Science and Technology for Development Programme (STD2)
European Community, contract No. TS2* -CT91-0336

EROSION ASSESSMENT, CLASSIFICATION AND SOIL REFERENCE COLLECTION OF SOILS IN (SUB)TROPICAL CHINA WITH FOCUS ON THE YINGTAN AND HAINAN AREAS

PROGRESS REPORT NO 1.

Period: 1 October 1991 - 1 April 1992

Including the results of a workshop held in Nanjing, 25-26 March 1992

Institute of Soil Science
Academia Sinica

CHRISTIAN-ALBRECHTS-UNIVERSITÄT ZU KIEL
Institut
für Pflanzenernährung und Bodenkunde

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ORSTOM
INSTITUT FRANÇAIS DE RECHERCHE SCIENTIFIQUE POUR LE DEVELOPPEMENT EN COOPERATION

ISRIC
INTERNATIONAL SOIL REFERENCE AND INFORMATION CENTRE

CONTENTS

<u>Acronyms used in this report</u>

EC	European Community
ISS-AS	Institute of Soil Science - Academia Sinica, Nanjing, China
ISRIC	International Soil Reference and Information Centre, Wageningen, the Netherlands
IPB	Institut für Pflanzenernährung, Kiel, Germany
JL	Justus Liebig Universitat, Giessen, Germany
ORSTOM	Institut Francais de Recherche Scientifique pour le Developpement en Cooperation
RFW	Rheinischen Friedrich Wilhelms Universität, Bonn, Germany
SOTER	Soil and Terrain digital database
STD	Science and Technology for Development of Programme of the European Community

1 INTRODUCTION

1.1 History

On advice of the Science and Technology for Development Programme (STD2) of the European Community (EC) three soil-oriented cooperation programmes of four European institutions with the Institute of Soil Science - Academia Sinica (ISS-AS) were joined into one project. The broad outlines of this joint cooperation were drafted with representatives of the participating institutions and EC-STD2 during a workshop at ISRIC in Wageningen, the Netherlands, in February 1991.
Upon request of ISS-AS a workshop was held in Nanjing on 25-26 March 1992.

1.2 Summary of the 3 sub-projects

Three research projects -further referred to as sub-projects A, B and C- will be executed by the European institutions and ISS-AS. A summary of these sub-projects is given below. For details, reference is made to the sub-contracts with each of the participating institutions, copies of which were sent to the EC in February 1992.

Sub-Project	Institution	Activity and goal
A.	JL	Erosion measurements in experimental plots for the determination of the erodibility of soils.
	IPB	Spacial information compilation for the elaboration of a detailed soil/terrain erosion model.
B.	ORSTOM	Study of soil/landscape transects at exploratory level for the classification of the soil/landscape.
C.	ISRIC	Establishment of a soil reference collection and pedon-database for the classification and assessment of soil/land.

Sub-project	A	B	C	
Scale Objective Area	Detailed - Soil erodibility study - Soil variability study Area: Yingtan Red Soil Station (4×6 km)	Reconnaissance Transects study Area: Yingtan (200 km) Guangzou (200 km) Hainan (200 km)	Exploratory Major soil types study. Area: Major ecological zones (including A + B areas)	STD2 1992/1993
Results	Soil erodibility indices Detailed erosion model Detailed GIS	(pedogenetic) rules for major soil type distribution/evaluation	1. soil reference collection 2. prototype small scale pedon database (SOTER)	
	▽	▽	▽	
Follow up	Small scale Soil and Terrain Digital Database (SOTER) of 3 selected areas (200 km × 200 km) in subtropical China			STD 3 1994/1995
	Goals: - rapid access to land resource data, - land degradation and land assessment applications			
	▽			
	Applications of SOTER nation wide			1996/2000

Fig. 1 Framework of actual sub-projects and possible follow-up activities.

1.3 Personnel

At present the following persons are involved in one or more of the sub-projects:

ISS-AS		sub-project
Prof. Zhao Qiguo	Director, senior advisor to	A, B, C
Prof. Gong Zitong	Head Department of Geography, coordinator at ISS-AS of	A, B, C
Zhou Huizhen	Geo Information Systems	A
Shi Xuezhen	Dep. Head of Dept. of Geography	A
Chen Zhicheng	Head Soil Laboratory	B
Zhang Taolin	Dep. Dir. Red Soils Station	B
He Yuagin	2nd. Dep. Dir. Red Soils Station	B
Zhang Gaulin	Ph.D. student	B, C
Luo Guobao	G.I.S./ pedon database	C, A
Wang Minzhu	Director Red Soils Station, coordinator of	C
Jiang Zhengqi	fieldwork & exposition	C
JL		
Prof.Dr. J. Breburda	Coordinator of	A (A1)
RFW		
Dr. H. Zakosek	Participation in	A and B
IPB		
Prof.Dr. J. Lamp	Coordinator of	A (A2 and A3)
ORSTOM		
Dr. B. Volkoff	Coordinator of	B
Dr. C. Valentin	Crust tests	A
ISRIC		
Ir. J.H. Kauffman	Coordinator EC-China project, coordinator of	C
Dr.Ir. L.R. Oldeman	Director ISRIC, coordinator SOTER	C

1.4 Finances

All participating institutions received first instalments according to EC contract regulations (see schedule of payments in Annex 9). During the workshop detailed instructions were given on administrative matters (see annex 7).

2 PROGRESS/WORKSHOP

After approval of the proposal, the project officially started on 1 November 1991, although a number of preparations were made before this date. First missions to the Institute of Soil Science, Academia Sinica (ISS-AS) were made by participants of the Institut für Pflanzenernährung (IPB), Justus Liebig Universität (JL), Rheinischen Friedrich Wilhelms Universität (RFW) and ORSTOM in October/November 1991. Workplans were prepared and fieldwork initiated. Based on these workplans sub-contracts were made for all the participating institutions. A meeting was held at ISRIC on 22-23 January 1992 on soil erosion models for small scale databases such as the Soil and Terrain Digital Database (SOTER), with ISRIC staff, invited staff of Wageningen Agricultural University and J. Lamp of IPB.

The event was used to discuss a workplan for the A sub-project drafted by J. Lamp in October 1991 in view of the project workplans as presented in the EC-ISRIC contract. Responsibilities for the activities to be executed by IPB, JL and RFW were indicated and a STD3 follow-up proposal along the lines of the SOTER methodology was discussed. ISRIC staff indicated its concern of a possible imbalance in Dr. Lamp's workplan between the quantity of hardware and software in view of the limited time and funds to realize adequate training for ISS-AS staff to use all these PC programmes. The result of the discussions was reported separately and sent to all participating institutions and EC-STD.

Progress of the sub-projects was reported by all participants, except JL and RFW, during the workshop at ISS-AS.

2.1 Objectives of the workshop

- Define in more detail the objectives and background of the sub-projects.
- Verify efficiency/feasibility of the workplan for all parties and indicate possible constraints.
- Discuss linkages between the activities/sub-projects.
- Specify in more detail the final results to be reached within the project period.
- Maximalise the involvement of ISS-AS in all activities, in order to obtain maximum benefit.

2.2 Programme (effectuated)

25 March		
Opening	Zhao Xi-guo	
Introduction	Kauffman	
Progress report IPB	Lamp	(Annex 2)
Progress report ORSTOM	Volkoff	(Annex 3)
Workplan ISRIC	Kauffman	(Annex 4)
Progress report ISS-AS	Gong Zi-tong	(Annex 6)
26 March		
General project matters	Kauffman	(Annex 7)
Constraints	discussion	
Progress reports	discussion	
Linkage of sub-projects	discussion	
SOTER lecture	Kauffman	(Annex 10)
Follow-up proposal	discussion	

It was concluded that good progress was made during the first half year that the project is operational. For details, reference is made to the progress reports (Annex 2 to 7). It was also concluded that all teams experienced a number of unforeseen delays/ constraints. The important ones are listed in the next paragraph.

3 CONSTRAINTS

3.1 Time

The project period of two years has been mentioned as probably been too short to realize all activities. It was decided to evaluate the situation again during the next meeting, planned for October 1992. A possible extension of one or more of the Sub-projects could then be discussed.

3.2 Availability of maps and aerial photographs

Sofar the acquisition of maps [topographical, geological, soil, land-use] was cumbersome and time consuming, and in some cases has still to be realized. In relation to this, it has been mentioned during the workshop that, for some of the European participants, maps have to be taken to their home countries for further analysis. The JL team needs at least one detailed topomap and one large scale photo to

execute the planned scanning of the images for automatic image interpretation of land-use patterns. The Director of ISS-AS will investigate several possibilities to obtain the requested materials.
For consultation by all parties involved, a complete set of maps will be put on display in the exposition room of ISS-AS at the next meeting in October 1992.

3.3 Erosion indices

A number of erosion indices to be measured by ISS-AS staff at the Yingtan Red Soil Experimental Station for sub-project A1 could not be realized because of lack of instructions. JL, the responsible institution, will take care of this issue.

3.4 Sealing & crust studies

It was not clear during the workshop when these studies will be made. Volkoff will contact Valentin about the workplan.

3.5 Hydro-dynamics

Zhang Taolin mentioned that the original reference to water movement studies was not anymore included in the text of sub-project B. This activity will now be included in the forthcoming planned activities.

3.6 Final workshop

No funds are available in the present STD2 project budget for a final workshop at the Red Soil Experimental Station at the end of the project. The EC-STD will be requested to indicate the possibilities of such a workshop of 4 days to present the results of this project to staff of ISS-AS, Nanjing Agricultural University and the relevant provincial agricultural institutions in the second half of 1993.

4 FORTHCOMING WORKPLAN

Detailed workplans for activities in China and at the European institutions were made for all sub-projects and discussed during the workshop. For details reference is made to the sub-contracts and up-dated information in the annexed progress reports. For sake of optimal cooperation and linkage between the sub-projects, the future fieldwork of all European participants is planned in the period September-October 1992. Results, constraints and detailed workplans will be discussed in a second workshop. It has been decided that the second workshop of all participants will take place preferably on 15 and 16 October 1992 in Nanjing.

ANNEX 1 Participants workshop EC-China soils project in Nanjing, 25-26 March 1992

ISS-AS	ISRIC	IPB	ORSTOM
Zhao Qiguo	Kauffman	Lamp	Volkoff
Gong Zitong			
Chen Zhicheng			
Zhou Huizhen			
Luo Guobao			
Shi Xuezhen			
Zhang Taolin			
Zhang Gaulin			
He Yuagin			

ANNEX 2 PROGRESS REPORT IPB

First progress report and workplan 1992 - 1993, presented at the Nanjing workshop, 25-26 March 1992

J. Lamp
Institut für Pflanzenernährung
und Bodenkunde (IPB)
University Kiel, Germany

Zhou Huizhen & Luo Guobao
Institute of Soil Science
Academia Sinica (ISS-AS)
Nanjing, China

Sub-project A: SOIL ERODIBILITY, DETAILED SOIL VARIABILITY STUDIES AND ACCOMPANYING GEOGRAPHICAL INFORMATION SYSTEM OF THE YINGTAN AREA IN CHINA

1 INTRODUCTION

1.1 Overview of tasks

This sub-project is split-up into three themes, for which different institutions have responsibility:

A1. Soil Erodibility, JL and RFW;
A2. Geographical Information System, ISS-AS and IPB; and
A3. Soil Variability Studies, IPB.

This does not eliminate the cooperation of the groups and linkage of topics of each main theme, which is presented in Fig. 1 and Fig. 2. It should be realized that cooperation, which is essential for the total project, is favoured by a clear and specific workplan. Communication between the institutions is effectuated during missions and by correspondence. If required IPB and JL will meet in Germany.

In the following, a report and workplan are presented for parts A2 and A3, jointly by the counterparts ISS and IPB. Part A1 will be separately reported by JL.

1.2 Objectives

In addition to the tasks as given in the sub-contract, the main objective of the A2 and A3 themes is the development of a detailed soil database of the Yingtan Red Soil Experimental Station (about 600 ha) for the following tasks:
- to train ISS-AS staff in general GIS techniques (digitizing, inputting, etc.)
- to study the soil taxa variability within the smallest SOTER map-unit

<u>Sub-project</u> Perform studies at Yingtan area in Jiangxi Province on

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------\                       /---------------------------------------------\                   /----
  B   |                       | A 1:  S O I L  E R O D I B I L I T Y        |                   | C
------|                       |---------------------------------------------|------\            |----
  T   |             /---------|Runoff plot experiments     Crumb test       |      |            | S
  r   |  /-----------C--|     | (1) natural sites (woodland) Wet+dry sieving|      |            | o
  a   |  :-----------C--|     | (2) cropland                 Dispersion ratio|     |            | i
  n   |  :-----------K--|     | (3) bare soil  ------------> USLE K-factor  |      |            | l
  s   |  :              |     |Rainfall simulator            Aggreg.stability|     |            |
  e   |  :-----------C--|     | (4) different land uses      Rainfall accept.|     |            | R
  c   |  :----------EI--|     |(5) Rainfall erosivity index  Erosion index  |      |            | e
  t   |  :              |     |(6) Crust analyses(ORSTOM)    Drop test ...  |      |            | f
  s   |  :              \-----|---------------------------------------------|------/            | e
      |  :                    | J L University Giessen   + ISS  +  ORSTOM   |                   | r
  +   |  :                    \---------------------------------------------/                   | e
      |  :                                                                                      | n
      |  E=EI*SL*K*C*M (U SLE)                                                                  | c
      |  :                                                                                      | e
  C   |  :    /---------------------------------\     /---------------------------------\       |
  l   |  :    | A 2: GEO-INFORMATION SYSTEM (GIS)|    | A 3: SOIL VARIABILITY           |       | C
  a   |  : /--|---------------------------------|  /--|---------------------------------|       | o
  s   |  : | ++|(1) User requirement            |/--> ++|(1) Selecting test area        |       | l
  s   |  : | ++|(2) User skill                  |:--> +-|(2) Collecting maps+images     |       | l
  i   |  : | ++|(3) Given data resources        |:    | ++|(3) Sampling scheme          |       | e
  f   |  : | ++|(4) Funds                       |:    | ++|(4) Survey main profiles(13) |       | c
  i   |  : | ++|(5) Selecting hard+software     |:    | ++|(5) Grid boring              |       | t
  c   |  : | ++|(6) Implementation              |:    | ++|(6) Field attribute coding   |       | i
  a   |  : | ++|(7) Selecting test area   <-----|/    |   |(7) Laboratory measuremnts   |       | o
  t   |  : | +-|(8) Collecting maps+images <-----|/   |   |(8) Variogram analyses       |       | n
  i   |  : | +-|(9) Survey soil+land(semi-detail) <\  |   |(9) Interpolation            |       | +
  o   |  : |   |(10)Digitizing                  |:    | +-|(10)Detect erosion by images |       |Pedon
  n   |  : |   |(11)Data base structuring       |\--> +-|(11)Land/soil survey of total area |  |Data
      |  <SL   |(12)Constructing DTM,soil/land map|   |   |(12)Overlay landuse pattern from|    |Base
      |  \->   |(13)Construction of erosion map <-M-| |   |    images on topomap        |       |
------|     \--|--------------------------------|     \---|-----------------------------|       |-----
ORSTOM|        | ISS  AS Nanjing + IPB          |       | IPB University Kiel   +  ISS    |       |ISRIC
+ISS  |        |                                |       |                                 |       |+ISS
------/        \--------------------------------/       \---------------------------------/       \-----

   /------------------------------------------------------------------------------------------\
   | EEC-Follow-up: STD3??   "Soil and Terrain Data Base for Jiangxi and Hainan Area for       |
   |                           Erosion + Silvi/Agriculture Planning + Nutrient Management"    |
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Figure 2 Organizational diagram.

- to study the main soil genetic factors and the distribution of soil data
- to develop techniques of optimal use of maps and photographs for (semi) detailed soil survey.
- to overlay the digital terrain model with scanned photography information.

1.3 Personnel

At present the following persons are involved in the A2 and A3 studies:

ISS-AS: Zhou Huizhen (GIS), Luo Guobao (Database)

IPB: J. Lamp

For the forthcoming workplan, it is planned to include in the working group:
- an assistant for digitizing maps (about 9 man-months)
- two field workers and one assistant for the execution of the additional 300 field observations in the test area of the Yingtan red soil experimental station

2 PROGRESS AND FORTHCOMING ACTIVITIES

2.1 Proposal for hardware and software installation at ISS

Based on the overall objectives and on topics (1) to (5) of theme A2 (see figure 2), a proposal on hardware and software was made and reported in October 1991.

2.2 Selection and implementation of hardware and software
(status: March 1992)

2.2.1 Computer

PC/386 with 387 Co-processor and 200 MByte hard disk, 21 inch colour monitor with high resolution (NEC 5D) and AGC graphic board (1280*1024, 256 colours) is just installed and now being tested.

2.2.2 Periphery

An A1 digitizer tablet (Summagraphics LCL) is linked to the computer and tested with ARC/INFO. A high resolution A4 colour scanner (HP Scanjet IIe) will be ordered, as well as an A3 colour printer (HP Paint-jet XL) as soon as funds are available. By the end of April 1992 the testing phase of the installation should be finished.

2.2.3 GIS

ARC/INFO, in the old version 3.3 from 1989 is loaded and testing of the hard-/software combination has started. A decision about upgrading of this old version (some new procedures are available), will be made after the GRASS system has been tested (late autumn 1992). This depends also on the prize for upgrading.

2.2.4 Additional software

SPSS, SURFER, dBase, Wordstar and other statistical, graphical or word processing tools are available. Geo-statistics can be done by the GEOEAS system.

2.3 Selection of test area and collection of maps and images

As a test area for initial studies in (local, detailed) soil variability, for testing the Geographical Information Systems and for the creation of the first geo-referenced soil database, an area of about 4 by 6 km was selected. This area has about the size of the smallest mappable unit (ca. 2 by 3 mm on a 1:1 Million map), which will be treated by the SOTER approach as one pixel. As an initial step to a possible forthcoming EC-project, the (micro- and meso-) variability of soils will be surveyed and studied within the A2- and A3- themes. For the location of the sampling sites, see Fig. 3.1 to 3.4 in Annex 8.

The area encloses the farmland of the Ecological Experimental Station on Red Soils (EESRS) with soils derived from claystone in the south. In the northern part soils derived from sand/siltstone are dominating. Four topographical maps 1:10,000 covering the total area were made available by the Cartographic Centre in Nanjing, the capital of Jiangxi, to The maps delineate settlements, streets, footpaths, etc., but also two land-use classes (wood- and farmland) and elevation isolines of 2.5 m.

From these maps, at least four coverages should be extracted and digitized by the GIS.

C1: Topography (settlements, roads, railway etc.)
C2: Hydrology (reservoirs, rivers, channels)
C3: Elevation isolines
C4: Land-use ("historical" data of ca. 20 years old)

Though the maps are from 1980, they are a very important geo-reference and information base for any subsequent survey.

Also panchromatic (black and white) photo-images of 1970 are partly available or will be supplemented next month. The original air-photos are 1:14,000 in scale, but enlargements of 1:7,000 will be used. The images give information about main land-use classes (woodland, farmland) to a much higher resolution (% coverage, parcelling and terracing) than the topomaps. Also different phenomena of erosion can be detected (see below).

2.4 Digitizing, database structure and map construction

These topics have not yet been covered, but will be taken up after the co-worker has familiarized himself with the GIS. The first coverages should be digitized and edited until summer, but it is essential, that a digitizing assistant - after training - can do the tedious work full-time. By autumn 1992, the database structures should be developed and first trials in map production be undertaken (see workplan and time schedule).

2.5 Detailed soil variability studies

At three sub-areas within the Yingtan test area detailed variability studies were performed. The sub-areas are on:
- claystone soils under woodland (ca. 1.5km west of EESRS),
- claystone soils under farmland (ca. 1 km north of EESRS),
- sand/siltstone soils under farmland (ca. 6 km north of EESRS).

These sub-areas are symbolized by letters Y, F and D, respectively.

2.5.1 Sampling scheme, profile and boring survey

In order to guarantee random sampling the borings of soils were based on a quadratic grid with varying distances (according to slope length). Details are given in table 1.

Table 1. Characteristics of selected subarea

Symbol	Geology	Land use	Slope (%)	Slope-length (m)	Grid size (m)	Borings
Y	Claystone	Woodland / meadow	3-6	300	50 × 50	23
F	Claystone	Farmland	6	200	40 × 40	18
D	Sandstone	Farmland	6	120	30 × 30	15
						Σ56

Each of the borings was based on a small "minipit" down to a depth to ca. 30 cm allowing to take samples from topsoil horizons from a broader extent, while samples from subsoils were taken from the borehole only.

Next to borings for each sub-area 3-6 main profiles were selected (14 in total) to represent the areal soil variability. Here profile pits down to at least 1 m (often 1.5 m) were excavated and additional borings in the bottom of the pits reached a soil depth of at least 2 m.

2.5.2 Field attribute coding

From all profiles and borings, soil samples were taken as follows:

- profile: 6 samples according to horizon depths,
- boring: samples at fixed depth: 0-5 cm (Ah), 0/5-12 cm (Ap), 12-30 cm, 30-60 cm, 60-90 cm and 90-120 cm.

The samples were stored into small profile and boring boxes, that allowed to collect about 120 g or 50 g of material, respectively.
In a field fresh status the following field attributes were coded according to FAO soil survey standards:

- layer number, symbol and lower depth (LNO, LSYM, LLD),
- Munsell colour codes of matrix and mottles, incl. percentage and type of mottling (H,V,C,MP,MH,MV,MC,MTYP). After drying the colour coding will be repeated.
- texture, consistence-when-moist, aggregate stability in water, root density and bulk density (LTEX, LCON, LSTA, ROOT, BD). These data could not be assessed for the lower layers of the (pressed) borings directly, but knowledge was transferred from the main profiles. The bulk density rating needs calibration.
- A free-field attribute allowed entry of uncoded descriptions for each layer.

All recorded layer data have been entered into a digital database (dBase).

Also site and profile data (location, soil type, geology, relief, land-use) have been recorded or will be updated the next time.

2.5.3 Laboratory measurements

The following analyses have to be carried out by IPB or ISS-AS in the forthcoming months:

Measurement	Method	Samples	done by
pH	water + KCl	all	ISS
avail.P		topsoil	ISS
avail.K		"	ISS
total C		"	IPB
total N		"	IPB
total P		"	IPB
extr. Fe	?	"	IPB
extr. Al	?	"	IPB
part. sizes		"	IPB

2.5.4 Variogram analyses and interpolation

Will be done after analyses of samples.

2.6 Detect erosion by remote images

The first assessments, presented on a draft map at the workshop, revealed that for the area of claystone gully erosion dominates, while on sandstone sites forms of severe sheet erosion were detected.

This approach has to be followed up after all images are available.

2.7 (Semi)-detailed land and soil survey

Weather was unfavourable in March, but first trials of land-use surveys were demonstrated on a draft map. In order to cover the total area (about 20 km2) these (semi)-detailed surveys have to be continued. It is strongly suggested to ISS-AS, that about 300 borings will be made in a free survey sampling scheme in order to finalize and check the soil map of the total area. With help of a trained field worker and an assistant for field data coding the survey should take not more than 30 field days.

2.8 Preparation of areal erosion modelling

By autumn 1992 most of the available standard data sources for the test area should be digitized, edited and stored in two databases, ARC/INFO for geographical data and dBase for all relational data (borings, evaluation schemes, etc.). Based on the provisioned model for predicting water (sheet or rill) erosion, the Universal Soil Loss Equation (USLE), the annual erosion rate E (t/ha) is a function of factors of rain (R=EI, see A1), slope degree and length (SL, derivable from the digital elevation model), soil erodibility (K-Factor, see A1, assessable from field soil data), of the crop (C) and protection management (M, terracing etc.). Considering the complex pattern of parcelling and land-use in many parts of China, the areal derivation of the *effective* slope length is a crucial obstacle.

In order to develop an advanced methodology for extracting parcelling pattern from airphotos, these have to be scanned and the data transferred to a raster based GIS, which provides also functions for image processing. Proposed is the (Unix operating) GRASS programme, which is public domain and is being used by the U.S. Soil Conservation Service (SCS) too. With "image texture" analysis routines especially to be developed at Kiel, it is hoped to overcome partly the aforementioned base problem of successful erosion modelling in China. If at least *one* airphoto and a related topomap can be sent abroad, we could try to develop and test this very specific software. IPB hopes, that a positive decision can be made by ISS officials soon.
After this, further work on erosion mapping and modelling can be carried out in 1993.

3 TIME SCHEDULE FOR 1992 - 1993

Activity	1992									1993									Done by
	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	
1. Lab analyses	x	x	x	x	x														IPB + ISS
2. Data entry						x													ISS + IPB
3. Geostatistics							x	x	x										IPB (ISS)
4. Additional surveys			x	x			x	x											ISS (IPB)
5. Digitize maps		x	x	x	x	x													ISS
6. Image extraction		x	x	x	x	x													IPB
7. GRASS/BOGS						x	x												IPB
8. Setup GIS base							x	x											ISS (IPB)
9. Start modelling								x	x										ISS (IPB)
10. Continue modelling									x	x	x	x	x	x	x	x			ISS (IPB)
11. Reporting												x	x	x	x	x	x	x	IPB + ISS

Remarks:

4: additionally, two field workers and one assistant will be provided by ISS for about 30 field days

5: an assistant should do the tedious digitizing work for about 9 months

6: a successful (automatic) extraction of complex photo signatures caused by complex parcelling/terracing can not fully be guaranteed, but is crucial for ongoing modelling work

7: It is planned to send an information scientist to ISS for two weeks to implement and train GRASS and the "Soil Map Construction Module" BOGS. For successful transfer of knowledge at least one information scientist should be made available by ISS.

10: Cooperative continuation of area erosion modelling is strongly hampered, if data can not be exchanged.

ANNEX 3 PROGRESS REPORT ORSTOM

First Progress Report : 1 October 1991- 31 March 1992, presented at the Nanjing workshop, 25-26 March 1992

Sub-project B: TRANSECT STUDIES AND DEVELOPMENT OF CLASSIFICATION CRITERIA

1 INTRODUCTION

The aim of this work, done in cooperation between soil scientists of Institute of Soil Science, Academia Sinica (ISS-AS), ORSTOM and the Institute of Soil Science of the RFW University, is a joint collection and interpretation of pedological data (field and laboratory data) obtained from some reference places of South and South East China.

The objectives are :
- to define soil classification criterias : based on the data collected in three transects a set of key soil/terrain parameters will be selected for the purpose of land evaluation;
- to define broad soil spatial distribution rules as a contribution to 'kilometric' (1:1,000,000) soil mapping.

Data to be collected are related to pedological materials (mineral composition, structure, chemical and physical properties) and their relationships with parent rocks and topography. Data will be obtained by observation, and analysis, of "mega-transects" located in three climatic regions in SE China : subtropical, intermediary, and tropical climate. The results of this sub-project will contribute to the generalization of the other two projects A and C. It will guide the selection of the reference profiles of sub-project C.

2 PERSONNEL

At present, the following persons are involved:

ORSTOM:	B. Volkoff
RFW:	H. Zakosek
ISS:	Chen Zhicheng, Zhang Ganlin (Soil classification), Zhang Taolin, He Yuaqin, Wang Minzhou (Soil variability and Agricultural Development)

3 PROGRESS

Fieldwork for the study of two transects were made in :

- Jiangxi in November 91 (20 days field work) and in
- Guangzhou in March 92 (20 days field work).

3.1 Jiangxi Transect

Transects of about 200 km were chosen on maps (mainly topographic), between the Poyang Lake and Wuyi Mountains (Huanggang, 2157m) (Fig. 4.1). This area belongs to the Southern Part of Central China, South Chanjiang, Low Mountains Hills and Basin Area (Fig. 4.2), and is included in the area of Red earth and Yellow earth of the Central Subtropics (Fig. 4.3).

The parent rocks are metamorphic rocks (gneiss, shales), granites, sedimentary rocks (sandstone, siltstones, clays) and volcanic rocks (syenites, rhyolites). Different geomorphological units are distinguished: middle mountains (>800 m), low mountains, high hills, low hills, plains.

In total, 22 complete soil profiles (from the top to the weathered rocks) were studied (2 from plains, 4 from high hills, 9 from low hills, and 7 from mountains).

For each profile a detailed description of the natural environment (topography, soil cover, land use, erosion) and the morphological characteristics of soil layers was made. Samples (about 200 for chemical and mineralogical analysis, and 10 for micromorphological analysis) were collected.

Pedological and geochemical analysis has been done in the ISS laboratory in Nanjing on a selected part of these samples :

- Pedological (particle distribution, pH (H_2O and KCl), Total Carbon, Total Nitrogen, CEC (pH 7 Ammonium acetate method), exchangeable cations (K, Na, Ca, Mg, exchangeable H^+ and Al^{3+}) on 50 samples of 5 profiles ;
- Geochemical analysis (28 total analysis by "three acids" method and 29 free iron oxide determinations).

Mineralogical analysis by X-ray has been done in Nanjing laboratory (15 samples) and in ORSTOM laboratory (35 samples including the 15 analyzed in Nanjing) from 6 selected profiles. In Nanjing laboratory, 15 samples of clay fractions were analyzed with treatment of oriented clay, from 2 to 50 degrees 2θ Cu-α radiation.

In ORSTOM laboratory following analysis have been done :

1. XR diffraction on powder samples (on clay, fine silt and coarse silt) of the 35 samples : 105 determinations (from 2 to 45 degrees 2θ),
2. XR diffraction on 24 samples of oriented clay and 6 samples of oriented fine silt (Mg saturate, Mg saturate + glycol, K saturate, K saturate + glycol, K saturate dry at 105°C, K saturate dry at 200°C, K saturate dry at 300°C, K saturate dry at 550°C, K saturate dry at 750°C) : 300 determinations from 2 to 15 degrees 2θ.

3.2 Guangdong Transect

This area is located in the north of Guangzhou between Wengyuan and Sihui (Fig. 4.4). It reaches 150 km. It is on the left side of the Beijiang river (Pearl river). The area consists of some mountain ranges which are parallel to the Nanling range direction (SW-NE). The altitude of the higher points is about 1300 m.

The transect is crossing two regions: The Southern Part of Central China: Nanling Mountain Area and South China Region: Coastal Hills and Plains of Fujiian and Guangdong Area (Fig. 4.2). It belongs to the Area of Lateritic Red Earth of South subtropical zone (Fig. 4.3).

The parent rocks are: igneous rocks (mainly granites) with metamorphic rocks (siliceous sandy shales), limestones, also sandstones and quaternary deposits. The geomorphological units are: mountains (mainly low mountains), low hills and plains. 14 complete profiles have been observed: 9 from low hills, 2 from high hills, and 3 from low mountains. About 140 samples were collected for chemical and mineralogical analysis, and 13 for micromorphological analysis.

4 FORTHCOMING WORKPLAN AND TIMETABLE

The initial workplan and time table will be followed without modifications.

5 CONSTRAINTS AND GENERAL REMARKS

Lack of sufficient basic background materials:

The field work had been carried out with a good topographic map (1:500,000) but without corresponding geological, geomorphological, pedological maps, and without sufficient information about the soils. The literature analysis is partly done.

Representation:

Major geomorphological units have been observed and some soil profiles were collected.

Paddy soils:

Anthropogenic paddy soils were not studied in this sub-project.

6 RESULTS

The first results are related to :

1°) Landscape classification;
2°) Weathered rocks description;
3°) Soil profile development: morphology (Table 1), chemical properties, mineralogical and geochemical characteristics of the main horizons.

8 CONCLUSIONS

The research work planned for this period has been realised with interesting results.

Table 1. The main soil horizons in the Jiangxi transect.

Upper Horizons	B Horizons	C Horizons
Structured Red-Brown "Massive" Brown-Red "Massive" Brown-Yellow Soft Dark Brown	Red Structured Clay Red "Massive" Clay Red Weak Structured Clay	Mottled Clay Soft Clay Loam

ANNEX 4 PROGRESS REPORT ISRIC

GENERAL PROJECT COORDINATION

The ISRIC's project coordinating activities can be summarized as follows:

- Handling of general correspondence with parties involved, including the programme of the first workshop at ISS-AS.
- The drafting of sub-project contents.
- The organisation of a meeting in Wageningen (22-23 January 1992) on erosion modelling, linkage of detailed erosion models to the small scale database, and a discussion on a follow-up proposal. The SOTER staff, J. Lamp and a number of erosion specialists from agricultural institutions participated in this meeting. Results of the meeting were distributed to participating institutions and the EC.

- The preparation and correspondence for the Nanjing workshop at ISS-AS.
- The assembling of the first progress report, including editing of reports of the participating institutions.

Sub-project C: ESTABLISHMENT OF SOIL REFERENCE COLLECTIONS AND PEDON DATABASE AT ISS-AS AND ISRIC

1 OBJECTIVES

The following project objectives were discussed at the workshop:

1. To establish a collection of reference soils from SE, NE and SW China, with priority to the research areas in SE China.
2. To adopt a database for storage of soil, climate, and other environmental data.
3. To publish the collected data and research results.
4. To provide the other sub-projects with complementary soil and research information.

The objectives and the required activities were further explained during the workshop with a lecture illustrated with a series of slides.

These objectives include the following results:
- Strengthening of the education, extension and research capacity of Institute of Soil Science - Academia Sinica.
- Contribute to the improvement of the Chinese soil classification system
- Development of a pedon database, which will be used for the proposed follow-up small scale Soil and Terrain Geographical Information System (SOTER).
- The Chinese soil reference collection/database will form part of an international network of National Soil Reference Collections and Database (NASREC) and to ISRIC's soil pedon database.

The following documentation was distributed and was used during the discussions for a more detailed workplan.
- NASREC Newsletter No.2
- Summary diagram of ISRIC Soil Information System (ISIS) database and its possible applications
- Soil Brief and the booklet 'Down to Earth'

2 WORKPLAN

2.1 Fieldwork

Field-observations and soil sampling will be made according the standardized procedures (FAO, ISIS, SOTER). Three periods are planned for the realization of the fieldwork. Regions, team, necessary time, number of locations and period are summarized as follows:
1. Yingtan, Guangdong, Hainan; ISRIC 1 and ISS-AS 3 staff-members and 2 local personnel, 38 days for 15 locations; period Sept/Oct 1992
2. Cao Yang, Sanjiang Jiling; ISRIC 1 and ISS-AS 2 staff-members and 2 local personnel, 40 days and about 10 locations; period May 1993
3. SW China; ISRIC 1 and ISS-AS 2 staff-members and 2 local personnel, 30 days and about 6 locations; period June 1993

2.2 Analysis

It has been decided that all samples will be analyzed by both ISS-AS and ISRIC. A statistical analysis will be made of the results with a comparable analytical procedure.

2.3 Database

Although a decision on the type of database has still to be made, it is proposed to use initially ISRIC's Soil Information System (ISIS) for the storage of the monolith information. It will enable the exchange of information on reference soils with ISRIC as well as with other NASREC's. In view of the proposed follow-up small-scale Soil and Terrain Digital Database (SOTER), the pedon database of SOTER will be use simultaneously. This is seen as a first prototype of the SOTER database.

2.4 Exposition

All collected monoliths will be displayed with accompanying information. The results of all other sub-projects will be displayed as well. The details will be further discussed during a next mission.

2.5 Publications

ISRIC's Soil Brief series as a form of publication for sub-project C was well received. At a later stage the necessary decisions on details of this activity will be made.

3 BUDGET FOR ISS-AS [Yuan - March 1992]

Based upon a selection of possible location a first draft of a budget for ISS-AS was made. The grand total of 276.000 Yuan is well in line with the total grant of the EC to ISS-AS for all sub-projects. The details of the draft budget are (1 ECU is about 7 Yuan):

Budget item	1st mission	2nd mission	3rd mission	TOTAL
Accommodation	26.000	17.000	16.000	
Travel (plane/train)	3.000	2.000	4.000	
Transport (car)*	6.000	10.000	7.500	
Transport (samples)	3.000	2.000	3.000	
Labour	3.000	2.000	2.000	
Sampling boxes*	1.500	1.500	1.500	
Tools	1.000	500	500	
TOTAL FIELDWORK	43.500	35.000	35.000	113.500

* 50% (other 50% by ISRIC)

Soil Analysis	60.000
Personnel	20.000
Exposition	33.000
Publications (10000 copies 'Soil Briefs')**	100.000
GRAND TOTAL	326.000

** Additional funding for this publication will be looked for.

ANNEX 5 PROGRESS REPORT JL/RFW

Prof.Dr. Breburda was requested (end March 1992) by telefax to send the JL progress report to ISRIC, but till today it is not received. The report will be included in the second progress report.

ANNEX 6 PROGRESS REPORT ISS-AS

Institute of Soil Science Academia Sinica

ISSAS

ISSAS **Phone:86-25-633318** **P.O.Box 821** **86-25-713781**
Nanjing, 210008 **Fax :86-25-712663**
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Science and Technology for Development Project (STD2) of the European Comunity--Sub-contract No. TS*-CT91-0336-ISS

EROSION ASSESSMENT, CLASSIFICATION AND SOIL REFERENCE COLLECTION OF SOILS IN (SUB)TROPICAL CHINA -- WITH FOCUS ON THE YINGTAN AND HAINAN AREAS

First Progress Report (1 October 1991 - 1 April 1992)

(Reported by Zhao Qiguo and Gong Zitong, ISS-AS)

The Project can be divided into three parts (i.e. Part A, Part B and Part C). Fieldwork for Part A and Part B have been carried out since September 1991. Some preparatory work was made before. Progress of Part A and Part B are presented as follows:

I. Part A: Soil Erodibility, Detailed Soil Variability Studies and Accompanying Geographical Information System

Part A1: Soil Erodibility Study

Personnel:
ISS-AS: Shi Deming, Shi Xuezheng
JL: J. Breburda

1. Establishment of 8 plots for the measuring of natural run-off in Yingtan Ecological Experimental Station of Red Soil.
   The region around Yingtan located in the mid-subtropical China is a representative area of Quaternary red clay. It was covered by broad-leave evergreen woodland about 30-70 years ago. But, at present it is barren land with sparse Masson pine and some grasses. We want to develop/stimulate agricultural production under condition of sound soil conservation.

   There are 2 replications in the experiment and 4 treatments -- Peanut/rape (typical upland farm crop system in the region), CK or natural state (only some grasses), Lespedeza and elephant grass. Every plot is ten meters long and 2.5 meters wide. Up to now we have measured 10 times soil loss and rain-off.

2. Establishment of 7 plots measuring the soil K-factor without any plant covers. Each plot represents one major soil type of low hills in Subtropical China. The soil, parent material and land use information are as follow:

Type of soil	Parent material	State of soil Utilization
red soil	Quaternary red clay	crop land (over 35 years)
red soil	Quaternary red clay	barren land
eroded red soil (only existing C Horizon)	Quaternary red clay	bare land
red soil	red sandstone	barren land
red soil	granite	barren land
eroded red soil (only existing C horizon)	granite	barren land
purple soil	purple shale	barren land

Additionally, a small climate observation station has been established in Ecological Experimental Station of Red Soils in Yingtan. With these observations, we want to calculate the rainfall erosion index unit (EI30).

3. Taking of 26 Soil Samples. Up to now 26 soil samples for chemical analysis were collected. We would like to analyze organic matter content, bulk density, natural clay, wet and dry sieving analysis, sesquioxides-silica ratio, soil aggregate stability, soil permeability, rainfall acceptance test, water content and saturation.

4. 1:50,000 colour-infrared flight photographs and 1:10,000 flight photographs in Xingguo county about 34,000 km^2 of south part of Jangxi Province were obtained. We finished the field survey of gully development in granite area. Prof. Breburda with Dr. Shi et al. made an excursion in the Jiangxi Province end 1991. We surveyed during 2 weeks the state of soil erosion in the Quaternary red clay and granite area, and visited relevant institutions. Additional information about soil erosion was collected at these institutions.

Existing problems and difficulties

1. We aren't sure that we are able to perform part A3, because the engine of rainfall simulator doesn't work. Maybe some parts of the engine are broken. We do our best to get the engine in order again and carry out part A3.

2. Dr. Valentin will carry out the soil and crust analysis. Specially crust analysis plays an important role in study of soil erosion and conservation of Subtropical China. It is necessary to send required equipment to China, as early as possible, because international transport and getting a Custom import permit requires a lot of time.

3. In view of only a two years period for the STD2-project and a lot of measurements to be done (soil erodibility indices and tests listed in part A), we suggest that the soil erosion study should focus on the main study of soil erodibility. Therefore, we like to discuss the necessity of the drop test, erosion ratio, dispersion ratio, erodibility indices, macropores, surface storage, clod size distribution and cohesion in the STD2-project. We like to request Prof. Breburda to provide us with the methods for the retention ability, crumbtest, soil aggregate stability, soil structural stability and soil permeability.

II. Part A2+A3: GIS and Detailed Soil Variability Studies

Personal:
ISS-AS: Zhuo Huizheng and Luo Guobao
IPB: J. Lamp

1. Selection of tested areas (done at Oct. 1991)

2. Field work at Yingtan Red Soil Station along three transects. The first two on farm land and wood land both derived from Quaternary red clay and the third one derived from sandstone. The work comprised:
   - 14 main profiles
   - 70 borings
   - 360 samples
   - field data coding and inputting
   - field survey and mapping

3. Collection of topographic maps including scales of 1:10,000, 1:500,000, 1:1,000,000 etc. and airphotos.

4. Purchase and installation of the following computer hardware and software:

   - A PC/386 with 387-Coprocessor and 200 MByte hard-disk, 21 inch colour monitor with high resolution (NEC 5D) and AGC graphic board (1280*1024, 256 colours) is just installed and being tested.

   - An A1 digitizer tablet (Summagraphics LCL) is just linked to the computer and tested with ARC/INFO. The testing phase of the existing hardware installation has be finished.

   - ARC/INFO, version 3.3 from 1989 is loaded and testing of the hard-/software combination has been done and training people for this software is going on.

   - GEOEAS, SPSS, SURFER, dBase, HG, STORYBODY, Wordstar, WP5.1 and other statistical, graphical or word processing tools are available and these software are operated smoothly by ISSAS people.

III. Part B: *Transects Study and Development of Classification Criteria*

Personnel:
ISS-AS: Chen Zhicheng, Zhang Taolin, Zhang Ganlin and Heyuanqiu
ORSTOM: B. Volkoff

1. Field survey and sampling in the line of Jinxian-Yujiang-Wuyi Mts. (done at Oct., 1991)

2. Lab. analysis of 5 main soil profiles including terms of soil colour, texture, gravel content, pH, OM, total N, CEC, exchangeable bases, exchangeable H and Al, free Fe2O3, chemical composition extracted by HCl-HNO3-H2SO4 and X-ray diffraction of clay minerals

3. Field survey and sampling in the line of Guangzhuo-Conghua-Wengyuanli (done at Feb.-Mar., 1992). (done at Feb.-Mar., 1992).

IV. Part C: *Establishment of Soil Reference Collections and Pedon Database*

Personnel:
ISS-AS: Luo Guobao, Zhang Ganlin and Wang Mingzhu
ISRIC: S. Kauffman

The workplan for this part was drafted with S. Kauffman of ISRIC. The first fieldwork period will be conducted in October 1992. For further details see Annex 4 - workplan ISRIC.

ANNEX 7 GENERAL PROJECT MATTERS

1 ADMINISTRATIVE MATTERS

The following matters were discussed during the workshop. For more details reference is made to the sub-contracts and the main contract EEC-ISRIC.

(Sub)contracts

No questions of participating institutions.

Instalments

Transfers will be made according to the sub-contract.

Bookkeeping

Send your bookkeeping timely to ISRIC. Include in your bookkeeping the exchange rate of the ECU to the national currency. Bookkeeping of all expenses -on real cost base- should be made according to the forms given in the EEC main contract (annex H). All documentation to be sent to ISRIC.
In the bookkeeping records, each item -supported by appropriate original receipts, bills, etc.- should have the following information:

date	description	amount	number of bill/receipt

Receipts/bills

The bookkeeping should be supported by original invoices, receipts, bills and air-ticket stubs, which should be attached to the bookkeeping forms (keep photocopies for your own file).

2 REPORTING

Half yearly progress reports

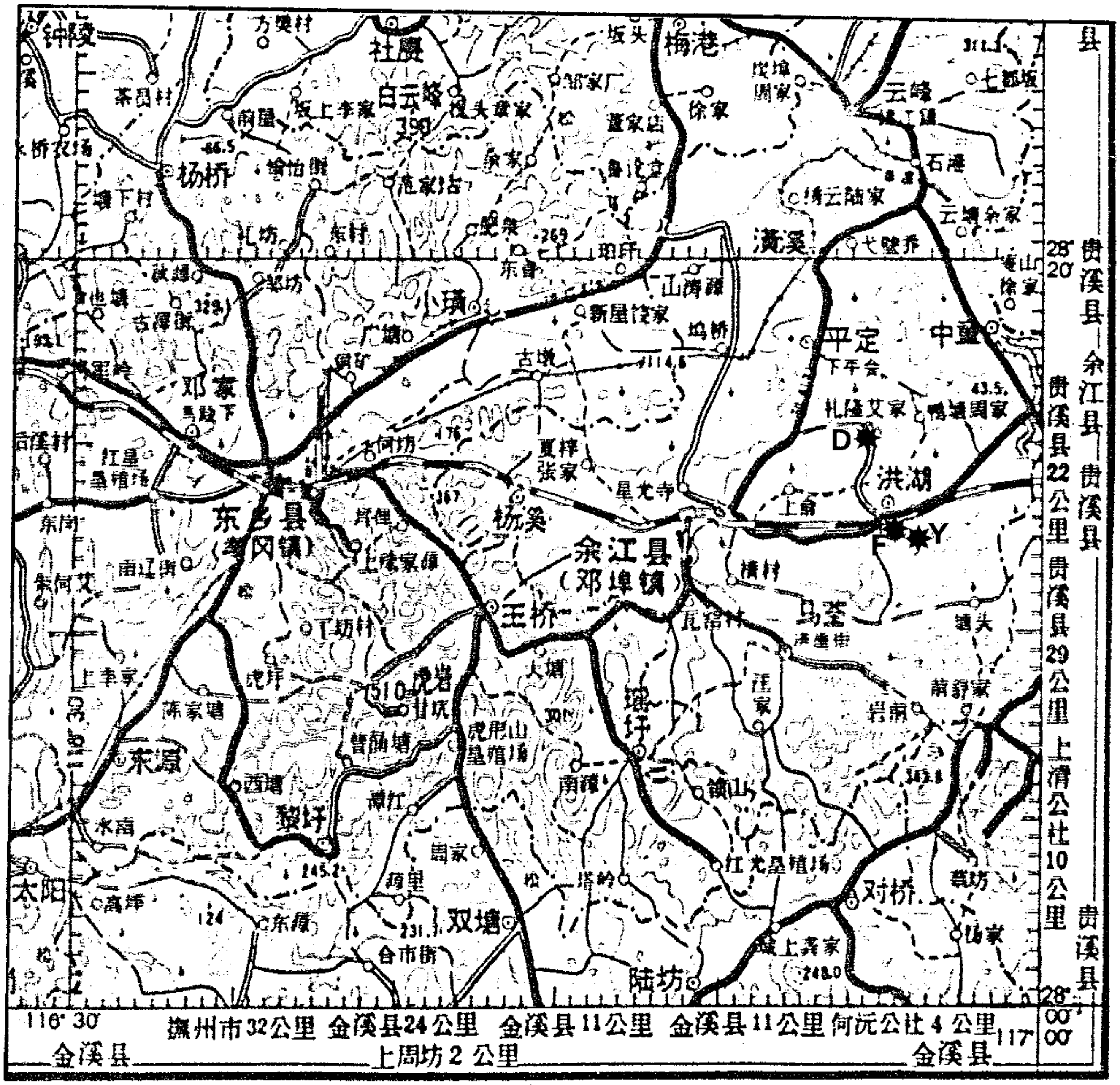
The half yearly reports should be sent to ISRIC (Except for JL report, all othe reports were received during the workshop in Nanjing). The reports should be composed of activities accomplished, summary of technical results obtained sofar and a forward plan of work for the following half year. A compilation of all reports with accompanying texts will be sent to all participating institutions and the EC-STD commission. All texts should be sent to ISRIC in a printed form and on diskette. It has been decided to use Word-Perfect (WP) format or a format which can be translated to WP.

Edited yearly progress reports

This yearly report should be sent to ISRIC. Reports should include more detailed results, relevant discussion and conclusions. The compilation will be circulated first for further comments before sending to the EC-STD commission.

Miscellaneous:
- ISRIC to prepare a *standard title page* for all research papers and progress reports.
- *General logo/sticker* for use on the title page, to improve recognition of the project in and outside the participating institutions. ISRIC/ISS-AS to prepare an example for comments and approval by participating institutions and EC-STD commission.

ANNEX 8　　LOCATION MAPS



根据1959年—1966年出版的第一版1：5万地形图编制的1：10万地形图，用1969年—1971年1：5万修测图修正，于1971年编绘，1972年第一版。
1954年北京座标系。
1956年黄海高程系，等高距为100米。
1969年版图式。

Figure 3.1　　Location of sites D, F and Y for detailed soil variability studies in the Yingtan area (Sub-project A).

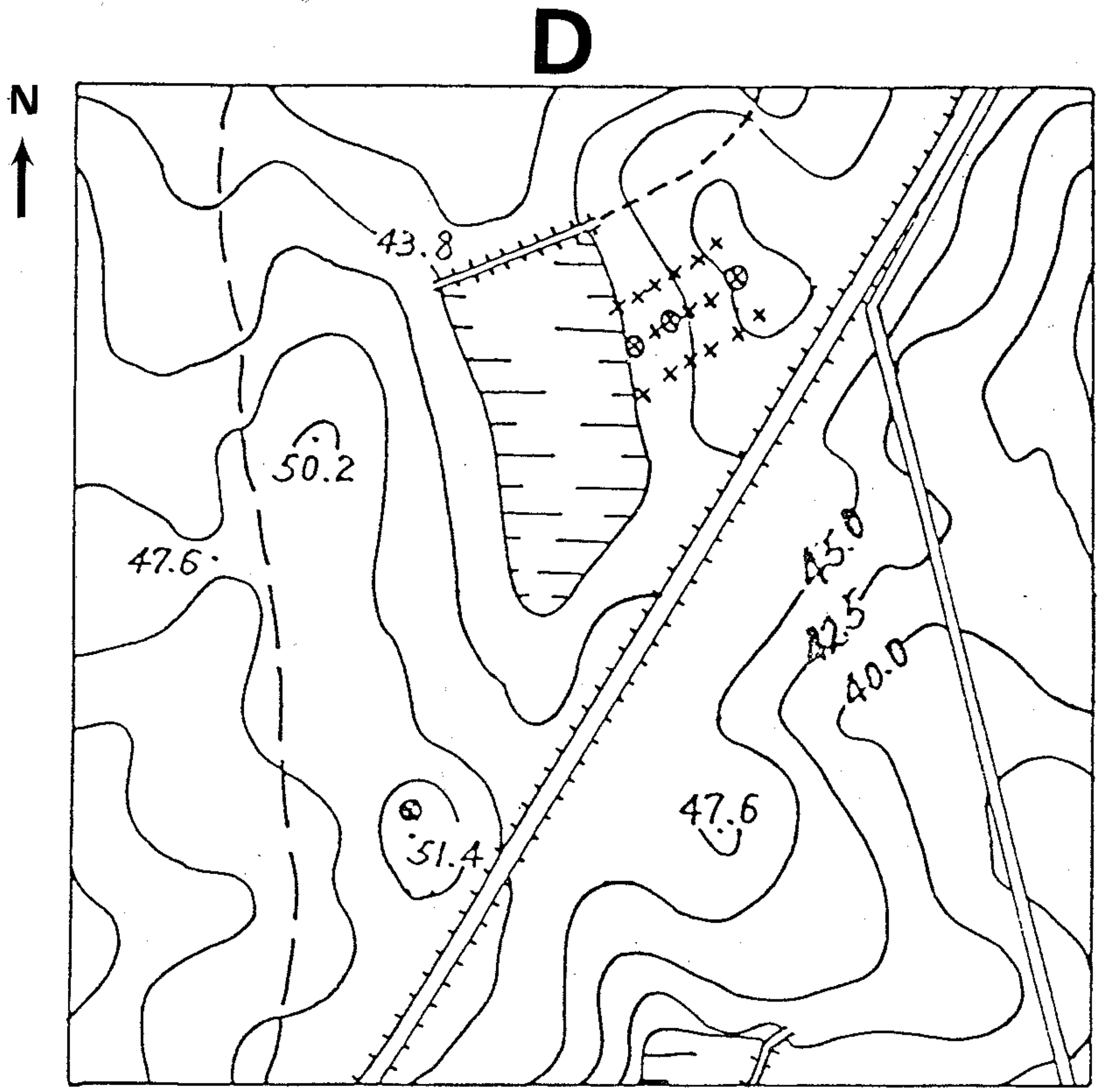


Figure 3.2 Site D. Location map of borings and soil profile pits.
× = boring
⊗ = soil profile pit

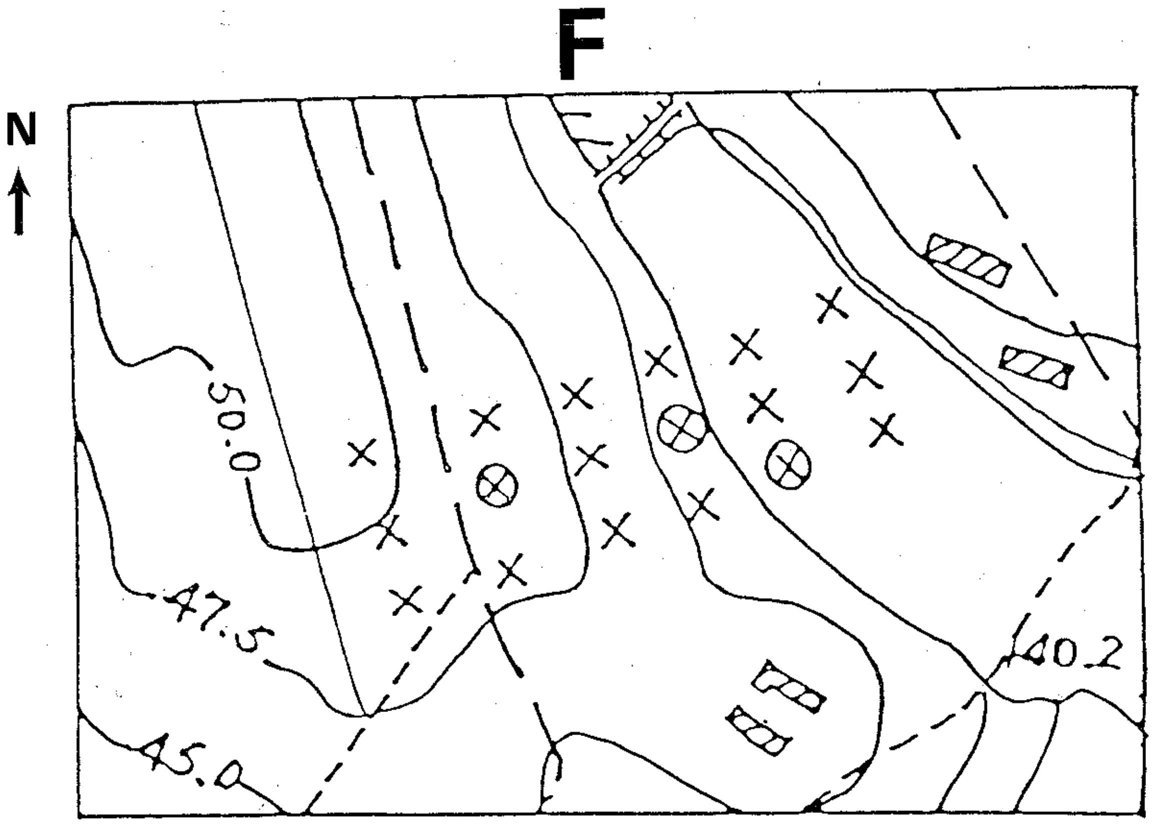


Figure 3.3 Site F. Location map of borings and soil profile pits.
× = boring
⊗ = soil profile pit

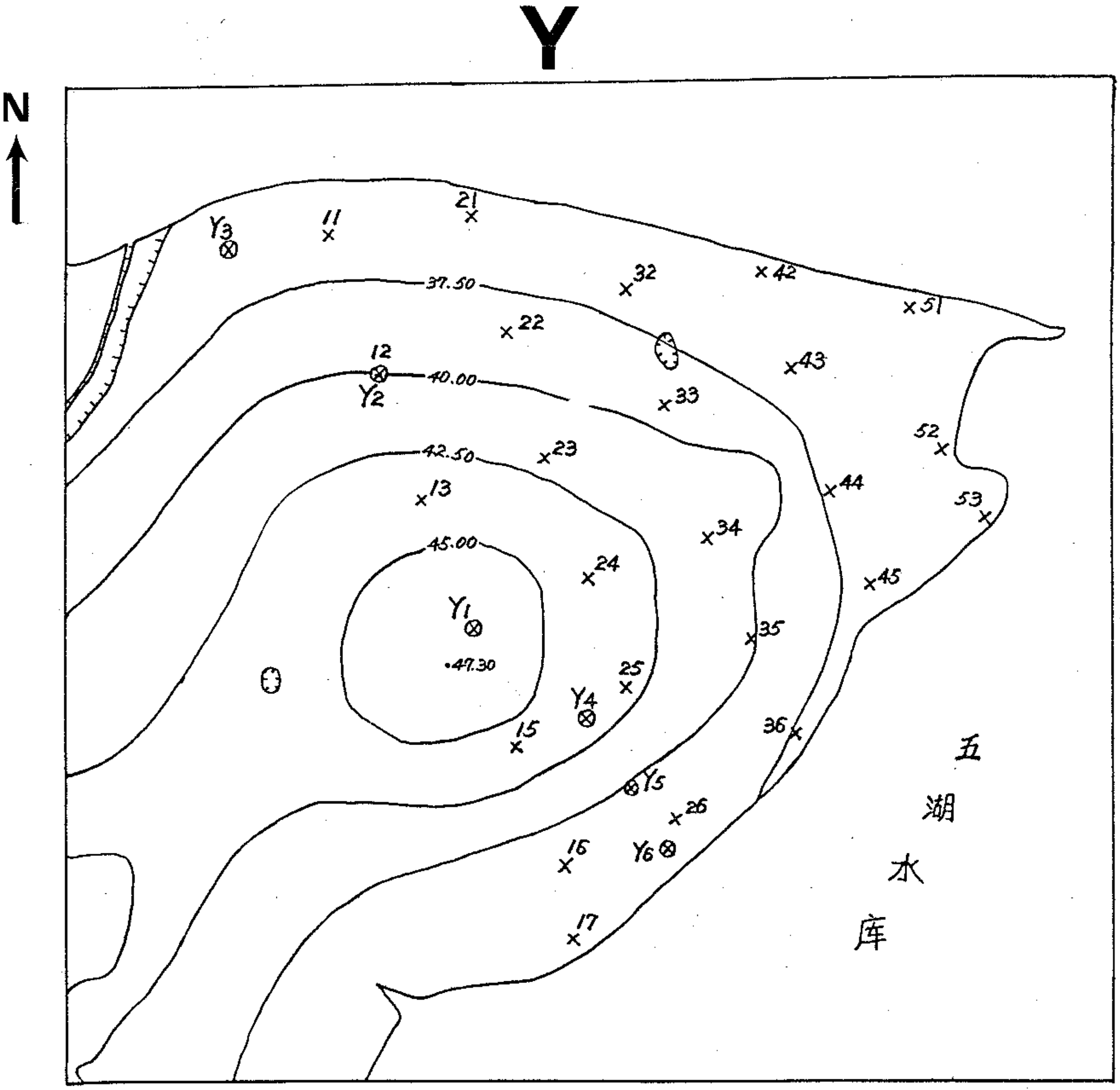


Figure 3.4 Site Y. Location map of borings and soil profile pits.
× = boring
⊗ = soil profile pit

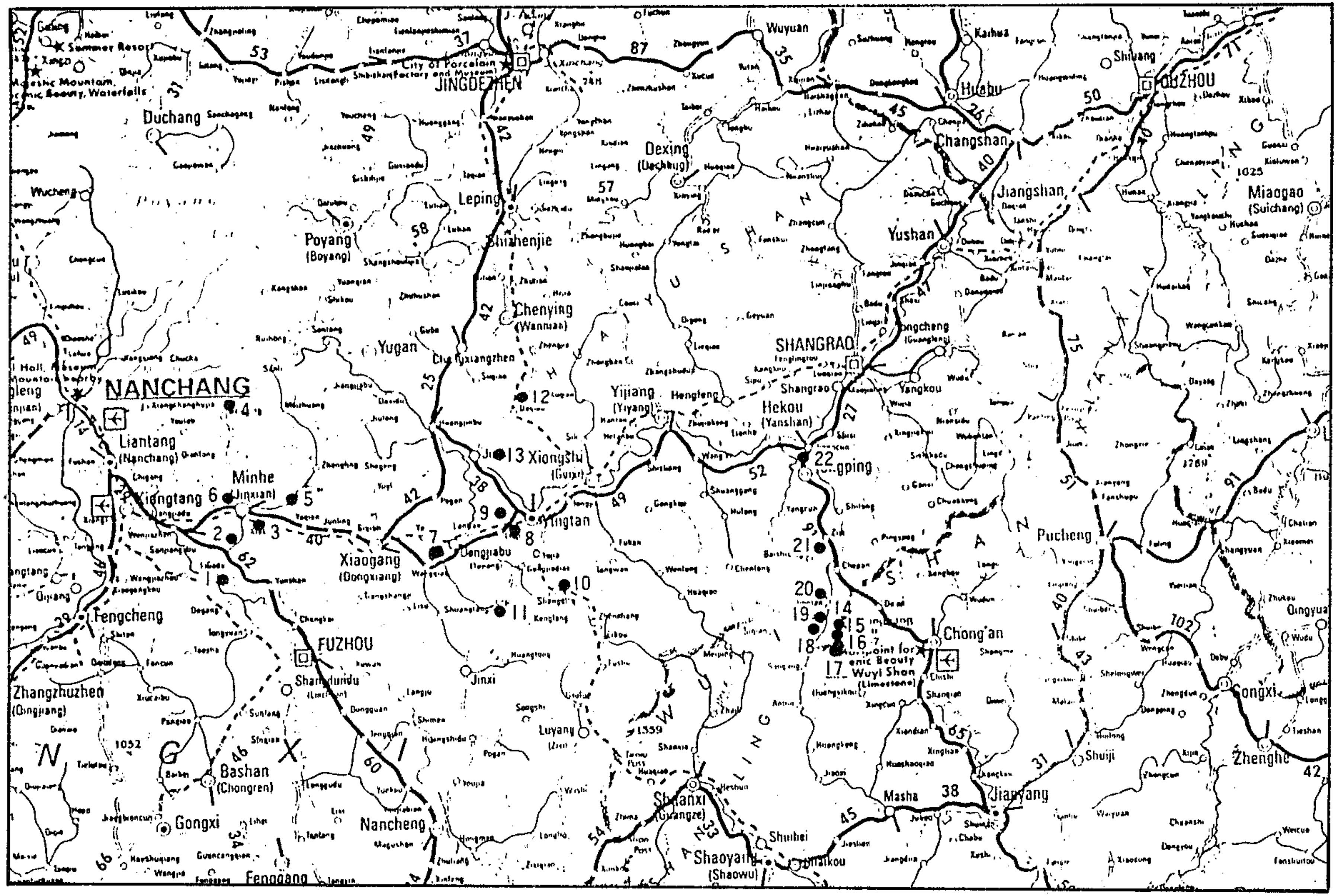
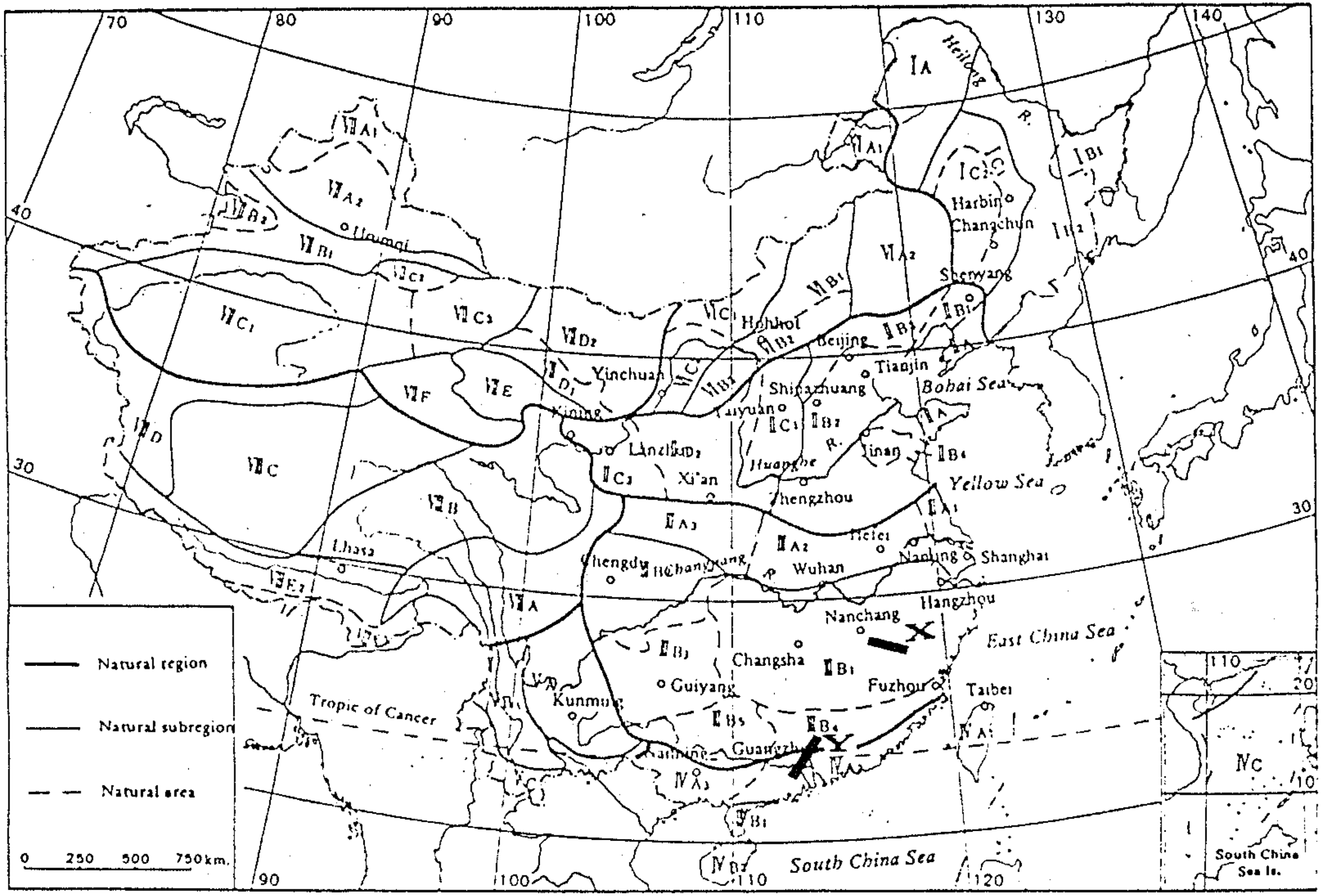
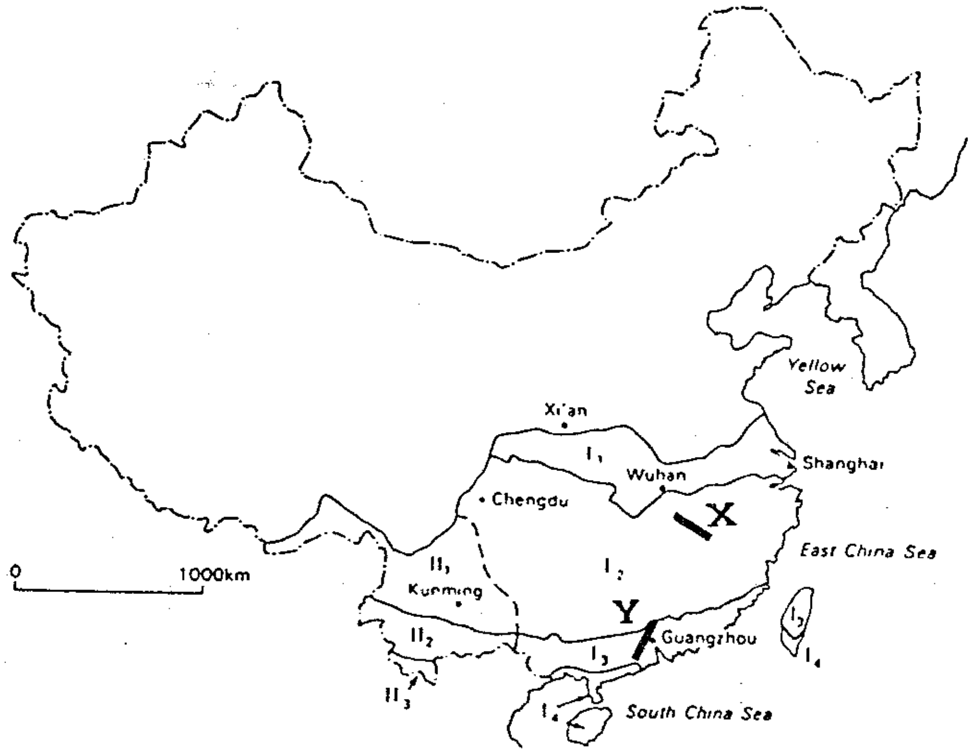


Figure 4.1 Jiangxi transect - Location of Profiles Sites.



China's Comprehensive, Physical Regionalization

Figure 4.2 Physical regions of China. X = Jiangxi transect; Y = Guangdong transect. (Sub-project B)



I Eastern subregion

1 Yellow-brown earth zone in north subtropics

2 Red earth and yellow earth zone in central subtropics

3 Lateritic red earth zone in south subtropics

4 Latosol zone in tropics

II Western subregion

1 Red earth zone in central subtropics

2 Lateritic red earth zone in south subtropics

3 Latosol zone in tropics

Figure 4.3 Map of tropical and subtropical China (X = Jiangxi transect; Y = Guangdong transect).

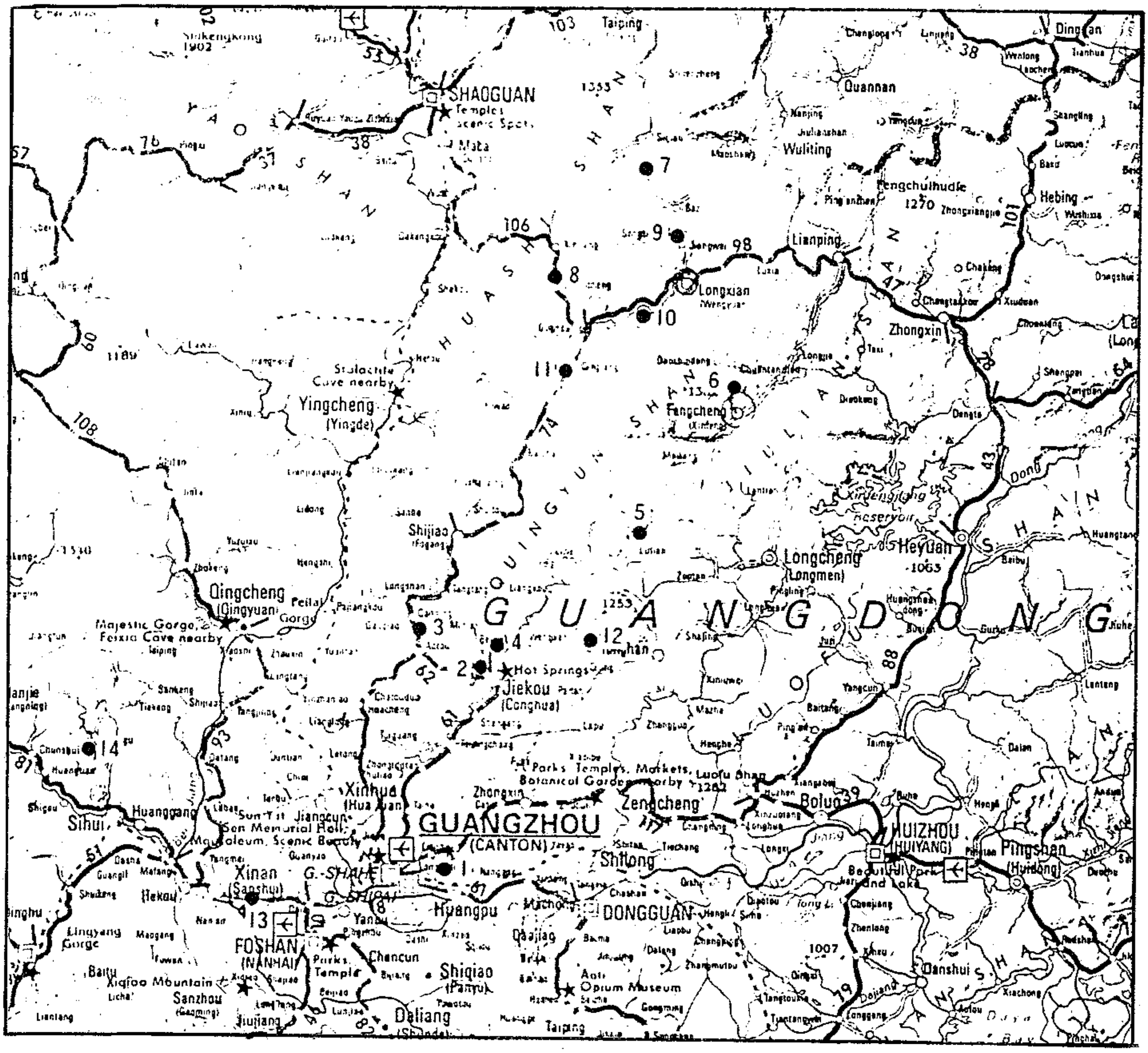


Figure 4.4 Guangdong transect - Location of Profiles Sites.

ANNEX 9 PAYMENT TO PARTICIPATING INSTITUTIONS

Institution	First (ECU)	Second[1]	Final[2]
ISSS-AS	50.000	50.000	57.000
ORSTOM	18.000	18.000	19.000
IBP-Kiel	10.000	10.000	10.000
JL-Giessen	11.000	11.000	10.000

[1] After reception of first progress report and financial statements.
[2] Final amount or parts of it according to EC contract regulations.

ANNEX 10 WORLD SOILS AND TERRAIN DIGITAL DATABASE (SOTER)

A Computerized Land Resource Development and Conservation System

BACKGROUND

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

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

1. A computerised database containing available and in most cases very detailed information on topography, soils, climate, vegetation, land use, populations (human, domestic animals, wildlife, etc.), and infrastructure, and the whole range of socio-economic factors such as food requirements attitudes, skills, costs of inputs, and availability of markets.
2. A so-called geographical information system or GIS, which ties each item of information to its precise geographical location, but which is able to display each separate type of information as a separate layer, or overlay. This makes it possible to display or print maps of any combination of information required virtually instantaneously.
3. A set of crop yield models which can calculate the level of production which could be obtained from each and any combination of soil and climate in the region or country, at a number of different input levels or management systems.

4. Using a table of user-decided dietary levels, a model for calculating the population which could be supported in any area.
5. The possibility to carry out full economic analysis at different levels
6. Various environmental impact models, which, for example, allow the calculation of rates of erosion for a given land unit, use, and production system.

Systems with the above capacity can now operate on common desk-top, office type computers with peripheral equipment such as digitising tables and colour printers. Hardware and software for the most basic system would cost in the order of $ 50 000, would be suitable for district planning at local level and would require only a few weeks of training to put into operation. At national level, where greater capacity and a higher quality of product is required total equipment costs would today be of the order of $ 150 000, of which the major part would probably be for software programmes. In this case training of local staff would take a matter of months.

Development of computerised natural resource inventory and land evaluation systems especially for use in developing countries has been carried out by FAO since the early nineteen-seventies, notably under the Agro-Ecological Zones programme, for which the Organisation is well known, and considerable experience has been obtained. In 1987 the International Soil Reference and Information Centre (ISRIC), based in Wageningen, the Netherlands undertook to carry out a global assessment of soil degradation for the UNEP which involved subprojects in some large pilot areas, each of which covered parts of more than one country. With technical assistance from FAO and from the Land Resource Research Centre in Canada, and in collaboration with experts and organisations in many parts of the world ISRIC developed a Methodology for a world Soils and Terrain Digital Database (SOTER) to carry out this task.
The system has now been tested in three pilot areas involving five countries, using local data and training national staff in operation. Experts in soil/climate resources and land use inventory and evaluation in a number of other Third-World countries, especially Africa, have moreover used their experience at improving the system's manual. Though further up-grading and improvement will continue, this system can now be established as an almost routine operation which mainly involves the provision of equipment, and training. Because such a project involves installation of an already developed system there is little risk of failure, or of the project failing to deliver planned outputs. Because of experience already gained, efficiency in terms of time and use of funds is far higher than in the majority of donor-funded development projects.

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

Following completion of SOTER pilot areas in Argentina, Uruguay, Brazil, USA, and Canada, requests for technical assistance in the same field were received by ISRIC from six neighbouring countries in West Africa, from Austria, Hungary, Czechoslovakia, and from several Middle Eastern and Central American countries. The number of requests to date is indicative of the demand for, and importance attached to the land resource database, land evaluation, and land use planning system which SOTER is capable of providing.