologic entry

The *geological units* form the *second entry* in the legend. The grouping is done pragmatically mainly according to the "resistance to weathering" and the "mineral richness" of the parent material/parent rock.

The scheme used in Kenya for the subdivision according to lithology is given in table 3.

In the mapping unit symbol the lithology is also indicated by a capital (2nd symbol), for example:

YL. Y : Piedmont plains
L : (Soils developed on alluvial from) crystalline limestone

PvB. Pv : Volcanic plains
B : (Soils developed on alluvium from early Pleistocene) olivine basalts

MF. M : Mountains and major scarps
F : (Soils developed on) basement system rocks rich in ferro-magnesian minerals.

Table 3. Lithological subdivision of parent rocks/parent materials (example from Kenya)

Igneous rocks

- acid igneous rocks
  - Y rhyolite, aplite, etc.
  - G granite, diorite, etc.
- intermediate igneous rocks
  - I andesite, trachyte, phonolite, syenite, etc.
- basic and ultrabasic igneous rocks, rich in Fe-Mg minerals
  - B basalt, gabbro, serpentinite, etc.
- undifferentiated igneous rocks
  - V (complex of) unspecified igneous rocks
- Pyroclastic rocks
  - P ash, pumice, tuff, welded tuff, etc.

Metamorphic rocks (predominantly "Basement System" rocks)

L marble, crystalline limestone
Q granitoid gneiss, quartzite
R quartzo-felspatic gneiss
M quartz-muscovite gneiss
N biotite gneiss
F gneiss rich in Fe-Mg minerals (e.g. hornblende gneiss)
U undifferentiated "Basement System" rocks (pred. gneiss)

Sedimentary rocks (predominantly consolidated)

Z conglomerate
S sandstone, grit, arkose, greywacke
K siltstone
D mudstone
W marl
T shale
L (coral reef) limestone, travertine
H chert, flint, chalcedonite, diatomite
O "bay sediments" of Plio-Pleistocene age
J lagoonal deposits
E aeolian sediments ("cover sands")

Unconsolidated sediments, undifferentiated

A alluvial, colluvial, marine deposits from various sources
Z gravel

The soil descriptive entry

The *third* entry into the legend describes the main soil unit, soil association or soil complex of the individual mapping units in a *descriptive* way. As stated before, such a descriptive terminology is applied to allow the interested non-soil specialist to gain an insight in the features of the soils concerned without being put off by the complicated terminology of modern soil taxonomists. A rather strict scheme is followed in all descriptions. This description refers mainly to the characteristics of the subsoil, usually the B horizon to 100 cm depth, or less if the bedrock occurs at a shallower depth. The following characteristics are described in the map legend in the sequence as indicated:

- drainage conditions
- depth (effective soil depth)
- colour (moist conditions)
- mottling if present (to be described in the legend only as "mottled")
- consistence (moist conditions; deleted for shallow soils)
- calcareousness if present
- salinity, sodicity of present
- stoniness if present
- rockiness if present
- cracking if present
- texture
- additions such as . . . "over petroplinthite"; . . . "over petrocalcic horizon", etc. if applicable; ("over rock" is not used as this is implied already in the second entry of the legend).

Other characteristics can be added as needed. Also important "inclusions" in the mapping unit are indicated after the description of the dominant soil unit.

Some additional information, notable on top soil features, can be indicated, for instance:

. . . "with a topsoil of . . ." (texture), used when the topsoil texture differs by two or more classes from the subsoil texture.

. . . "with a humic/acid humic topsoil" (humic in the case of a mollic epipedon; acid humic in the case of an umbric epipedon).

. . . "with stoneline(s)": if very prominent in a particular mapping unit.

Following the capital symbols used for landform and parent material/rock, each mapping unit symbol contains one or more symbols to express the soil properties; for instance, r for red colour, c for compact, a for abrupt textural change.

An example is: MFr.

MFr.	M :	Mountains and major scarps
	F :	(Soils developed on) gneisses rich in ferromagnesian minerals
	r :	well drained, predominantly deep, dark reddish brown to yellowish red, friable, sandy clay loam to clay laom; in places stony and rocky.

A number of properties of the soil or the land that are of direct importance for soil management such as shallowness, stoniness, salinity, strong present day erosion are also indicated by a letter symbol and in general also with "screens" on the map.

For example: MFrP: like MFr, but shallow.

In addition, the slope class of each mapping unit area is indicated in the mapping units symbol as follows: $\frac{\text{USmr}}{\text{B}}$: slope class B (gently undulating, slopes 2-5%)

The mapping unit description is normally followed by the *taxonomic classification* of the soils concerned. This will allow the soil specialist to correlate the soil unit with soils in different areas, and will ensure the extrapolation of agronomic research data.

An example of this approach to map legend construction is given in table 4 showing a part of the legend of the reconnaissance soil survey map (scale 1:100,000 of the Kwale area in Kenya (Michieka et al., 1978).

On the basis of such soil surveys, a system of land evaluation is applied in Kenya. Details of the system, including the presentation on maps are reported elsewhere (van de Weg and Mbuvi, 1975, Nyandat and Muchena, 1980, van de Weg and Muchena, in prep.). In addition to the soil survey data, an agro-climatic zonification, a vegetation/land use survey, and agro-socioeconomic data are used at the exercise.

Table 4. Example of legend construction

COASTAL UPLANDS (major rivers deeply incised; slopes in general from 0-16%)		
USm		**Soils developed on medium-grained sands** (Magarini sands)
	USmb	well drained, very deep, yellowish red to strong brown, friable, sandy clay loam to sandy clay, underlying 20 to 40 cm of loamy sand to sandy loam **(orthic FERRALSOLS)**
UT		**Soils developed on shales** (Upper Jurassic shales)
	UT1P	well drained to imperfectly drained, shallow to moderately deep, yellowish brown to dark brown, firm to very firm, clay; in places calcareous **(eutric CAMBISOLS, partly lithic phase)**
EROSIONAL PLAIN, in places dissected (slopes in general less than 5%)		
PKT		**Soils developed on siltstones and shales** (Lower Maji-ya-Chumvi beds)
	PKT1P	well drained, shallow, dark reddish brown to very dark brown, fine sandy clay loam to clay **(eutric CAMBISOLS, lithic phase and LITHOSOLS)**
COASTAL PLAIN (slopes in general less than 5%)		
PL		**Soils developed on coral limestone with sand admixtures** (coral reef)
	PL1	well drained, deep to very deep, red to yellowish red, very friable, fairly rocky, loamy sand to sandy loam **(ferralic ARENOSOLS)**
	PL2	well drained, deep to very deep, dark red to reddish brown, friable, sandy clay loam to sandy clay, underlying 20 to 50 cm of loamy sand **(rhodic FERRALSOLS)**
RIVER TERRACES AND FLOODPLAINS (slopes in general less than 2%)		
AA		**Soils developed on subrecent and recent alluvial deposits**
	AA1	well drained, deep to very deep, stratified soils of varying colour, consistence and texture **(eutric FLUVISOLS)**
BEACH RIDGES, TIDAL FLATS AND TIDAL SWAMPS (slopes less than 2%)		
TA		**Soils developed on recent marine deposits**
	TA1	well drained, very deep, grey to pale brown, loose sand **(dystric REGOSOLS)**
	TA2	very poorly drained, very deep, olive to greenish grey, excessively saline, strongly alkali, unripened (soft) soils of varying texture; with sulfidic material **(thionic FLUVISOLS, saline-sodic phase)**

The names between parenthesis reflect the scientific soil classification according to the FAO/Unesco legend for the "Soil map of the world".

Some comparable approaches

Basically, the above physiognomic-lithomorphic approach is the same as the physiographic soil survey of the Dutch "Edelman" school as developed in the late fourties and early fifties. It found useful application at an early stage of soil surveys in several developing countries, see e.g. Buringh (1960). This mapping, however, lacked precise pedologic information and soil classification and was moreover developed in mainly alluvial areas.

The approach also owes much to the *Land System approach* developed by the CSIRO in Australia (Christian and Stewart, 1968). The central concept of that approach consists of a land system map in which a holistic inventory of the land resources is represented. The land systems ("recurrent patterns of landform, soils and vegetation recognizable on aerial photographs") are subdivided into their constituent land units (resp. land facets) described in tables (indicating landform, vegetation and soils) and illustrated by blockdiagrams. The land system approach has however as major disadvantage the fact that only rarely the land units/facets actually are mapped, and that the soils information is often rather scanty and obscured by other land information.

In some African countries IRAT (Institut de Recherches Agronomiques Tropicales et des Cultures vivrières, France) introduced in the early seventies the *carte morpho-pédologique* in which geomorphological and pedological data are also combined. The purpose of this mapping methodology is to show clearly those units which have the same management problems. The map units are separated and grouped on the basis of lithology, geomorphology, type of pedogenesis, and soil classification (Tricart, 1978) while on the same map also the actual "types de dynamique morphogénique" are indicated. These maps are, however, not so easy to read and seem too "scientific" for non specialist users.

Acknowledgements
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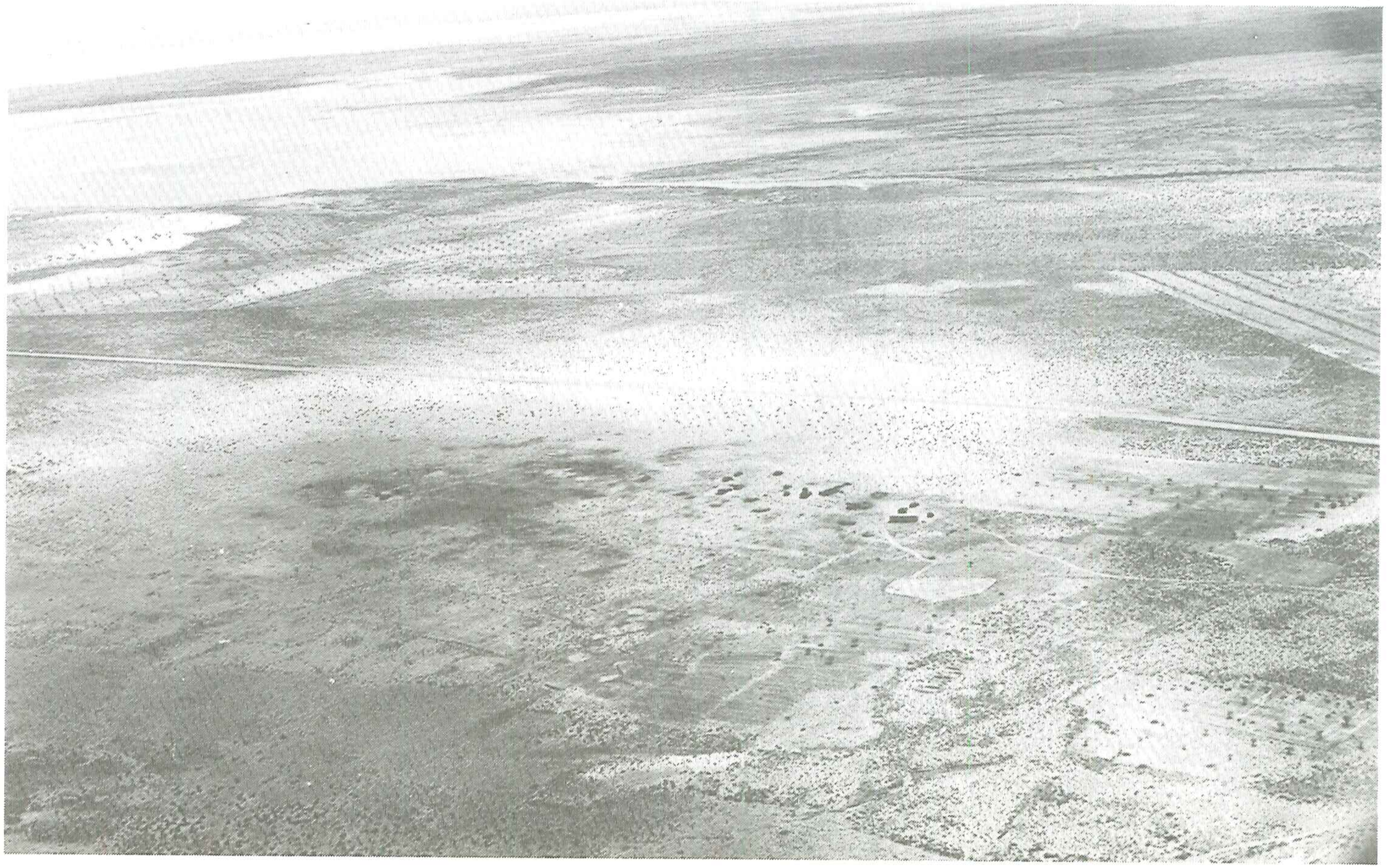


Photo 1. Aerial view of desertification due to overgrazing near recent nomadic settlement, Tunesia. Note the diffuse boundary of lighttoned, sandy area of deflation and incipient small sand dunes. (photo A. Rapp, 1974)

2.2. Desertification: Extent, Causes and Control

J. H. V. van Baren

This contribution is mainly based upon a review of literature for a lecture at the "Nederlandse Geografen Dagen 1980". An extended version of the lecture was subsequently published (Sombroek and Van Baren, 1980). The purposes were to introduce the subject to geographers who are mostly teaching at high school level and to give suggestions for further reading.

Summary

Some characteristics of deserts, which occupy about five percent of the total land surface of the earth, and several aspects of desertification are discussed. The intensification and expansion of desert conditions lead to a reduced biological productivity with a consequent reduction in plant biomass, the land's carrying capacity for livestock, crop yields and human health. Processes of desertification threaten about one-third of the total land surface.

Desertification can be regarded as a complex interaction between means of subsistence (agricultural and non-agricultural), ecological factors and sociological and political systems. Possibilities to cope with the consequences of desertification are mentioned and measures of control are discussed.

Introduction

The extensive drought in the Sahel between 1968 and 1973 and the organization of the U.N. Conference on Desertification, Nairobi, Kenya, 1977 resulted in a wealth of new publications. This article is mainly based upon these publications and gives particular attention to aspects of desertification in the Sahel.

The Sahel is an ill-defined transitional zone between the Sahara desert in the north and the moist savanna in the south and extends from Senegal and Mauritania to the Sudan. The mean annual rainfall is between 200 to 250 mm and 400 to 600 mm, the annual and monthly variations are high. Rainfall is usually sufficient for the growth of grasses and some scattered trees, but generally too low for foodcrops.

For a general introduction to deserts and bordering dry regions in different continents reference is made to Hills (1966), McGinnies, Goldman and Paylore (1967), Goudie and Wilkinson (1977), and Goodall and Perry (1979). Paylore (1966) prepared a selected bibliography on arid-lands research between 1891 and 1965 at the University of Arizona as well as a world directory of arid-lands research institutions in 1967. The Royal Tropical Institute in Amsterdam publishes "Sahel Documentatie"; the Sahel Documentation Center in East Lansing the "Sahel Bibliographic Bulletin". Both list documents available on the Sahel countries. For climatic data see among others the Klimadiagramm Weltatlas (1967); the recently started series of Climatic Atlases by WMO, Unesco and Cartographia; and Müller (1980). Dubief (1959) made an extensive study of the climate in the Sahara. For desert soils see the maps and explanatory texts of the FAO-Unesco Soil Map of the World, Dregne (1976), Fauck (1978) and Kovda et al. (1979). Vegetation maps can be found in Smithuesen (1976); the Weltforstatlas (1952-1962); and the World Atlas of Agriculture (1969). Studies on agroclimatology of some semi-arid regions have been prepared in the framework of the FAO-Unesco-WMO Agroclimatology Project. Unesco and FAO (1963) published a Bio-climatological map of the Mediterranean zone, and FAO (1968) a Grass Cover map of Africa. The geomorphology of desert zones had been treated by Cooke and Warren (1973) and Mabbutt (1977). For several aspects of desertification reference is made to Glantz (1977), Secretariat of the U.N. Conference on Desertification (1977), Mainguet (1979), Heathcote (1980), Kovda (1980), Meckelein (1980) and Dan et al. (1981). Within the framework of FAO's

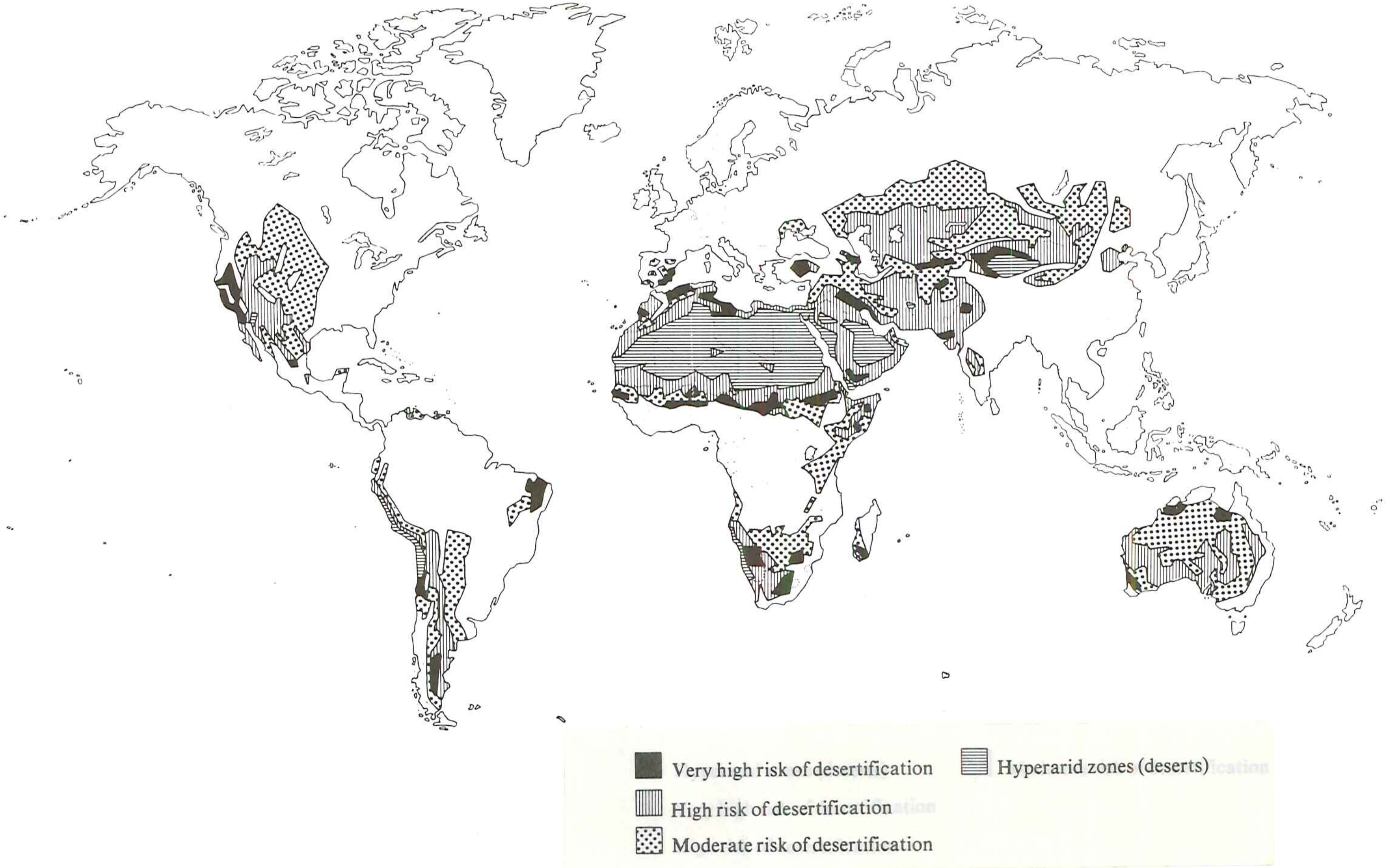
Agro-ecological Zones Project (FAO, 1978) a study was made of the potential land use by agro-ecological zones to obtain a first approximation of the production potential of the world's land resources. As an outcome of the FAO-UNEP-Unesco Project "A World Assessment of Soil Degradation - Phase I", soil degradation maps of Africa north of the Equator and the Near and Middle East were prepared at a scale of 1:5 million (FAO, 1980 b). One set of maps shows present soil degradation, the other the risks of soil degradation. The methodology, developed in FAO, distinguishes six groups of soil degradation processes: water erosion; wind erosion; salinization and sodication; and chemical, physical and biological degradation (FAO, 1979 b). For each mapping unit the intensity of the processes is given in four classes. The methodology is also applicable to surveys and studies at larger scales. The maps show clearly that soil degradation occurs over very large areas and also that areas that are not being degraded at present are liable to become so in the future. The results of the Agro-ecological Zones Project and the Soil Degradation Projects are utilized by FAO and UNFPA (U.N. Fund for Populations Activities) in their study entitled: "Land Resources for Populations of the Future" (FAO, 1979 a and 1980 a).

Deserts: Definition and Extent

Many definitions of deserts have been made. In this article the one used for the preparation of the World Map of Desertification (U.N. Conf. on Desertification, 1977 b) is followed. It states that deserts are regions where vegetation is scarce or absent because of deficient rainfall or edaphic aridity. Deserts (see Map 1) can be arranged according to the causes of their aridity into:

- the hot deserts. These lie roughly within latitudes 20° and 25° north and south of the Equator, with marginal extensions 5° or more beyond these limits. They occur where the subsiding and diverging air masses of the high pressure cells provide atmospheric conditions unfavourable to precipitation.
  Principally the mean annual rainfall is less than 250 mm per year and highly variable: the summer and winter temperatures are high. Examples: the Sahara, the Arabian and the Great Australian deserts.
- the hot coastal deserts. Characteristics of the hot deserts are in some ways modified along the western coasts of continents. Cool sea currents or the upwelling of cold water lower the temperatures considerably. Examples: the Namib desert in Southwest Africa, the Atacama desert in Chile.
- the temperate deserts. These occur in interior Asia and North America and are characterized by high annual and diurnal temperature ranges and dry air. Examples: the Gobi desert in China, the North American desert.
- the cold deserts. These comprise the arctic and polar deserts (Smiley and Zumberge, 1974; Claridge and Campbell, 1981). The precipitation is largely under 300 mm, the relative humidity is high and evaporation is low. These regions are not to be considered as "dry" in the same sense as the other deserts. By many authors they are not regarded as deserts at all and they are not given on Map 1. Examples: Greenland, Antarctica.

Aridity, in which precipitation as well as evaporation play a role, is the common characteristic of all deserts. Apart from this factor, dry climates can be very different, e.g. in (seasonal) temperatures, distribution of the precipitation over the year, wind, or humidity of the air. The separate climatic factors exert also an intricate



Map 1. Deserts and areas subject to desertification

From: U.N. Conf. on Desertification, 1977 a, as published in IUCN, UNEP, WWF, World Conservation Strategy, 1980.

influence on the distribution of the vegetation, soils, landforms and fauna. The deliniation of arid regions on the basis of vegetation, soil and drainage characteristics result in boundaries that do not coincide with climatic boundaries. Dregne (1976) mentions the following areas:

Table 1. Areas of desert zones according to different factors

factor	*area in km² x 1000*	*author*
climate	48858	Shantz, 1956
vegetation	46750	Shantz, 1956
soil	46149	Dregne, 1976
drainage	41838	De Martonne, 1927
(including polar regions)		

The extent of polar deserts has been estimated at 5 million km² (Péwé, 1974). Based upon the Budyko Ratio, Henning and Flohn (1977) prepared the Climate Aridity Index Map. The Budyko Ratio is the ratio between net radiation and precipitation at the surface, both quantities expressed in energy units and applied to long-term yearly mean values. The map shows that arid and semi-arid climates also exists in parts of eastern North America and of Central Europe. The extent of arid soils per continent is given in Table 2.

Table 2. Arid soils per continent, except polar deserts (Dregne, 1976)

continent	*area in km² x 1000*	*area in % of land surface*
Africa	17660	59.2
Asia	14405	33.0
Australia	6250	82.1
Europe	644	6.6
North America	4355	18.0
South America	2835	16.2
Total	46149	

It may be concluded that 40-50 million km² land, or about one-third of the total land surface of the earth, has severe moisture limitations.

Desertification: Definition and Extent

Over the years several definitions have been formulated, but for the present purpose the wording of the U.N. Conference on Desertification (1977 b) is followed. Desertification is defined as "the intensification or extension of desert conditions. It is a process leading to a reduced biological productivity, with consequent reduction in plant biomass, in the land's carrying capacity for livestock, in crop yields and human well-being."

Recently, UNEP (1979) mentioned that all forms of land and soil degradation, e.g. wind- and water erosion, salinization and alkalinization, decline of soil fertility and soil structure should be considered as variants of desertification.

From a soil's point of view the process is the partly irreversible change to a drier soil humidity condition. In terms of Soil Taxonomy (United States Dept. of Agriculture, 1975) it would imply the change from an udic to an ustic, from an ustic to an aridic or from a xeric to an aridic moisture regime.

The vulnerability of the ecosystem for different forms of desertification depends on the climate, the relief, the soil, the vegetation and human and animal influences. At the World Map of Desertification (U.N. Conf. on Desertification, 1977 b) three degrees of desertification hazards are mentioned: very high, high and moderate. For each of the map areas the dominant process of vulnerability of the land to desertification is given, as follows:

Areas subject to sand movement.

These regions are subject to many related processes, indicated for instance by active sand dunes (*erg, nefoud, koum*); fixed dunes with barren sandy patches, sand sheets on sandy soils which may be modified by overgrazing or overcultivation and form sandy hillocks (*nebkha*); and residual sandy surfaces left by deflation of fine material. Junge (1979) estimates that 60-200 million tons/year of mineral dust is blown out of the Sahara into the troposhere. From the rest of the world 200 million tons is added, which indicates that the Sahara belt is a very important supplier of the world's dust (Morales, 1979).

Areas with stony and rocky surfaces, subject to deflation or sheet wash.

An important indication is the occurrence of stones at the surface. These include the *reg* or *serir* of the Sahara and the *gibber plain* of Australia; also included are piedmont plains mantled with stones or rock debris; and areas of extensive rock outcrops or of calcareous or gypseous hardpan (*hammada*).

Areas subject to soil stripping and accelerated gully erosion.

Processes in these regions include stripping of topsoil and accelerated run-off leading to gully erosion on slopes and/or sheet erosion on flat land. An important process of degradation is the sealing of the soil surface (synonyms: capping, hardsetting). The surface is sealed by rain splash, resulting in increased run-off and a decrease in water available for seed germination and plant growth. Sheet, rill and gully erosion can result in the loss of vegetation and the deposition of soil material in lower lying areas. This process occurs widely in the Sahel-zone, Sudan and Australia and depends partly on the textural composition of soil material. In northern Nigeria, young dunes or coversands, consisting of well-sorted sand, are much less vulnerable than old coversands that are poorly sorted (Sombroek and Zonneveld, 1971). A clear correlation was not only found between age and lithology of the sediments, but also with the soil type and related vulnerability to surface sealing.

Areas subject to salinization and alkalinization.

In these regions there is likely to be an expansion of saline and alkaline soils, with vegetation degraded or absent through excess salt or soil structure, for example, impermeability due to an excess of sodium. These are mainly closed basins without external drainage and include *sebkhas, chotts, kevirs, takyrs, playas, salars* and *salinas;* and alluvial and littoral plains of very low gradient and with fine textured soils.

The desertification hazard has been evaluated on the basis of the vulnerability of the land combined with human and animal pressure. The three classes (very high, high and moderate) are given on Map 1, while Table 3 gives the areas, showing that nearly 38 million km^2 or 26 percent of the land's surface is threatened by desertification. The actual deserts cover already 8 million km^2 or 5.5 percent of the land's surface.

Table 3. Areas subject to desertification hazard and actual deserts (U.N. Conference on Desertification, 1977, A/CONF. 74/2, p. 9).

	South America		North and Central America		Africa		Asia	
	km^2 x 1000	%	km^2 x 1000	%	km^2 x 1000	%	km^2 x 1000	%
Very high degree of desertification hazards	414	2.3	163	0.7	1725	5.7	790	1.8
High	1261	7.1	1313	5.4	4911	16.2	7253	16.5
Moderate	1602	9.0	2854	11.8	3741	12.3	5608	12.8
(subtotal)	(3278)	(18.4)	(4330)	(17.9)	(10377)	(34.2)	(13651	(31.1)
Extreme desert	200	1.1	33	0.1	6178	20.4	1581	3.6
Total	3477	19.5	4363	18.0	16555	54.6	15232	34.7

	Australia		Europe		World	
	km^2 x 1000	%	km^2 x 1000	%	km^2 x 1000	%
Very high degree of desertification hazards	308	4.0	49	0.5	3449	2.4
High	1722	22.4	-	-	16460	11.2
Moderate	3712	48.3	190	1.8	17707	12.1
(subtotal)	(5742)	(74.7)	(239)	(2.3)	(37616)	(25.7)
Extreme desert	-	-	-	-	7992	5.5
Total	5742	74.7	239	2.3	45608	31.2

As a special type of desertification may be mentioned the one occurring in extremely arid environments (Meckelein, 1980).. Not much attention was given to date to the intensification of desert conditions as this occurs in oases. This type can be found in the deserts of South America and North Africa, the Near and Middle East and Central Asia. It is expressed by decay of wells, ponds and especially of the *qanats* and shows up in neglected gardens, palm groves, abandoned settlements, etc. Meckelein speaks of a "world-wide crisis of oases" through encroachment by sands, water deficiency and increased soil salinity. The publication of Meckelein features several case studies of oases in the Near East and North Africa.

For the U.N. Conference on Desertification three innovative maps on world desertification were prepared: a map on the status of desertification in the hot arid regions (Dregne, 1977), a climate aridity index map (Henning and Flohn, 1977) and an experimental scheme of aridity and drought probability (Kovda, 1977). Kovda uses seven criteria of land aridity: type of soil; soil acidity; type of landscape/vegetation; type and kind of soil water balance; type and degree of residual or secondary accumulations of substances in the soil body (e.g. sesquioxides, silica, calcium carbonate, gypsum, soluble salts); type and degree of present salinization; and probability of secondary salinization under irrigation. Based on the FAO-Unesco Soil Map of the World, soils were categorized on the basis of these seven criteria into fourteen land aridity units. Seven classes of drought frequency were superimposed on the land aridity units to show the distribution of land aridity, drought regions and drought probability over the world. The experimental map shows that the areas prone to desert encroachment or vulnerable to desertification may be far greater than could be determined on the basis of climatological data only.

The various approaches mentioned here indicate widely different results on the hazards of desertification. For more refined and detailed study a greater number of indicators is needed. Reining (1978) mentions 3 physical, 2 biological-agricultural and 4 social groups, subdivided into 36 indicators and at an UNEP consultative meeting (UNEP, 1979) the following groups of indicators were found of importance: geomorphological indicators (various forms of wind and water erosion); soil indicators (e.g. salinization, surface sealing, compaction, decline of fertility); production indicators (e.g. primary and secondary production of biomass, production of milk and meat, number of cattle); and socio-economical indicators (e.g. present land use and its change, establishment of homesteads and changes, extension or abandonment in the density of population).

It is estimated that 628 million people or 14 percent of the world's population are living in the dry zones (Kates et al., 1977; data of 1974). Of these 72 percent live in the semi-arid, 27 percent in the arid and 1 percent in the extremely arid zones. An estimated 78 million of them live in regions with a high to very high hazard of desertification, indicating the magnitude and importance of this process.

Desertification, Causes

The ideas about the problems of very dry regions have undergone changes during the past decennia.

During the first five years of the existence of Unesco's Advisory Committee on Arid Zone Research, established in 1951, attention was mainly directed to ecological aspects. The literature (Glantz, 1977) shows that with few exceptions (e.g.

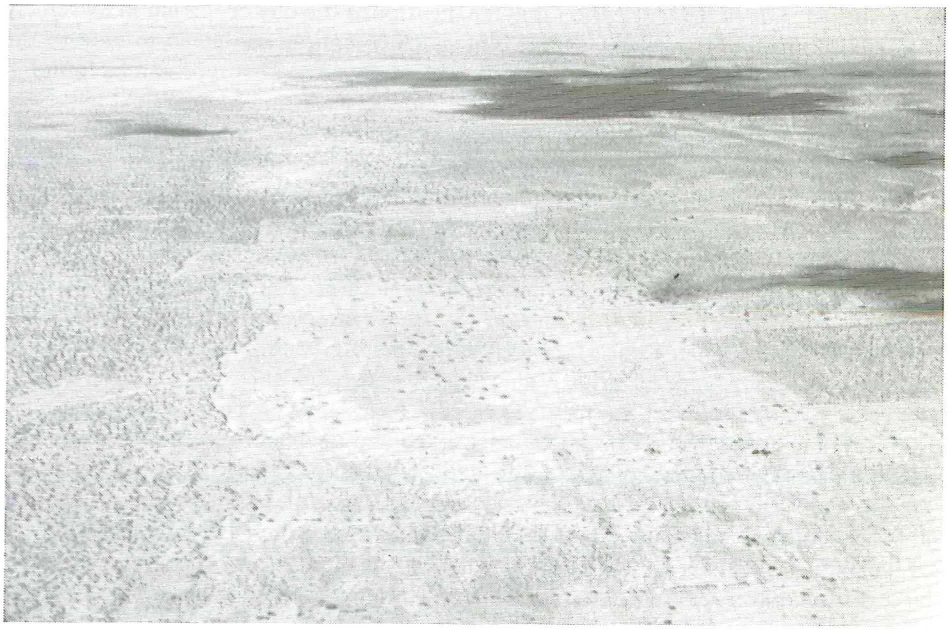


Photo 2. Aerial view of dersertificàt-ion due to overcultivation and subsequent wind erosion in Rhanterium steppe near Foum Tatahouine, Tunesia. Note the distinct, rectangular pattern of the cultivated fields. (photo A. Rapp, 1974)

Photo 3. Dune fixation and reafforestation in Libya. Diss (Imperata cylindrica) and Aristida pungens are the plants generally used for dune fixation. (photo FAO)

Stebbing, 1937 and 1938; Harroy, 1944), only since the beginning of the 1970's more attention is being given to anthropo-genetical factors. A break with the traditional socio-cultural structures and different forms of modernization along Western lines are mentioned as important causes of desertification (Harroy, 1944; Kates et al., 1977; Goodall and Perry, 1979; and Heathcote, 1980).

As a matter of course, climatic changes are without doubt of great importance and a wealth of data on paleoclimate and recent conditions is available (e.g. Goudie, 1972; Lamb, 1973; Leroux, 1973 and 1975; Rapp, 1974; Bunting et al., 1975; Le Houérou, 1977 and Williams and Faure, 1981). As other factors are mentioned:

- the rise in cattle population in excess of the natural bearing capacity, especially near homesteads and water sources (Le Houérou, 1962 and 1977; Pabot, 1962; Bernus, 1971);
- the increase in area under foodcrops for the increasing local population, as well as for export (Warren and Maizels, 1977);
- the use of more wood for construction and, especially, for cooking and heating (Eckholm, 1975 and 1976; Le Houérou, 1977).

The increase of urban population results in an intensification of these factors. Especially with the occurrence of drought, the cities are the refuge of the rural population, still enhancing the effects mentioned before (Kates et al., 1977).

Desertification: Adaptation and Control

Guidelines for this section are mainly: Rapp (1974), Rapp et al. (1976), Kates et al. (1977), Anaya (1977), UNEP Desertification Control Bulletins, UNEP Plan of Action to Combat Desertification (1978), World Conservation Strategy (1980), and Mann (1980).

Desertification is a result of a complex interaction between means of subsistence (agriculture including husbandry, and non-agriculture in urban areas); ecological factors; and sociological and political systems. A number of methods to cope with the consequences of desertification, such as declining availability of food and water, have been invented in the course of time by the people affected by this phenomenon. Kates et al. (1977) mentions four principal modes: absorbing the effects; accepting the effects; reducing the consequences; and changes land use and/or location.

Without doubt, the implementation of these choices will have great influences on the society. The inhabitants of dry zones have learned to a certain degree to live with the effects of desertification, although no quantitative estimates are known of the degree to which a society can suffer productivity losses. Kates et al. (1977) mentions that it is reasonable to estimate that a short-term loss of 10 percent can be easily coped with. Only little research has been done on evaluation of the capacity to absorb greater losses. Individuals and groups bear their losses when they occur, or share them with kin, community and (inter) national relief. A chronic decrease in productivity cannot, however, be borne for a very long period. The community will try to stop the effects, whether they are the encroachment of the agricultural fields by moving sand, the degradation of the vegetation, wind and water erosion, or salinization and alkalinization. Various technologies are known and much research is carried out for finding the best ways of controlling these results of desertification (Rapp et al., 1976; Anaya, 1977; Biswas and Biswas, 1980; Mann, 1980). Coping with desertific-

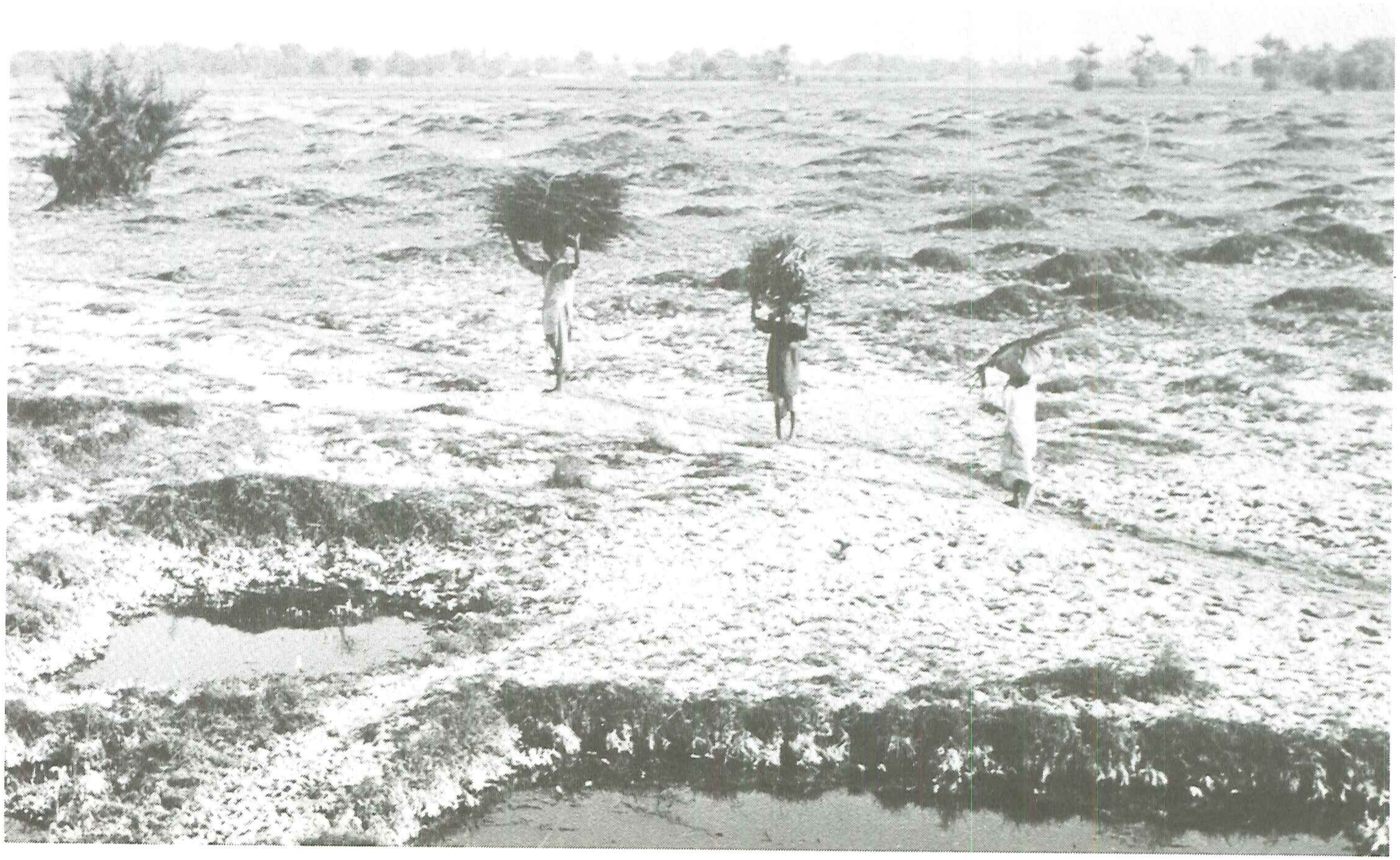


Photo 4. The cutting and stripping of trees for firewood and construction threatens many arid and semi-arid regions. (photo World Conservation Strategy)

ation is also possible by changes in livelihood or location, or both. These changes can be temporary or permanent. Included are changes in the use of land, the application of irrigation and a decrease in the number of animals. Large numbers of animals can also be moved to better areas and in the past, this has been done most frequently (Jorritsma, 1979). During the last few years, studies on the human perceptions have played and, possibly, will play a significant role in desertification and its control (Bowden, 1979, and Heathcote, 1980). Based upon four regional studies in the dry zones of Australia, Sri Lanka and the U.S.A., Heathcote gives ideas about the incorparation of these perceptions in planning resource management and combating desertification.

The technological advances in stopping desert encroachment and to push back the effects are substantial. The selection and the use of the possibilities depend on a number of factors, e.g. the motivation of the people affected; the availability of management staff; the alternative courses of action; the extent of the area; financial means and time. Each situation is unique and solutions for general application cannot be given. Biswas and Biswas (1980) present case studies of combating desertification in Australia, China, Iran, Israel, the U.S.A. and the U.S.S.R. Kovda (1980) gives practical approaches to irrigation, salinity control and non-irrigation farming, emphasizing the importance of preventing secondary salinization of soils as this is often caused by efforts to reclaim land through irrigation as much as by aridity and desertification. At the Symposium on Arid Zone Research and Development (Mann, 1980) several sessions were devoted to desert management and technology of desertification control. Anaya (1977) gives a long list of technologies that can be used in dry regions. To single out a few possibilities to make better use of the available water, soil, plant and animal resources the following examples may be mentioned:

- *water:* drilling wells; use of wind-energy for pumps; desalinization and distillation; recycling; more efficient methods of irrigation, e.g. trickle irrigation; surface and subterranean water harvesting; better management of catchment areas through the construction of dykes, water outlets and water storages.
- *soil:* various forms of soil conservation; the use of appropriate implements and machinery; measures against salinization and alkalinization.
- *plant and animal:* multiple cropping; better management of rangelands, flocks and herds; (re)afforestation; prevention of fires; improvement of the health, feeding and herding of animals.

Mabbutt (1980) reviews the problems involved in the development of the world's dry lands and the transfer of technology. In the World Conservation Strategy (1980) of IUCN, UNEP and WWF attention is also given to the dry areas. The fear is expressed that too little is done about the implementation of the action programme adopted at the U.N. Conference on Desertification in 1977. Rozanov (1980) outlines the role of the world scientific community in implementing this plan of action.

Internationally, the interest for and importance of arid regions is also shown by the establishment of several study groups within professional societies, e.g. the International Geographical Union and the International Society of Soil Science. Since a few years the Journal of Arid Environments and Arid Lands Abstracts appear. Furthermore, basic and applied research as well as projects are carried out by many organizations and institutions.

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(An additional list of literature is available from the author).

3 ACTIVITIES OF THE SECTIONS

3.1 Soil monolith collection and exhibition

During the reporting period the number of soil monoliths has increased with 95 to 471. A large part is comprised of the 52 soils belonging to the Glinka Memorial Collection of the U.S.S.R.

Contacts have been established with a dozen countries about the collection of soils for ISM. It may be added that there is a growing interest in building up national benchmark soil collections, in part concurrently with that for ISM.

Acquisitions in 1980

Belgium: One of the guest researchers at ISM, Dr. D. L. Mokma, and student Mr. J. Schrevel, collected two soil profiles. Accompanied by all relevant field data, these were given to ISM. They are a part of large number of podzols studied in Belgium, Germany and the Netherlands for a monograph on podzols in temperate regions of Europe and North America.

Cameroon: Ir. G. W. van Barneveld, FAO soil scientist in Cameroon, donated one monolith of the soil belonging to the Benchmark Soil Project. Samples and relevant data on this soil will be sent to us at a later date.

Indonesia: Dr. P. Buurman, staff member of the Department of Soil Science and Geology, Agricultural University Wageningen, collected four monoliths near Bogor. This work was carried out in cooperation with the Soil Research Institute and the Department of Soil Sciences, Agricultural University, Bogor.

Italy: One of the staff members collected, together with ISM trainee Mr. R. D. Asiamah, Soil Research Institute, Kumasi, Ghana, nine soil profiles in southern Italy. Most of the soils collected are developed in various weathering products of limestone and dolomite.

Kenya: In close cooperation with, and active support of Kenya Soil Survey 16 soil monoliths were collected for ISM, while also eight monoliths were taken for the Department of Soil Science and Geology, Agricultural University Wageningen. It is planned that additional soil monoliths will be taken in 1981. Furthermore, four monoliths were donated to ISM by the said Department, together with the samples, analytical data, etc. These soils were collected by Ir. W. G. Wielemaker near Kisii. They demonstrate the effects of intensive termite activity on soils.

Ultimately, the Kenyan collection will mostly illustrate Ferralsols, Nitosols, Andosols, Acrisols, Planosols, Solonchaks and Solonetz in the tropics.

Netherlands: As part of the training programme, profiles were collected in the surroundings of Wageningen with three Unesco associate experts and some other interested persons. Furthermore, a soil formed in boulder clay was collected near Winterswijk.

U.S.A.: The State Soil Scientist, Soil Conservation Service in North Carolina, Dr. H. J. Byrd, collected three soil profiles. This is the start of a collection of 28 soils from the continental U.S.

U.S.S.R.: A major acquisition for ISM is formed by a collection of 52 soils, taken for the First International Congress of Soil Science, held in 1927 in the U.S. This collection has been safeguarded by the U.S. Soil Conservation Service ever since. It was decided to hand over this interesting collection to ISM. The soils are in the original wooden boxes, but are partly impregnated in the 1950's with a vinyl resin. From the soils, samples for laboratory analyses and micromorphology will be taken, after which the remaining material will be impregnated. The soils carry names in the old U.S.S.R. nomenclature and the approximate location. No other data are available at present, and it is doubtful whether much field information can be added about the region, site and soil.

With the consent of Prof. V. M. Fridland, Dokuchaev Soil Institute, Moscow and Soil Conservation Service Washington, this collection will be known as the "Glinka Memorial Collection".

Future acquisitions

Arrangements for collecting soil profiles have been made with a number of countries. These plans are in various stages of implementation.

China: The Director visited China at the invitation of the Soil Science Society of China. Arrangements have been discussed on the training of a Chinese soil scientist and the concurrent building up of a collection of soils for ISM and of a national collection.

It is planned that these activities will take place in 1982.

Colombia: The Director laid the first contacts with the Instituto Geografico Agostin Codazzi and the Centro Inter-Americano de Fotointerpretación in Bogotá for a collection of Colombian soils. It is envisaged that a collection of soils will be taken in 1981 or 1982. He also discussed the form of ISM support for building up a national collection of benchmark soils. This can probably be carried out as a technical assistance sub-project of the Dutch Directorate of International Cooperation (DGIS).

Ghana: An additional number of soil profiles, partly selected at earlier occasions will probably be collected in 1981. This work will be carried out in close cooperation with the Soil Research Institute in Kumasi.

Poland: One of the staff members visited Poland for two weeks to select 15 soils for the ISM collection. The cooperating agencies are the Agricultural University of Warsaw, the Agricultural University of Wroclaw and the Institute of Soil Science and Plant Cultivation at Pulawy.

The soil profiles will be taken by Polish soil scientists, probably in 1981. The establishment in the near future of a Polish National Soil Museum in Warsaw was discussed and ISM offered to give advice in this matter.

United Kingdom: A selection has been made of 22 soils, representative of all soils covering more than 1% in England and Wales. The sampling will be carried out by ISM staff after the International Working Meeting on Soil Micromorphology in London, August 1981.

U.S.A.: Besides soil profiles from continental U.S.A., also soils from Hawaii will be collected, probably in 1981. This work is carried out by Dr. H. Ikawa, Honolulu, who has acquainted himself with taking and preparing soil monoliths during his stay in Wageningen.

General

Tentative arrangements for collecting soil monoliths have been made with institutions and individual experts in a large number of countries. These are mostly countries from which no soils appear in the collection, but also from which additional material is needed for filling up gaps.

Some of the countries concerned have also plans to build up national benchmark soil collections. Both activities may partly be carried out concurrently. These countries, except from those already mentioned, are: Belgium, Brazil, Morocco, Pakistan, Sudan, Syria, Tunesia, and Venezuela.

Preparation of monoliths

During the reporting period about 50 profiles have been impregnated and prepared for the exhibition. The procedures are set out in Technical Paper 1.

Most of the chemicals used for the impregnation of soil material are toxic for an appreciable amount. These liquids contain various amounts of benzene and toluen, both known for their carcinogene effects. For casual impregnation in the open air there is much less danger. Yet, given the growing number of persons who are permanently assigned to do impregnation work for building up national collections, it is felt that ISM should play a role in selecting less dangerous chemicals. A programme to this effect will be drawn up in 1981-82.

Monolith collection, December 1980. Within brackets: acquisitions in 1980

Australia	33		Malaysia	10	
Belgium	4	(+ 2)	Namibia	11	
Botswana	7		Netherlands	19	(+ 4)
Cameroon	1	(+ 1)	New Zealand	5	
Canada	21		Nigeria	14	
Colombia	1		Norway	3	
Czechoslovakia	8		Romania	11	
Denmark (Greenland)	2		South Africa	20	
F. R. Germany	17		Spain	18	
Finland	5		Sweden	17	
France	11		Syria	4	
Ghana	4		Thailand	13	
Greece	14		Turkey	13	
Hungary	20		U.S.A.	3	(+ 3)
Ireland	11		U.S.S.R.	62	(+52)
India	30		West Samoa	5	
Indonesia	4	(+ 4)	Yugoslavia	3	
Italy	17	(+ 9)	Zambia	10	
Kenya	20	(+20)			

Total: 471 (+95)

Exhibition

In 1980 minor changes have been made in the set-up of the soil monolith exhibition. In the course of the year the documentation with the soil monoliths was partly supplemented with additional data and consistency was brought into the displayed information.

A first draft was prepared by Mr. A. de Sitter to supply information on the soil limitations and land qualities as recommended by the Netherlands Advisory Council (NAC) last year. This draft is still under discussion and the matter will be elaborated upon next year.

3.2 Laboratory

Analytical work

This year attention was focussed on the 16 monoliths selected for Soil Monolith Papers.

These monoliths are analyzed in somewhat more detail than the monoliths destined for exhibition alone e.g. elemental analysis of clay fraction, microscopic analysis of the sand fraction. For some 25 other monoliths the routine analyses were completed, including four from Kenya donated by Mr. W. G. Wielemaker of the Dept. of Pedology and Geology, Agricultural University of Wageningen in return for the analyses.

Some 15 man-weeks were spent on analytical work for ITC in partial return for the seconding of an analyst at ISM.

In view of the rate of acquisition of new monoliths and the still existing back-log it may become inevitable (as stated already last year) to put out to contract some of the routine analyses of a number of samples. The costs may be prohibitive, however.

Research

Included in the research programme were the following topics:

- Organic and inorganic carbon determination. A new potentiometric method was developed to determine organic and inorganic C in soils and rocks, using the automatic titrator. A twin set-up is presently in operation and is being tested with standard materials. The results thus far are excellent and the method is expected to be publishable soon.
- In soils of arid and semi-arid climates the clay mineral palygorskite (attapulgite) may become of diagnostic value. The only way of positive identification thus far is by X-ray diffraction. For rapid classification, a field test for palygorskite is presently being developed and the prospects are promising.
- One of the powerful methods to determine amorphous compounds (allophane) in soils is by means of the CEC delta value (Aomine and Jackson). However, this is a cumbersome and time-consuming method and therefore not widely used (2-4 samples per man-day). A new method has been developed to overcome this problem. With this method one man could run 30-50 samples per day. The method is in the operable stage but still requires calibration against the existing method.

Programme on comparison of methods, procedures and results of laboratory analysis for classification purposes (LABEX)

The year started quite dusty for the laboratory people when the ten bulk reference samples (of 75 kg each) were dried, milled and mixed. This was done in the catacombs of the Department of Soil Science and Geology of the Agricultural University.

Subsamples of 200 g were sent to the 20 participants of the Programme and the first analytical results have been returned. The contribution of samples by participants is not running as smoothly as was hoped. There are still four or five batches of samples to come. As a consequence, analytical work by the Royal Tropical Institute (KIT) could not start yet.

3.3 Micromorphology

Technical work

The preparation of thin sections is carried out by the technician of ISM at the laboratory of the Netherlands Soil Survey Institute (Stiboka).

Most of the work in 1980 concerned samples for the Project: "Micromorphological analysis and characterization of Benchmark Soils of India". So far 202 samples (80 pedons) were received from India, about 100 of which are prepared and ready for inspection. The remainder is in preparation. An additional 25 samples of the ISM collection, regarding various countries (Australia, Canada, Italy) were prepared. Also a number of thin sections were made for special research of ITC staff members. Samples were received for the ISM collection from Canada (37), China (4), Indonesia (20), Italy (70), Kenya (91), and the Netherlands (5).

The grinding machine for the preparation of rock thin sections, which was installed last year, was made operative.

Research

The study of thin sections is carried out at the premises of ISM. The description of thin sections has been progressing steadily and the guidelines for description are gradually being adapted and improved. Descriptions were made of soils from Australia, Ireland, Malaysia, Thailand, Zambia.

A detailed analysis of a soil from Thailand was made as a contribution to the forthcoming Soil Monolith Paper. Similar analyses of soils from Zambia and Ireland are currently carried out.

Additional photomicrographs and explanatory texts for the exhibition hall were prepared. Experiments to prepare high quality diapositives of selected micromorphological features for inclusion in the Soil Monolith Papers have given good results.

3.4 Documentation

Map collection and library

The objectives of building up a systematic collection of soil and other thematic maps with the accompanying technical reports were given in the 1979 annual report.

During the temporary appointment of Ir. A. de Sitter on a part-time basis from May 1979, about 1000 maps and reports were received. This followed requests to soil survey institutes and other governmental agencies, universities, consulting companies, private persons, etc. For this purpose, all countries of which no or insufficient material was available at ISM, were contacted. The institutions that responded to the ISM call for maps and reports are listed in appendix B. The total number of maps, mostly on soil, geology, vegetation, climate, but topographic maps not included, exceeds now 3000.

After the expiration of the contract of Mr. de Sitter, the documentation work was taken over by Ir. P. Martens, also on a temporary basis up to January 1981. Storing of the maps is carried out by Mr. B. C. P. H. van Baak on a free lance basis.

In order to expand the collection at ISM, preferably on a more-or-less regular basis, it is regarded as a necessity to have a follow-up of the contacts already established for this purpose and to establish new contacts. It is feared that without a more permanent occupation of the post of documentalist, this useful activity of ISM cannot be actively pursued anymore. Also the aspect of providing services to a growing number of interested persons will be seriously hampered without a full-fledged documentalist.

The library contains not only technical reports as mentioned above, but also books, journals, and series. Since there is an appreciable increase in the prices of books and especially of journal subscriptions, the purchase of new publications was limited to less than 150. However, nearly 90 books were received free of charge. These were sent to the editor of the section "New Publications" in the Bulletin of the ISSS, and with the approval of the Secretary-General of the Society, these are mostly handed over to ISM. Furthermore, also the number of journals is deliberately kept at a low number, now 15. Being near to several large agricultural libaties it is felt superfluous to build up a large collection at ISM itself.

Sales section

With the consent of Unesco, ISM is a selling agent for the FAO-Unesco Soil Map of the World. It may be known that during 1980 all maps and explanatory texts except on Europe, have become available. Some other publications on soil related subjects are on sale as well.

Although the price of the slides in the sales collection remained the same, there was a drop in the number of slides sold to visitors. A new selection of extra slides was made, but also because of increasing duplicating costs, ISM is hesitant to enlarge the sales collection too much.

Computerized information

To investigate the possibilities of computerizing the information of soil maps, either available at ISM or only catalogued, and in search of an internationally accepted standard description of cartographic material, ISM is in contact with the Dutch Central Catalogue of Cartography (C.C.K.) in Utrecht, the Netherlands.

The further development of C.C.K. to include maps and accompanying reports, and the applicability and profitable use of the system for the aims of ISM is followed with interest. Obviously, this must be regarded as a long-term project.

3.5 Education and information

During 1980 ISM received about 2300 visitors from 76 countries. The majority of the visitors was from the Netherlands; about 500 came from abroad. Compared to 1979 the number of visitors decreased slightly. This is due to special events in 1979 (official opening of ISM; a number of "open day" visits), which were not organized in 1980. These special events attracted about 750 people. Corrected figures therefore show an increase of visitors of about 30%.

Group visits

About 1700 people visited ISM in groups, mainly from educational institutions (universities, agricultural and technical colleges, high schools) and from international training courses and congresses (see appendix A). Also a number of non-professional groups paid a short visit to ISM. It is tried, however, to keep visits of the latter kind as limited as possible.

The group visits normally had an informative character. The visitors were informed on the place and role of ISM in the international soil community and were introduced through a lecture and a visit to the exhibition hall in the world of soils, often with reference to problem areas in the world (Sahel zone, Amazon basin, etc.). These visits took normally two to three hours.

A number of groups from the Netherlands and abroad visited ISM for training, especially in soil classification according to both the FAO-Unesco Legend of the soil map of the world and the USDA Soil Taxonomy. Such groups spend usually at least one full day at ISM and demand intensive preparation (displaying selected soil monoliths with accompanying documentation, lecturing on special topics, preparing and correcting tests, etc.). In 1980, the following groups visited ISM for training:

- Agricultural College (HLS), tropical section (during four consecutive days), from Deventer
- Agricultural University (LH), from Wageningen
- Free University of Amsterdam
- University of Amsterdam
- University of Hamburg (Germany).

It is expected that these kinds of visits will increase in the future. For 1981 there are already some requests for such instruction from other groups, e.g. from Belgium and England, especially with regard to the soils of the developing countries.

Individual visits

The number of individual visitors is estimated at 600 (about 50 per month). The character of these visits varies. There were general informative visits, during which people were shown around various sections of ISM. Other visits concentrated on discussions with staff members on special topics. An important category of visitors is formed by students and by persons preparing their posting abroad, who come to study the soil monolith collection and to make use of the documentation facilities. Other visitors include soil scientists who come to ISM mainly for discussing business affairs of the International Society of Soil Science.

Special visits

ISM welcomed in 1980 the Director General of FAO, Dr. E. Saouma, the Director General of the International Service of National Agricultural Research (ISNAR), Dr. W. G. Gamble, and the Board of Trustees of ISNAR.

Discussions at ISM between members of the Board of ISNAR and representatives of several Dutch research institutes on land and water resources data of developing countries.

4 PROJECTS

4.1 Unesco-ISM cooperation programme for soil studies in MAB project areas

The Unesco Division of Ecological Sciences in Paris and the International Soil Museum (ISM) in Wageningen, are undertaking a programme of cooperative work to gather soil data in Man and the Biosphere (MAB) project areas.

In 1980, three associate experts in ecological sciences (soil science) made available by the Dutch Government went to their respective duty stations. The associate experts are officially attached to the Unesco Regional Offices for Science and Technology located in the region they have to cover. They are:

Mr. R. F. Breimer	- Regional Office for Latin America and the Caribbean in Montevideo, Uruguay
Mr. A. J. van Kekem	- Regional Office for Africa in Nairobi, Kenya
Mr. H. van Reuler	- Regional Office for South-East Asia in Jakarta, Indonesia.

Due to the rather specialized character of the work, requiring facilities normally not available at the Regional Offices, the associate experts are in fact based at national institutes in the field of soil science near each Regional Office:

- Direccion de Suelos y Fertilizantes, Avenida Garzon 456, Montevideo, Uruguay
- Kenya Soil Survey, P.O. Box 14733, Nairobi, Kenya
- Soil Research Institute, Jalan Ir. H. Juanda 98, Bogor, Indonesia.

History of the MAB programme

In the late sixties, several international organizations and committees stressed the need for an intensification of scientific studies of the world's biosphere resources at an international level. In 1968, Unesco organized an intergovernmental conference in Paris, in cooperation with the International Biological Programme (IBP) and the International Union for Conservation of Nature and Natural Resources (IUCN).

This conference had as subject, "The scientific basis for rational use and conservation of the resources of the biosphere", more simply known as the Biosphere Conference. Resulting from this conference, the Unesco General Conference in 1970 officially launched the Man and the Biosphere Programme (MAB) and its coordinating council. The Council formulated 14 main themes of research related either to the impact of human activities on a number typical ecosystems, or to the general interactions between man and the environment.

The period 1972-1976 was used for planning and preparation of field projects. For each MAB theme the objectives and operating procedures were studied. Next, the global and regional planning were undertaken. In 1976 all the guidelines for the total MAB programme became available and the country programmes could start. The MAB research in each participating country is coordinated by a MAB National Committee. In 1978 there were 95 countries participating with several thousand scientists in over 900 field projects.

Soil studies in the MAB project areas

The inclusion of soil studies in the MAB research is based on two main considerations:

- many biosphere reserves and other sites of MAB field projects suffer from inadequate knowledge of the soil characteristics of the areas concerned
- there is a lack of standardized forms of characterization which would enable comparisons of soil characteristics to be made from project to project and from region to region.

In addition, the programme will enable the ISM to collect soil monoliths from relatively virgin sites in well defined ecosystems. For educational purposes, monoliths representing soil sequences are to be preferred.

For the time being, the soil studies will be limited to the MAB no. 1, 3 and 8 projects.

MAB theme nr. 1 - Ecological effects of increasing human activities on tropical and subtropical forest ecosystems. This project provides the main focus for MAB activities in the humid tropics. A principle objective of this project is to help to develop a scientific basis for the long term predictable use of natural resources and for the management of ecosystems in the tropical and subtropical forest zones of the world.

MAB theme no. 3 - Impact of human activities and land use practices on grazing lands: savanna, grassland (from temperate to arid areas), tundra. The grazing lands, that are covered by the ISM-Unesco programme are located in the tropical subhumid to arid zones. The overall objective is to help provide a scientific framework for information, research and training on conservation oriented management of ecosystems for grazing.

MAB theme no. 8 - Conservation of natural areas and of the genetic material they contain (biosphere reserves). An international network of biosphere reserves is being established with as main aims: conservation of representative ecosystems to provide sites for long-term research and monitoring of environmental change; to make available facilities for education and training.

Outline of the programme of work

The soil studies in the MAB project areas concern in first instance the gathering and updating of already available data. If there is not sufficient data available complementary fieldwork will have to be carried out.

The characterization of the areas concerned will be done by means of soil maps and reports. Due to the large variation in size of the areas no definite rules about the scale of the maps can be given. For the large sites a scale of 1:250,000 is proposed, for the smaller areas the scale is depending on the size.

On request detailed soil maps will be produced to support the research of MAB scientists who are working in these areas. Another task of the associate experts will be to gather some soil monoliths of characteristic soils occurring in the study areas.

The legend of the soil map will be built up as follows:

highest level	- the physiography
second level	- the geology, especially the richness of the parent material
third level	- the soils, indicated in a descriptive way and named after the FAO/-Unesco legend of the soil map of the world.

It is stressed that the characterization is a part of the interdisciplinary research in the areas.

The soil map will be accompanied by a report which will contain all the normal elements of a survey report. A table will be presented containing the correlation of the soils in the different classification systems.

The land evaluation will be mainly handled in terms of the limitations of each mapping unit for plant growth. If possible an estimation of the representativeness of the reserve sites in relation to the surrounding ecosystems will be given.

The role of the International Soil Museum

The ISM takes care of the scientific and technical backstopping of the three associate experts. In March/April 1980 the ISM organized an introduction course of three weeks. During this course lectures were given by experts in different fields. In cooperation with the ISM staff members, field equipment was purchased on the account of Unesco.

Every two months scientific progress reports are sent to the Director of ISM with a copy to the Director of the Unesco Division of Ecological Sciences. If necessary, funds will be made available by Unesco for short consultancies by ISM staff members.

If soil analysis cannot be carried out at the host institute, ISM will take care of it. A selection of soil profiles and soil samples will be sent to the ISM for analysis, conservation and storage.

Programme accomplishments

Although the associate experts arrived quite recently at their respective duty stations some progress has already been made. The first time after arrival was used to settle down and to get acquainted with the local conditions.

- *Africa region* (Mr. van Kekem, arrival in May 1980)

Orientation trips were made to the following Biosphere Reserves:
Mount Kulal in Kenya, Tai forest in Ivory Coast and Makoku reserve in Gabon. The fieldwork will start in the Mount Kulal area in cooperation with the Integrated Project on Arid Lands (IPAL).

Other priority areas are Yangambi reserve in Zaire, Omo reserve in Nigeria and the Dimonika reserve in Congo.

- *Latin America and the Caribbean region* (Mr. Breimer, arrival in July 1980)

A seminar on Soil Conservation in Buenos Aires was attended and contacts were made for future work. Several field trips were made in company of the staff members of the Direccion de Suelos.

Priority areas: Cordoba project in Argentina, Partagonia and Tierra del Fuego reserves in Chile, Oyapoc reserve in Guyana, San Carlos de Rio Negro reserve in Venezuela and the Iquitos reserve in Peru.

- *South-East Asia* (Mr. van Reuler, arrival in August 1980)

An orientation visit has been made to the Cibodas Biosphere Reserve near Bogor, Indonesia. Several field trips were made with staff members of the Soil Research Institute.

Priority areas: Cibodas reserve in Indonesia and the Apo Kayan site in East Kalimantan, Indonesia; Pasoh-Tasek Bera forest in Malaysia, Puerto Galera reserve in Philippines and the Sakaerat Environmental Station in Thailand.

4.2 Cooperation with India on soil micromorphology

The project "Establishment of a soil micromorphological unit and micromorphological analyses and characterization of Benchmark Soils of India", (cf. Annual Report 1979) is still awaiting the final approval of the Dutch Government. The project document has been sent to the competent Indian Authority for the last refinements.

For financial-administrative reasons the organization of this project in the Netherlands will be the responsability of the Director of the Dutch Soil Survey Institure (Stiboka) in close cooperation with the International Soil Museum (ISM). In India the organization will be in the hands of Dr. Murthy of the National Bureau of Soil Survey and Land Use Planning in Nagpur.

The part of the project concerning the micromorphological analyses and characterization of Benchmark Soils of India is separately financed by the Dutch Government. The thin sections are prepared by a technician of the ISM and the description and interpretation is carried out by a trained micromorphologist, employed by Stiboka for this purpose (Dr. M. J. Kooistra). So far about 25 pedons have been described and provisional interpretations have been made.

The other objectives of this project will become operational after final approval of the complete project.

4.3 Small projects

Small projects include activities that do not form part of the regular work programme and that are carried out on request from regular ISM funds.

Poland. X-ray diffraction and interpretation of four soil samples for detection of soil zeolites (Prof. Brogovski).

Pakistan. X-ray diffraction and interpretation of the clay fraction of ten Benchmark Soils (Mr. Nisar Ahmed).

Iraq. Analysis of soluble salts in 187 water samples (Dept. of Geology, ITC).

Tropical Ultisols and Oxisols. Selection and analysis of thin sections of Ultisols and Oxisols (Drs. R. Hillen, V.U., Amsterdam).

Spain. Preparation, analysis and photography of thin sections of calcic horizons (Ir. G. W. W. Elbersen, ITC).

India. Selection, analysis and photography of thin sections of a climatic sequence of alluvial soils (Dr. M. L. Manchanda, ITC).

Kenya. Assistance in drafting the exploratory soil map of Kenya, which is to be printed by Stiboka (Kenya Soil Survey). Advising on a FAO/UNFPA case study of natural resources based population carrying capacities.

5 GUEST RESEARCH AND TRAINING

5.1 Guest research

The function of being host to soil scientists is realized specifically by the provision of facilities to research fellows and trainees. Guest researchers include soil scientists, who come to ISM for periods between three months and one year to study soils or soil related subjects, and who are paid either through a fellowship or a sabbatical leave arrangement.

Soil scientists interested to stay at ISM for a period between three months and one year, on sabbatical leave or else, are invited to contact the Director.

Preference will be given to those scientists who want to study a major soil of their own area in comparison to similar soils from elsewhere as present in the ISM monolith collection. It is hoped that this will result in monographs, to be published by ISM.

The Centre has no funds of its own to pay a salary or the travel costs, but can be instrumental in obtaining grants for board and lodging in Wageningen, for scientists from OECD countries.

Comparison of Podzols (Spodosols) in Temperate Regions
(Dr. D. L. Mokma, Michigan State University, U.S.A.)
Period: 15 September 1980 - September 1981.
Funding: combined Michigan State University; Agricultural University Wageningen; International Agricultural Centre, Wageningen.

In the development of the new U.S. soil classification system (Soil Taxonomy) it was thought most Podzols would classify as Spodosols. The laboratory criteria for the spodic horizon was based mainly on research to distinguish Spodosols from Inceptisols in New York and Alaska. Many soils which morphologically appear to be Spodosols do not meet the chemical and physical requirements of the spodic horizon. The Podzol B horizon in both the British and Canadian systems are defined using some similar methods, but with different critical values. The objective of this research is to compare some chemical and physical properties of Podzols from various parts of temperate regions. Based on these findings, revised requirements for the spodic horizon will be proposed.

The research will include the following items:

1. Collect and assemble existing data on the Podzol monoliths in the International Soil Museum collection. Determine 1) organic carbon, iron, and aluminum in sodium pyrophosphate (pH 10) extracts; 2) iron and aluminum in sodium dithionite-citrate extracts; and 3) iron and aluminum in ammonium oxalate extracts on all horizons of Podzol monoliths in the ISM collection.
2. Collect soil samples from about 20 profiles in the Netherlands, Belgium and possibly West Germany (cooperative with P. Buurman - LH). The profiles will include well-drained Podzols, varying from weakly to strongly developed, Ground-Water Podzols, and non-Podzols (Brown Podzols, Entisols, Inceptisols). Analyses will include, in addition to those in item 1, particle size distribution, organic car-

bon (NaOH extractable) and CEC (NH4 OAc).

3. Work with Mr. J. Schrevel, a LH student in the last phase of his study. He will (1) review literature on Podzolization, Podzols, and criteria for Podzol B horizon and spodic horizon; (2) using various criteria, determine Podzol B and spodic horizons from previous studies; and (3) calculate C/Al, C/Fe and C/Fe+Al ratios, after Petersen, from previous studies. His research will include the analyses on the soils from the Netherlands, Belgium, and West Germany (item 2).
4. Collect available data on Podzols from literature and scientists from countries in temperate regions, including: the Netherlands, United States, Germany, Belgium, Canada, and Denmark. This would include visits to Belgium and Germany.
5. Collect laboratory data on the Podzols in the U.S.S.R. Collection of 1927 being shipped from the United States. Analyses will include those in items 1 and 2.
6. Collect laboratory data on the Kalkaska monolith (Typic Haplorthod, sandy, mixed, frigid) to be shipped from Michigan. Analyses will include those in items 1 and 2.
7. Preparation of a manuscript summarizing the findings of this study and making recommendations on revision of spodic horizon requirements.

Agroclimatic Survey of Southeast Asia

(Dr. R. Oldeman, Interagency Group on Agricultural Biometeorology)

Period: 25 August - 15 December 1980

Funding: Bureau of Research in Applied Technology, Ministry of Foreign Affairs of the Netherlands.

Under supervision of the Interagency Group on Agricultural Biometeorology, established in 1968 by FAO, Unesco and WMO, agroclimatological surveys have been carried out in arid and semi-arid zones of Africa and the Middle East and in the tropical highlands of South America. In 1978 the Interagency Group decided to initiate an agroclimatic survey of the humid tropics. The countries of the Association of Southeast Asian Nations (ASEAN) were requested to cooperate. A coordinator was appointed to establish in the participating countries - Indonesia, Malaysia, Philippines and Thailand - working groups, which were to collect the relevant data on climate, soils and agricultural production. This phase ended in July 1980. In the period September 1980 - September 1981 the data will be interpreted and published by the Interagency Group analogous to the surveys mentioned above, for serving the following purposes:

- To what level can crop yields be raised and can agricultural land be extended.
- To indicate the hazards of bringing into cultivation land which is at the moment under natural vegetation.
- To transfer knowledge among the participating countries on agricultural alternatives in identical agroclimatic zones.
- To contribute on regional scale, to those aspects of agricultural research, in which climate plays a role.
- To map agroclimatic zones based on their suitability for various crops and agricultural systems.

The agroclimatologist Dr. Ir. R. Oldeman was approached as coordinator by the Interagency Group for the survey and will carry out an interpretation of collected data as guest researcher at the International Soil Museum and from 15 December on at the International Institute for Land Reclamation and Improvement (ILRI), in close cooperation with the Centre for World Food Studies, all based in Wageningen. Funds are provided within the framework of bilateral agricultural cooperation with Indonesia.

Elaboration of Soil Data from Kenya
(Dr. W. Siderius, Kenya Soil Survey)
Period: 1 December 1980 - 1 April 1981.
Funding: Sabbatical leave, DGIS.

The programme uses Kenyan soils as starting point for the study on problematics of soil and land use in developing countries. The study includes the following three subjects:

- The deepening of the knowledge on the methodology and application of agricultural evaluation of a number of specific soils from the tropics, with emphasis on the production by the small-scale and large-scale land user of food- and cash crops under rainfed and/or irrigation (conditions). National and international appraisal systems will be tested on usefulness and suggestions for improvement will be elaborated.

The results of this study will be presented with the documentation of the soil monoliths on display at the ISM.

- The preparation and editing of a Soil Monolith Paper on once of the major soils in East Africa, especially in Kenya, a Humic Nitosol (EAK 16). This soil is very intensively used both in small-scale and large-scale agriculture.
- The orientation on current or planned projects and/or programmes in the field of land resources mapping and land evaluation in Asia, Africa and Latin-America. This may include a course in Spanish.

Dr. Ikawa (left) and Mr. Asiamah (digging), taking a soil profile during the training course.

5.2 Training

ISM offers facilities for training in specialized techniques. Such training may take periods varying from one week to a few months. Training is open for students of universities and for soil scientists, in groups or individually. In 1980 ISM staff has given training in soil micromorphology, laboratory techniques and collection and preservation of soil profiles.

Soil micromorphology

Mr. M. L. Manchanda from India spent about three months at ISM for the partial fulfilment of his MSc study at ITC. His objectives were to get an introduction in micromorphology, including microscopic techniques, recognition, description and interpretation of micromorphological phenomena, and to make a study of thin sections of selected Indian soils. The results of this study were to be incorporated in his ITC MSc-thesis.

Drs. R. Hillen, Free University of Amsterdam, was a guest for one week at ISM. His aim was to study the micromorphology of a selection of tropical soils (Ultisols and Oxisols). Also Mr. R. D. Asiamah from Ghana was instructed in micromorphology.

Laboratory techniques

In November and December ISM gave hospitality to a group of soil chemists from Vietnam (Mr. Nguyen My Hoa, Mr. Tram Kim Tink and Mr. Vo Thi Guong), who have been doing practicals in the laboratory. The instructions were given by Staff of the Agricultural University, with assistance of ISM analists.

Training in collection and preservation of soil profiles

The specialized know-how at ISM for the collection and preservation of soil profiles has captured the interest of people from all over the world to receive training in this field. In 1980, Mr. R. D. Asiamah from Ghana and Dr. H. Ikawa from Hawaii, USA followed a complete course, while the three MAB associates received field training. There is a growing number of applications for such training.

Henceforth ISM will organize an annual course on monolith preparation called "training course in the establishment and use of national soil reference collections". It will have a duration of 4 to 6 weeks and take place in April-May each year.

Interested soil scientists from developing countries, attached to national Soil Survey Organizations or Soil Departments of Universities, are suggested to apply for a fellowship grant - travel, board & lodging - to: Dr. F. di Castri, Director, Division of Ecological Sciences, Unesco, 7 Place de Fontenoy, 75700 Paris, France; or to the Unesco Regional Offices for Science & Technology in Montevideo, Djakarta, Nairobi or Cairo.

Soil scientists from countries that have a Cultural, Scientific or Agricultural Research Cooperation Treaty with the Netherlands may apply to the Dutch Embassy in their country.

6 TRAVEL AND MISSION REPORTS

Staff members of ISM attended several international meetings and congresses, and carried out missions to other countries. Only the more important events are mentioned. Dr. Sombroek's participation was usually in his dual capacity as Director of ISM and Secretary-General of the ISSS, often with outside funding.

(80/2) Visit to the Indian National Bureau for Soil Survey and Land Use Planning in Nagpur; participation in the International Symposium on Principles and Practices of Reclamation and Management of Salt-affected Soils in Karnal and Meeting of the ISSS Executive Committee in New Delhi, February 1980.
Participant: W. G. Sombroek.

Discussions on the preparation for a project of cooperation on studies and training on the micromorphology of Indian soils (see section 4.2); discussions on soil classification and soil survey of the country's collection of data and reports on saline/alkali soils and soil fertility/soil reclamation data. Discussions on current ISSS affairs, and review of local preparations for the 12th International Congress of Soil Science.

(80/3) Meeting in Rome of a Working Group on Soils Policy, organized by UNEP, with cooperation of FAO; March 1980. Participant: W. G. Sombroek.

Exchange of information of on-going international programmes on soil research in the broadest sense, resulting in recommendations to harmonize these programmes through annual meetings, and to create a clearing house for the collection and exchange of information on development-oriented soil research. Discussion of a background paper on a "World Soils Policy", with a view to arrive at an agreement on the subject, taking into consideration scientific, technical, legal, cultural, educational and institutional aspects.

(80/4) Panel consultation in Rome on a Strategy for Land Evaluation and Agrotechnology Transfer in the Tropics, organized by FAO and the US Benchmark Soils Project; March 1980. Participant: W. G. Sombroek.

Review of the results of the present Benchmark Soils Project, and confrontation with the FAO approach to land evaluation and agroclimatological zonification. Recommendation that a new fully international and interdisciplinary project should be embarked upon, which would establish an International Network of Benchmark sites for Agrotechnology Transfer (INBAT). Such a network would comprise initially twenty sites, partly at the International Agricultural Research Centres, partly at national research centres in the tropics. At such sites, the relationships land characteristics - land qualities - crop performance would be studied in depth, with a view to strengthen the methodology of both land evaluation and agrotechnology transfer, including modelling.

(80/5) Soil monolith collection trip to Italy: April 1980. Participants: O. C. Spaargaren and R. D. Asiamah. (see section 3.1)

(80/6) Third International Soil Classification Workshop, Syria and Libanon, organized by the Arab Centre for the Studies of Arid Zones and Dry Lands (ACSAD) in Damascus, the University of Puerto Rico and USAID; April 1980. Participant: W. G. Sombroek.

Contribution to the improvement of the US Soil Taxonomy system of soil classification for arid and semi-arid environments. Recommendations on the progress of the ACSAD programme to compile a soil map 1 : 1,000,000 of all Arab countries. Establishment of contacts with the national soil correlators/soil surveyors of all Arab countries, and preliminar arrangements for the collection of soil monoliths in several of these countries.

(80/7) Informal Consultation in Sofia on an International Reference Base for Soil Classification, organized by FAO, Unesco, UNEP and ISSS; May 1980. Participant: W. G. Sombroek.

Agreement between representatives of the convening organizations and of several major soil classification systems that an international reference system is now much needed, especially for application by developing countries. The legend terminology of the FAO/Unesco Soil Map of the World project is to be taken as starting point. An international Working Group is to be established, to work out details in the forthcoming years (see also section 7.1).

(80/9) Discussions in Paris on the joint ISM-Unesco/MAB soils Programme, May 1980. Participants: W. G. Sombroek and the Unesco associate experts A. van Kekem, H. van Reuler and R. Breimer.

Agreement on methodology to be applied at soil studies in the MAB biosphere reserves and research sites. Identification of priority study areas in Latin America, Africa and South-East Asia. Agreement on financial facilities and details of backstopping function of ISM (see section 4.1).

(80/10) Soil monolith collection trip to Kenya, May 1980. Participant: J. H. V. van Baren (see section 3.1).

(80/11) Visit to British Soil Institutions, viz. Soil Survey of England and Wales, and Lethcombe Laboratory of the Agricultural Research Council, July 1980. Participant: D. Creutzberg.

Discussions on soil monolith collection in England (see section 3.1) and the feasibility of demonstration at ISM of the effects of different soil tillage practices.

(80/12) Seventh Latin American Soil Science Congress, in San Jose - Costa Rica, organized by the Asociacion Latino-americano de la Ciencia del Suelo, June 1980. Participant: W. G. Sombroek.

Establishment of contacts with soil scientists of the region. Collection of information on soil survey work and agroclimatological zonification being carried out by national and regional institutions.

(80/12) Visit to Colombian Soil Institutions, viz. the Departamento de Suelos of the Instituto Geografico Agostin Codazzi (IGAC), and the Centro InterAmericano de Fotointerprétacion (CIAF), July 1980. Participant: W. G. Sombroek.

Discussions on forms of cooperation between ISM and IGAC, in particular on support for the establishment of a national soil reference collection in Bogotá (to be carried out in 1981); with funding to be sought from the Dutch Directorate for Development Cooperation.

(80/13) Soil monolith collection trip to Poland, July 1980. Participant: D. Creutzberg (see section 3.1).

(80/14) Twelfth Technical Meeting of the Hungarian Soil Science Society in Kaposvár-Budapest, September 1980. Participant: W. G. Sombroek.

(80/15) International Symposium on Paddy Soils in the People's Republic of China, and visit to the Nanjing Institute of Soil Science, October 1980. Participant: W. G. Sombroek.

Acquaintance with high-intensity rice cropping of China and the effects thereof on various soils. Agreement on a programme of cooperation between ISM and the Nanjing Institute for joint monolith collection and classification correlation of the main soils of China (to be carried out in 1982, funding to be sought from the respective national Academies of Science).

(80/18) Meeting in Washington of the Advisory Panel on the Soil Management Support Services programme of USAID/USDA Soil Conservation Service, December 1980. Participant: W. G. Sombroek.

Review of the achievements of this new programme of US technical assistance, concentrating on the wider use of the US Soil Taxonomy System of soil classification in developing countries. Recommendations on the scope and functioning of the programme. Discussions on the progress of the collection of US soil monoliths for ISM by American soil scientists (see section 3.1). Agreement that ISM obtain photonegatives of the world coverage (600 sheets) of soil maps scale 1 : 1,000,000 as prepared by the World Soil Geography office of the US Soil Conservation Service.

7 INTERINSTITUTIONAL RELATIONS

7.1 International relations and activities

FAO

The traditional close contacts have been maintained during the year. Several times discussions were held on ways and means of cooperation on an envisaged programme of updating the FAO/Unesco Soil Map of the World, and on elaboration of the FAO/Unesco Soil Legend into an International Reference Base for soil classification.

Unesco

The cooperation with Unesco has taken a new dimension by the support that ISM gives to the Unesco-MAB programme through three Dutch associate experts that are to work from the Unesco regional offices for Southeast Asia, Africa and Latin America for the study of soils in the MAB Biosphere Reserves and Research Sites. A "memo of understanding" has been drawn up between ISM and Unesco specifying the methodology to be followed, the form of the backstopping, and details of the funding for the frequent travels of the associates in their respective regions (for further details see section 4.1).

UNEP

Useful contacts have been established with this relatively new UN organization on environmental matters both with its Headquarters in Nairobi, Kenya and its Liaison Office in Geneva, Switzerland. The cooperation has centered on exchange of information on desertification and the elaboration of a "World Soils Policy" (details hereon are given in the ISSS Bulletin no. 57, 1980/1).

A request has been submitted to UNEP for a four-year programme support to ISM, to speed-up the establishment of a referential collection and documentation of world soils, with special emphasis on developing countries and desertification areas. This request has been accepted in principle and will be considered for funding in 1982.

ISSS

Relations have understandably continued to be close, because of the housing at ISM of the Secretariat-General of this international organization of all professionals in soil science.

Particularly close contacts has been maintained with the Chairman and other Officers of ISSS Commission V (soil genesis, classification and cartography), in view of the plans to arrive at a FAO/Unesco/ISSS International Reference Base for soil classification (cf. Sofia meeting, mission report 80/7 and the ISSS Bulletin No. 57, 1980/1).

European Commission

A proposal has been submitted, through Dr. J. Schelling of Stiboka, to the Land Use Programme Committee of the European Commission for financial support to the establishment at ISM of a reference monolith collection and publication of major West-European Soils, linked with the forthcoming 1 : 1,000,000 soil map of the EC countries (which uses the FAO/Unesco legend terminology). As the costs involved proved to be too high, a more modest proposal, involving only the unified laboratory analysis of representative European soils, may be submitted instead.

International Committees on Soil Classification

Staff of ISM are members of all of the US Sponsored Committees on improvement of the US Soil Taxonomy system of classification (ICOMLAC, ICOMOX, ICOMAND, ICOMMORT, etc; see ISSS Bulletin 57). The results of the work of these Committees are gaining extra international significance in view of the proposed International Reference Base for Soil Classification. All reports, papers and field data, including slides, of the Committees will therefore be collected at ISM, and it intends to actively promulgate the results.

The Director took part in an international workshop on the classification of soils of arid regions, hosted by the Arab Centre for the Studies of Arid zones and Dry lands (ACSAD). This workshop resulted in a number of new contacts with leading soil scientists of the Arab countries of North Africa and the Middle East. (see also mission report 80/6)

Brazilian and Japanese soil scientists have prepared new approximations of their national soil classification systems, both of which contain valuable elements for international correlation.

Others

The proposed International Board of Soil Resources Management (IBSRM), to deal with soil constraints in the tropics and subtropics, is still on the planning board. Funds are being sought from CGIAR (Consultative Group on International Agricultural Research). If it indeed comes off the ground, possibly through ISNAR - The Hague, then ISM by its nature will be closely involved or even forms part and parcel of this new organization.

The coordinator of the IFEAS "Save Our Soils" Project, which is partly funded by DGIS, has requested ISM's assistance at the soil correlation work needed for its respective study areas in a number of developing countries.

The contacts with the Benchmark Soils Project of the USAID/Universities of Hawaii and Puerto Rico have been strengthened, also in view of the proposal that there will be a follow-up, together with FAO. This would entail the establishment of an International Network of Benchmark sites for Agrotechnology Transfer (INBAT) where not only soils, but also climate and crop performance will be studied and monitored in great depth, also in view of further developing criteria for land evaluation under different management systems.

Cooperation with US Development agencies includes also the ISM participation in the Advisory Panel of the Soil Management Support Services (SMSS; see mission report 80/18).

7.2 National relations and activities

- the cooperation with the Royal Tropical Institute (KIT) has been formalized through an official Agreement of Cooperation.
- The cooperation with the neighbouring Department of Soils and Geology of the Agricultural University has been further strengthened, in line with the existing Agreement of Cooperation.
- Working contacts have been maintained with the Soil Survey Institute (Stiboka) in particular with regards to the micromorphology project in India and the soil mapping for Kenya.
- The Netherlands Foundation for the Advancement of Tropical Research (WOTRO) has been requested for travel funds to identify the feasibility of soil studies in two national parks/reserves in Kenya and Uganda respectively, following suggestions of the local authorities.
- As member of IAC's Projects Advisor Committee (PAC) and of a subcommission on associate experts of the Advisory Committee on Development experts (ACD), the Director has been advising on aspects of Dutch Technical Assistance in the Agricultural sphere.
- Contacts have been established with the Royal Academy of Sciences (KNAW) in Amsterdam, partly in connection with a proposed scientific exchange programme with the Nanjing Institute of Soil Science of the Academia Sinica.
- The Director is setting up a Dutch Contact Group on the development of an International Reference Base for Soil Classification.

Lectures

As in the preceding years staff members of ISM gave a series of lectures in the course "Soil and Erosion Survey ITC" in Enschede on soil genesis and soil classification (Van Baren and Creutzberg) and on physico-chemical aspects of soil formation (Van Reeuwijk).

Single lectures were presented at a joint meeting of the Royal Academy of Sciences (KNAW) and the ICIPE Board in Amsterdam on the philosophy of soil classification (Sombroek); at a meeting of the Royal Dutch Society for Geography (KNAG) in Amsterdam on desertification (Van Baren, see section 2.2); and at the University of Leiden on Amazon soil resources (Sombroek).

8 PUBLICATIONS

8.1 Soil Monolith Papers

In 1980 a new start was made with the Soil Monolith Paper (SMP) series. A Soil Monolith Paper is to provide information on a FAO-Unesco soil unit, using a soil monolith as a typical example. Thus, the number of SMP's may eventually reach 106, being equal to the number of soil units.

The contents of a SMP may be summarized as follows:

1. General regional and global information on the soil unit.
2. Regional environmental setting.
3. Soil genesis and soil classification.
4. Land qualities and land evaluation.

The paper will contain relevant figures and tables, while also a selection of eight slides will be added to each SMP showing field profile, soil monolith, landscape, micromorphological features and the like.

The selection of soil monoliths that will be the subject of a paper is based on the following criteria:

- representativeness for the FAO-Unesco soil unit.
- occurrence in an area that is indicated as such on the Soil Map of the World or that is characteristic for the occurrence of the soil.
- geographical extent of the soil unit over the world.
- the available sample- and analytical material.
- the quality of the documentation (slides, field profile descriptions, etc.)

Three Soil Monolith Papers are in the course of preparation: SMP 1 on a Thionic Fluvisol (Thailand 1), SMP 2 on a Orthic Ferralsol (Zambia 2) and SMP 3 on a Placic Podzol (Ireland 9), while 13 other monoliths have been provisionally selected for future publications, notably: I16, a Humic Andosol from Italy; E3, a Chromic Vertisol from Spain; ZA11, an Orthic Solonetz from South Africa; TR8, a Calcic Xerosol from Turkey; RB1, a Chromic Cambisol from Botswana; I4, a Chromic Luvisol from Italy; E4, a Vertic Luvisol from Spain; F22, a Gleyic Podzoluvisol from France; Z8, a Ferric Acrisol from Zambia; ZA11, a Plinthic Acrisol from South Africa; Z10, a Dystric Nitosol from Zambia; EAK 16, a Humic Nitosol from Kenya; and Z5 Xanthic Ferralsol from Zambia. During the year the ISM staff has put much effort to define the standards of the SMP series. The scientific level should be comparable to that of well known international journals. It is hoped to reach a broad public of students, soil scientists and other interested persons.

The Soil Monolith Papers will be written and edited either by the staff of ISM, or by guest researchers. People interested in making a contribution to the SMP series as guest researcher are hereby invited to apply to the Director of ISM (see also section 5).

8.2 Technical papers

In the course of this year some progress was made with the preparation of *Technical Paper no. 2,* entitled: The photography of soils and associated land-scapes, by J. M. Ragg and D. Creutzberg. The paper is based on a manuscript by Mr. J. M.

Ragg of the Soil Survey of England and Wales. It is intended to provide guidelines for soil scientists with only a superficial knowledge of photography.

ISM staff has suggested a number of additions and amendments and included a number of tables and diagrams to the original manuscript. The authors have discussed the refinements of the Technical Paper during visits to ISM by Mr. Ragg and to the U.K. by Mr. Creutzberg. The final text is now being edited by Mr. Ragg.

Field extract of "Soil Taxonomy"

Since the publication in 1975 of "Soil Taxonomy" (Agric. Hdb. 436, Soil Conservation Service, USDA, 754 pp.) it became apparent that there was a need for a small and handy book containing the essentials of the system, which could be used with more ease than the original edition. In 1980, ISM prepared such a handy field extract (size 11×25 cm, 95 pp) containing the definitions of all diagnostic characteristics in a shortened form, the family differentiae in full as well as the key to orders, suborders and great groups. The relevant sections of the approved amendments of May 1978 are also included. The USDA/SCS has granted permission to publish this Field Extract under ISM's name.

8.3 Annual report 1979

An annual report over the year 1979 has been issued this year, giving details on the institutional developments, activities of the sections, travel and mission reports, interinstitutional relations, publications and personnel. It also includes an article by W. G. Sombroek on "Soils of the Amazon region and their ecological stability".

As for six years no annual reports have been issued, some activities and developments of the past years are given as well. It is the intention to issue from now on such reports every year.

Visit of a Russian delegation to ISM, September 11, 1980. Prof. A. Bayev and Prof. V. Kovda inspecting a soil monolith in preparation.

9 PERSONNEL

9.1 ISM Board of Management

Members of the Board of Management were on December 31, 1980:

- Prof. Dr. Ir. G. H. Bolt, Chairman Netherlands Advisory Council.
- Prof. Dr. L. van der Plas, Agricultural University Wageningen.
- Ir. J. B. Ritzema van Ikema, International Institute for Aerial Survey and Earth Sciences (ITC), Enschede.
- Ir. R. P. H. P. van der Schans, Division 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 and 1979.
Members of the IAP on December 31, 1980, were:

- Prof. Dr. G. Aubert, ORSTOM, Bondy, France.
- Dr. F. di Castri, Unesco, Paris, France.
- Dr. R. Dudal, FAO, Rome, Italy.
- Dr. S. Holzhey, USDA-SCS, Washington, USA.
- Dr. R. Herrera, IVIC, Caracas, Venezuela.
- Prof. Dr. V. A. Kovda, Moscow State University, Moscow, USSR.
- Dr. R. S. Murthy, National Bureau of Soil Survey and Land Use Planning, Nagpur, India.
- Dr. A. M. Osman, ACSAD, Damascus, Syria.
- Dr. S. Pereira Barreto, ORSTOM, Dakar, Senegal.
- Dr. L. D. Swindale, ICRISAT, Hyderabad, India.

9.3 Netherlands Advisory Council

Members of the NAC on December 31, 1980 were:

- Ir. J. G. van Alphen, International Institute for Land Reclamation and Improvement (ILRI), Wageningen.
- Prof. Dr. Ir. J. Bennema, Department of Soil Science and Geology, Agricultural University Wageningen.
- Prof. Dr. Ir. G. H. Bolt, Department of Soils and Fertilizers, Agricultural University Wageningen (Chairman).
- Dr. Ir. J. C. Dijkerman, M.Sc. Course Soil and Water, Agricultural University Wageningen.
- Prof. Dr. Ir. A. van Diest, Royal Netherlands Society of Agriculture, Wageningen.
- Dr. Ir. Th. J. Ferrari, Institute for Soil Fertility, Haren.

- Prof. Dr. Ir. D. Goosen, International Institute for Aerial Survey and Earth Sciences (ITC), Enschede.
- Ir. B. van Heuveln, State University of Groningen.
- Dr. F. Kadijk, Laboratory for Soil and Crop Testing, Oosterbeek.
- Prof. Dr. Ir. F. R. Moormann, State University of Utrecht.
- Ir. A. Muller, Royal Tropical Institute, Amsterdam.
- Ir. J. C. Pape, Soil Science Society of the Netherlands, Wageningen.
- Dr. Ir. J. Schelling, Soil Survey Institute (Stiboka), Wageningen.
- Drs. J. F. Th. Schoute, Free University, Amsterdam.
- Prof. Dr. Ir. A. P. A. Vink, Laboratory for Physical Geography and Soil Science, University of Amsterdam.
- Ir. W. van Vuure, Division for Agricultural Research, Ministry of Agriculture and Fisheries, Wageningen.
- Dr. Ir. G. P. Wind, Institute for Land and Water Management Research (ICW), Wageningen.

9.4 ISM Staff

9.4.1 Present Staff

On December 31, 1980 the ISM Staff members were:

Director	: Dr. Ir. W. G. Sombroek
Soil curator	: Drs. J. H. V. van Baren
Micromorphologists	: Drs. D. Creutzberg Ing. R. O. Bleyert
Head of Laboratory	: Dr. Ir. L. P. van Reeuwijk, M.Sc.
Documentalist	: (vacancy)
Educational officer	: Dr. O. C. Spaargaren
Laboratory analysts	: J. R. M. Huting A. J. M. van Oostrum R. A. Smaal (seconded by ITC)
Technicians:	
- impregnation, technical services	: W. Bomer
- photography and drawing	: W. C. W. A. Bomer
- thin section preparation	: J. D. Schreiber
Internal administrator	: J. Brussen
Clerical staff	: Mrs. P. C. van Leeuwen Mrs. A. C. Reyerse
Service staff	: Mrs. J. C. Jonker-Verbiesen Mrs. J. Nijhuis-Möller
External administrator	: Managing Director, ITC, Enschede

9.4.2 Mutations in Staff

The following staff members left ISM during 1980:

- Ir. A. de Sitter, who joined in 1979 as a documentalist with a fixed term contract. He was not only responsible for the establishment of a documentation of soil maps and reports for each country, but also for laying contacts with soil survey organizations, publishers of soil and related thematic maps, etc.
- Mrs. G. J. Giesen-Peters, who joined in 1977 as a secretary after the transfer of ISM to Wageningen. She ably organized the administration and archives of ISM. She resigned becaused of the birth of her first child.

The following staff members joined ISM during 1980:

- Mrs. A. C. Reyerse, as part-time secretary. She has gained experience as a secretary at various institutes in Wageningen.

Occasionnally, the ISM employs people on a task basis. In 1980 they were:

- Mr. B. C. P. H. van Baak, librarian, for map filing.
- Ir. P. Martens, who continued the work of the documentalist.

9.5 Guest researchers and trainees

The following scientists have received hospitality at ISM for research or for training purposes:

Dr. Ir. R. Oldeman, coming from Indonesia.
Dr. D. L. Mokma, USA.
Dr. W. Siderius, coming from Kenya.
Mr. R. D. Asiamah, Ghana.
Drs. R. Hillen, Amsterdam.
Mr. M. L. Manchanda, India.
Ir. R. F. Breimer, going to Latin America.
Ir. A. J. van Kekem, going to Africa.
Ir. H. van Reuler, going to Southeast Asia.
Mr. Do Thank Ren, Vietnam.
Mr. Nguyen My Hoa, Vietnam.
Mr. Tram Kim Tink, Vietnam.
Mr. Vo Thi Guong, Vietnam.

APPENDIX A - List of visitors in 1980

Groups of professional visitors

National	
LH Bodemkunde	65
LH Cultuurtechniek	30
LH Trop. Plantenteelt	30
LH Landb. Plantenteelt	30
UvA Fys. Geografie	20
VU Fys. Geografie	15
RUG biologen	40
TH Delft Hydrologie	30
HLS Deventer	25
HLS Dordrecht	60
HLS Den Bosch	100
HLTS Rijswijk	70
MLTS Kerk-Avezaath	70
MTS Velp	35
MTS Utrecht	35
MO Aardrijksk. Utrecht	25
Stiboka	15
Planologische Dienst	15

International	
Université de Paris	15
Groupe d'étudiants de la Bretagne et Vendée	15
Kath. Univ. Leuven	55
Universität Hamburg	30
Universität Bochum	15
Universität Giessen	40
Universität Osnabrück	25
Polyt. College Portsmouth	25
University of Leeds	10
Int. Course on Hydrology (Delft)	20
Int. Course Soil and Erosion Survey ITC	45
Int. Drainage Course (Wageningen)	30
Training course FAO Fertilizers Programme	20
Board of ISNAR	10
Workshop Ultra-microscope techniques	10
Congres Int. Potash Institute	40
EEC Seminar on Soil Degradation	20
Int. Symp. on Land Evaluation for Forestry	15

Groups of non-professional visitors

National	
Natuurwetenschappelijk Gezelschap Wageningen	50
Wageningse Bejaarden	15
STOVA Wageningen	95
Vereniging van Havenmeesters	75
Wagenings Lyceum	50
Heldring College Zetten	15
Rijksscholengemeenschap Bussum	55
Eemland College Amersfoort	45
Min. van Landbouw "Ideeënbus"	50

International	
Foreign Student Service (NUFFIC)	75

Totals of group visitors

	national	international	total
professional	710	440	1150
non-professional	450	75	525
total	1160	515	1675

Names of visitors from abroad in 1980

Official representatives of international organizations

P. Arens (FAO)
K. M. Badruddozo (ISNAR)
B. M. I. Bengtsson (ISNAR)
G. T. Castillo (ISNAR)
L. B. Crouch (ISNAR)
R. K. Cunningham (ISNAR)
J. Diouf (ISNAR)
D. Gabriëls (ISSS)
W. G. Gamble (Dir.-Gen. ISNAR)
L. S. Hardin (ISNAR)
W. A. C. Mathieson (ISNAR)
I. E. Muriithi (ISNAR)
G. A. Pendergast (EEC)
M. F. Purnell (FAO)
S. A. Qasem (ISNAR)
V. W. Ruttan (ISNAR)
E. Saouma (Dir.-Gen. FAO)
H. A. Steppler (ISNAR)
W. Treitz (ISNAR)

Visitors per country

Afghanistan
M. Q. Yusufi

Albania
A. Bashu
H. Hebili
L. Veshi

Argentina
O. M. Casamiquela
A. De Petre
L. R. Figueroa

Australia
J. Brouwer
P. Fogerty
D. Guilfoyle
C. Hall
P. Halvey
A. Honan
K. Martin
R. Morris
J. Velde
C. Wells

Bangladesh
W. Z. Akonda
K. M. Edris
A. Mahbood
A. Qwader
A. K. M. Sharif
M. Taufiqul Arif

Belgium
L. Aerts
A. Andries
F. Bodart
J. Boudewijn
P. Brebels
S. Bros
B. Champigonneke
J. Delbaere
F. Delecour
J. Delvaux
W. De Swert
P. D'Hertefeld
A. D'Huys
A. Ectors
P. Haerebrauch
P. Herlout
L. Hoefkens
J. Looyen
J. Martens
J. Perele
L. Rossew
R. Vandenbroek
H. Vandendriessche
K. Van Kerrebroeck
J. Van Steenwinkel
J. Verheyen

Bolivia
J. C. Quiroga Mendizabal
F. Sarovia

Brazil
R. Alves de Lima
E. Arain
G. Beekman
M. Beekman
M. C. Dirickson Perazza
N. Kämpf
P. C. Molina
J. J. de Oliveira
E. Santiago
H. H. Suguino

Burma
T. Myint
U. A. Nyuni
U. M. Wai

Bulgaria
M. Penkov

Canada
J. S. Nichols
L. J. P. Van Vliet

China
Cheng C.-T.
Chui I.-C.
Lin P.
Lui H. H.
Tang X.-W.
Tseng Y.-N.
Yu H.-P.
Lin J.-K.
Wang T.-S.

Colombia
A. Alvaro Calaro
E. Cuesta
N. Weeda

Cyprus
C. Photiou

Czechoslovakia
P. Horvàth
B. Novàk

Denmark
L. Hansen
L. Larsen
S. B. Nielsen

Dominican Republic
F. Bautista

Egypt
M. A. S. Ashry
K. Elscherief
M. Mashali
F. B. Moustafa
H. G. Nada
A. B. Sekkina
M. Sowelim
Y. S. Youssef

Eire
P. Drennan
A. J. Cole
D. McGrath
B. Shanahan
J. Walsh

Ethiopia
B. Desto
M. Godana
S. Habte
T. Woudeneh

Fed. Rep. of Germany
H.-J. Altemüller
R. M. Bader
E. Egenoff
A. Elborg
H. Fölster
G. Freitag
Z. Gracanin
R. Gur
E. Haaze
B. Hahn
G. Hauptmann
W. Hellebreemd
M. Hellwig
B. Hintze
E. Honius
U. Jungkunz
N. Jürgers
T. Kleineidam
A. Knuth
H. Krogmann
B. Maasz
U. Martin
C. Melchert
H. Meyer
H.-U. Nerie
W. Ochmann
N. Pfitzmann
H.-H. Preusse
H. U. Preusse
T. Preusse
U. Reichenbach
H. Reisach
J. Rohwer
D. Rösle
R. Rossow
D. Sauerbeck
S. Schaafhausen
H. W. Scharpenseel

FR Germany (cont'd)
M. Schauer
D. Schröder
U. Schwan
S. Schwarz
P. Stander
S. Stephan
C. Thien
C. Von Sert
M. Weiss
G. Werner
Th. Wollersen
H. Zakosek

Finland
P. Mäkkinen
A. Ritari

France
E. Anavy
J. Anavy
G. de Beaucorps
P. Bellot
L.-M. Bresson
M. Chevery
J. Chretien
P. Curmi
J. Ducloux
P. Dutil
N. Federoff
A. de Framond
B. Genere
A. Gerard
A. Guerin
A. Guyon
J. Herbert
J. R. Jacq
A. Jaoul
T. Lefèbre d'Heuencourt
C. Marius
F. Nicollas
G. Pedro
S. Pellerin
P. Savalle
R. H. Tanguy
D. Tessier

Gambia
S. M. Jabang

Ghana
S. A. Amankwah
R. D. Asiamah
K. Nyalemegbe

Greece
G. Nakos
H. Raftoprulos
M. Sabatakakis
D. Tsotsos
P. Zikos

Hong Kong
Ching C.
K. Styles

Iceland
A. Snaebjörnsson

India
A. D. Adoni
J. S. Ahuja
K. Gopalakrishna
P. B. Kinnera
M. S. Kuhad
M. L. Manchanda
P. Mandal
A. D. Patil
A. S. Sastry
V. Sriramula
H. S. Teotia

Indonesia
M. Al-Jabri
S. Alwi
J. K. Bulo
T. Dihardja
M. Harijogjo
J. Koswara
B. Mubien
J. L. Nanere
S. Nurumi
M. Rusadin
N. Salubi
M. Sayoso
Y. Suhardjaja
M. Widianto
M. Widjawati
T. Yunianto

Iraq
Y. M. H. Alany

Israel
A. Blum
A. A. Cohen
O. Goland

Italy
G. Chisci
D. Magaldi
M. Peglio

Ivory Coast
C. Valentin

Jamaica
V. A. Campbell

Japan
K. Sato
K. Yamagiwa
M. Yamagiwa

Jordan
Z. Al-Wadi

Kenya
P. Ewagata
H. Kangu
K. S. Kuloba
E. Muchunu M.
A. S. K. Mwangi
J. P. Rakwach
W. Siderius
A. W. Wanjala
K. Zadock

Korea
Chao S. K.
Cheong O. B.
Jun S. H.
Kim H.-K.
Rhee Y.-C.
T. Van Achthoven

Malawi
Z. D. Jere
F. T. Kalanda
W. E. Kayuni

Malaysia
Cajetan P.
Hashim B. D.
Law K. F.

Mali
P. N. de Leeuw

Mexico
G. Iniguez
A. Saldana Pedroza

Morocco
A. Souirji

Mozambique
J. M. Salomao

Nepal
K. R. Adhikary
M. M. Baida
T. R. Bixta
G. P. Mandal
S. S. Shrestha
D. Vohara

Nigeria
O. Abdegbilero
F. O. R. Akaningbo
O. A. Begho
A. 'Bisi Farinde
O. Igiri
H. Labaran
N. Mgbemena
O. A. Ogbonnay
E. M. B. Ogbun
N. A. Ojalade
U. C. Okena
O. T. Olatunji
A. Otchere
M. Salihu
C. O. Udodi

Pakistan
M. Arshad
M. Y. Haved
A. O. Sisiqui

Peru
J. G. Chuquiure S.
M. D. Peréz
H. E. Sanchez Flores

Philippines
M. M. Agua
E. Gugnosen
A. P. Gianan
N. S. Ioanan
A. C. Rimas

Poland
M. M. Borys

Portugal
L. de Oliveira
O. de Oliveira
E. Portella
L. F. C. S. dos Reis

Sierra Leone
J. A. Eschweiler
M. R. Labai
G. C. Nyoka
L. Touber

Singapore
Pui M.
Pui S. K.
Wong K. Y.

South Africa
J. Le Roux

Spain
M. Gamboa

Sri Lanka
C. D. Gangodawila
S. Ghanakumar
L. S. S. Jayasundera
R. M. Kularatna
P. B. Samaralava

Sudan
A. H. Ahmed
H. A. Dawoud
M. Elmadi E.
H. A. Kamal
A. R. Osman
I. A. Osman
A. B. Saeed
S. A. Sulienan

Sweden
S. Sedin

Switzerland
J. J. Oertli
E. Rosenast

Syria
J. O. Job
I. Sate

Tanzania
I. K. Jullaya
A. C. Leget
S. Msaki
T. L. Mulamula
H. O. L. Ngohzto
C. Nyeupe
L. Pleizier
R. M. Shoo
J. R. Vedante

Thailand
O. Apibarlpuvanart
S. Chaiwatnanodon
U. Charuratana
C. Chernisi
C. Kasiyaratin
S. Koossalaperom
M. Nimit
P. Purabol
S. Sathasin
S. Siripong
K. Sroytong
T. Teeradej
P. Thongma

Tonga
M. Vakante

Trinidad
R. Salandy

Turkey
H. Emecem
S. Ozaner
S. Senol

Uganda
M. A. Bekunda
C. M. R. Muheki

United Kingdom
G. F. Albany Ward
B. Avery
M. Avery
J. F. Binny
R. M. Bishop
E. M. Bridges
R. C. S. Bunn
G. Cooke
D. B. Davies
D. B. S. Fitch
R. J. Gibbs
M. Goss
J. Green
A. N. Maywood Smith

U.K. (cont'd)
P. Loveland
C. Mahony
P. Newbould
R. E. F. Heslop
A. E. Johnston
M. D. Kinsella
E. Kirkby
J. Lawson
T. Leening

C. Pike
D. W. F. Prior
D. H. W. Roberts
S. Sadi
F. E. Sanders
B. Simpson
W. T. Thomson
P. A. Waters
J. Wood

Upper Volta
M. Jordans

U.S.A.
L. J. Anderson
M. Anderson
D. Botto
R. Briles
W. Collins
A. Edwards
V. Gamble
G. Hardy
H. Ikawa
D. L. Mokma

U.S.S.R.
A. Bayev
V. Kovda
E. Mishustin

Venezuela
J. A. Comerma
W. Peters

Vietnam
Do Thank Ren
Levan Can
Nguyen My Hoa
Tram Kim Tinh
Vo Thi Guong

Yougoslavia
S. Vlustelicu

Zimbabwe
O. T. Mandiringana

APPENDIX B Institutes, organizations and agencies responding to ISM's call for maps and publications

Argentina
INTA
Centro de Investigaciones
de Recursos Naturales
Buenos Aires
(C.O. Scoppa)

Austria
Geogr. Inst. Universität Wien
Universitätsstrasse 7
A-1010 Wien
(J. Fink)

Inst. Bodenforschung Baugeol.
Univ. Bodenkultur
Gregor-Mendel-Strasse 33
A-1180 Wien
(W. E. H. Blum)

Bangladesh
Dept. of Soil Survey
Soil Surv. Interpr. Proj.
UNDP/FAO
P.O. Box 224, Dacca-2
(M. F. W. Zijsvelt)

Belgium
Lab. Fys. Aardrijksk. & Bodem-
studie
Geologisch Instituut RUG
Krijgslaan 271
B-9000 Gent
(F. de Coninck)

Bolivia
Servicio Geologico
Casilla de Correo 2729
La Paz
(C. E. Brockmann)

Botswana
Ministry of Agriculture
Dept. of Field Services
Private Bag 003
Gaborone
(D. J. Eldridge)

Brazil
EMBRAPA
Serv. Nac. de Levantamento
e Conservaçao de Solos
(M. N. Camargo)

Brunei
Dept. of Agriculture
Brunei
(A. W. Allen)

Burundi
Université du Burundi
Fac. Sciences Agronomiques
B. P. 2940
Bujumbura
(L. Tack)

Colombia
Inst. Geogr. "Agustin Codazzi"
Subdireccion Agrologica
Bogotá
(M. P. Hernandez, L. D. Lopez)

Denmark
Bureau of Land Data
Ministry of Agriculture
Enghavevej 2
DK-7100 Vejle
(F. D. Mathiesen)

EEC
Div. de l'Environnement
Conseil de l'Europe
Strasbourg
(P. Baum)

El Salvador
Dept. de Suelos
3e Calle Oriente No. 1-5
Santa Tecla
(S. Molina H.)

Ethiopia
UNECA
P.O. Box 3001
Addis Abeba
(A. M. Wassef)

FAO
AGLS
FAO-Headquarters
Via delle Terme di Caracalla
00100 Roma, Italy
(A. Pecrót)

Finland
Agric. Research Centre
Inst. of Soil Science
PL 18
SF-01301 Vantaa 30
(L. Urvas)

Geol. Survey of Finland
Information Bureau
SF-02150 Espoo-15
(E. Vainio)

France
Serv. Central Documentation
ORSTOM
70-74 Route d'Aulnay
73140 Bondy
(P. Rondeau)

Hungary
Res. Inst. Soil Sc. Agric. Chem.
Hungarian Acad. of Sciences
Herman Otto Üt 15
H-1525 Budapest
(I. Szabolcs)

India
National Bureau of Soil
Survey & Land Use Planning
Seminar Hills
Nagpur-440006
(R. S. Murthy)

Jamaica
Ministry of Agriculture
Rural Physical Planning Unit
Western Region
16 East Street
Montego Bay
(J. J. Scholten)

Kuwait
Soil & Irrigation Section
Dept. of Agriculture
Min. of Public Works
Kuwait
(W. Farawana)

Lesotho
UNDP
P.O. Box 301
Maseru
(T. A. J. Hendriksen)

Liberia
Mano River Union
P.M. Bag 9050
Monrovia
(W. J. Veldkamp)

Malawi
Chitedze Agric. Res. Centre
P.O. Box 158
Lilongwe
(E. M. Ntokotha/
M. Mugemezulu)

Mozambique
Inst. Invest. Agron.
C.P. 1199
Maputo
(A. Jansen)

Nepal
Min. Food, Agric. & Irrigation
Dept. of Agriculture
Div. Soil Sc. & Agric. Chem.
Khumaltar, Lalitpur
(P. L. Maharjan)

New Zealand
Rural Dev. & Ext. Centre
Lincoln College
Canterbury
(J. E. Fenwick)

Papua New Guinea
Dept. of Primary Industry
Land Use Section
P.O. Box 1863
Boroko
(V. Gainey)

PDR of Yemen
AL-KODIGIAR
Proj. Improv. Crop Prod.
UNDP/FAO
P.O. Box 1188
Aden
(A. S. Al-Dukail)

Peru
ONERN
Calle 17 No. 355
Urb. El Palomar-San Isidro
Apartado 4992
Lima
(M. Mendoza & E. A. Autero)

Portugal
Dept. of Soils
Inst. Superior de Agronomia
Tapada de Ajuda
1399-Lisboa-Codex
(R. Pinto Ricardo)

Puerto Rico (U.S.A.)
Universidad de Puerto Rico
Coll. of Agric. Sciences
Mayaguez
Puerto Rico 00708
(F. H. Beinroth)

Sierra Leone
Land Resources Surv. Proj.
P.M.B. 187
Freetown
(D. C. Schwaar)

South Africa
Loxton, Hunting and Assoc.
P.O. Box 39265
Bramley 2018
Johannesburg
(B. J. van Niekerk)

Soil and Irrigation Res. Inst.
Dept. of Agric. & Fisheries
P.B. X 79
Pretoria
(C. M. MacVicar)

Potchefstroom University
Inst. f. Pedological Research
2520 Potchefstroom
(H. J. von M. Harmse)

SASA Exp. Stat.
P.O. Mount Edgecombe, 4300

Surinam
Dienst Bodemkartering
Rust en Vredestraat 79-81
Paramaribo
(E. C. Tjoe Awie)

Swaziland
Min. of Agric. and Coop.
Agriculture Dept.
P.O. Box 162
Mbabane

Switzerland
Eidg. Forschungsanstalt
f. Landw. Pflanzenbau
Zürich-Reckenholz
Postfach 8046 Zürich
(K. Peyer)

Thailand
Soil Survey Division
Land Development Department
Bangkhen Bangkok 9
(S. Panichapong)

Trinidad
Min. of Agriculture
Central Exp. Stat.
Centeno (Arima Post Office)
(W. E. Searl)

United Kingdom
Land Resources Dev. Centre
Min. of Overseas Development
Tolworth Tower
Surbiton, Surrey
England KT6 7DY
(P. E. Harding, S. E. Turner)

U.S.A.
New York State College of
Agriculture & Life Sciences
Cornell University
Dept. of Agronomy
Ithaca N.Y. 14853
(T. R. Forbes)

USDA-SCS
Soil Surv. Class. and Correl.
P.O. Box 2890
Washington DC 20013
(J. E. McClelland,
R. W. Arnold)

Venezuela
Centro Nac. Invest. Agropec.
Min. de Agricultura y Cria
AP 4653
Maracay 2101
(J. A. Comerma)

Zimbabwe
Chem. and Soil Res. Inst.
P.O. Box 8100, Causeway
Salisbury
(W. D. Purves)

LIST OF ISM PUBLICATIONS

Technical Paper 1: Procedures for the collection and preservation of soil profiles (J.H.V. van Baren and W. Bomer). 23 pp.

Technical Paper 2: The photography of soils and associated landscapes (J.M. Ragg and D. Creutzberg) (in preparation)

Technical Paper 3: A new suction apparatus for mounting clay specimens on small-size porous plates for X-ray diffraction (L.P. van Reeuwijk). 4pp.

AIMS OF ISM

- to serve as a documentation centre on soils of the world - through its collection of soil monoliths and reports and maps on land resources 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 or regional benchmark soil 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