Final Draft

Sustainable Land Management for Agricultural Production in Hainan Province (Hainan SOTER)
UNDP project CPR/96/105/A/99

FAO STS SERVICE MISSION REPORT

LAND DATA MANAGEMENT AND UTILISATION MISSION FOR UNDP HAINAN SOTER PROJECT

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Regional Office for Asia and The Pacific (RAP)

CONTENTS

ACRONYMS AND ABBREVIATIONS

CATAS	Chinese Academy of Tropical Agricultural Sciences, Danzhou
CICETE	China International Centre for Economic and Technical Exchanges, Beijing
CSIS	County SOTER Information System at a scale of 1:50,000
DEM	Digital Elevation Model
GIS	Geographic Information System
HPGC	Hainan Provincial Geomatics Centre, Haikou
HSIS	Hainan SOTER Information System at a scale of 1:250,000
ICT	Information Communication Technology
ISRIC	International Soil Reference and Information Centre, Wageningen
ISSAS	Institute of Soil Science, Academia Sinica, Nanjing
SOTER	Global and National Soils and Terrain Digital Databases
UNDP	United Nations Development Programme, Beijing

ACKNOWLEDGEMENTS

The result of this mission depended on the contributions of various organizations. Preparatory work and logistics by FAO Regional Offices, discussions with the ISSAS and CATAS project teams in Nanjing and Hainan, field visits organized by CATAS, discussion with the Bureau of Agriculture of Danzhou county, and discussions at UNDP and FAO offices. All persons involved in this mission, of which the names are given in the report, are gratefully acknowledged for their contributions. Special thanks for the dedicated translation work by Zhou Jiannan.

SUMMARY

Upon request of FAO Regional Office in Bangkok a STS consultancy service mission was made by Sjef Kauffman[1] for UNDP project CRP/96/105: Sustainable Land Management for Agricultural Production in Hainan Province, P.R. of China, shortly indicated as the Hainan-SOTER project. The main activities of the mission consisted of visits to the Chinese implementing agencies. It included a four-day visit to the Institute of Soil Science, Academia Sinica (ISSAS) in Nanjing, and a six-day visit to the Chinese Academy of Tropical Agricultural Sciences (CATAS) in Hainan. Both visits consisted of discussions with the project teams focusing on the capacities of the project teams to implement the project, a review of the progress made with the database and GIS components of the soils and terrain information systems in development, the required applications tools to generate useful information, and an analysis of the potential user groups and their involvement in the project. The visit to CATAS included also a brief technical training and field visits to two Counties and one user group at County level. In addition debriefing visits to FAO and UNDP regional offices in Beijing and Bangkok were made.

Section 1 of the mission reports gives background information of the Hainan-SOTER project, the terms of reference of this mission. Figure 1 on page seven summarizes the main components of the Hainan-SOTER information system, the information flows, and the feedback of user groups. Sections 2 and 3 gives the main findings of the visits to ISSAS and CATAS, focusing on a review of the work realized by ISSAS and CATAS respectively. The review includes: (i) the collected spatial (map), soil and terrain attribute data, which are adequate for the project goals; (ii) a series of detailed technical comments on the GIS and database so far accomplished. The main conclusions and recommendations are summarized for ISSAS in section 4.1 and for CATAS in section 4.2 respectively. The mission report includes a review of the potential user groups for the soils and terrain information systems at both provincial and county level (section 3.5). The effectiveness of the project will depend on the use of the project information products by user groups. A recommendation for strengthening the user group involvement in the project is included in section 4.2.

KEYWORDS

Soils, land resources, land management, land evaluation, information systems, database and GIS, information users, and information demand.

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1 INTRODUCTION

1.1 BACKGROUND

Upon request of FAO Regional Office in Bangkok a STS consultancy service mission was made by Sjef Kauffman[2] for UNDP project CRP/96/105: Sustainable Land Management for Agricultural Production in Hainan Province, P.R. of China, shortly indicated as the Hainan-SOTER project. The following summarizes the background and framework of the Hainan-SOTER project. This project aims at the sustainable development of the agricultural sector of Hainan Province. It will provide training of national and provincial agricultural research and extension institutions. The project goal is to complete a Soils and Terrain Information System of Hainan and support agricultural demonstration sites to benefit subsistence farmers. The information system has the potential to address a wide array of agro-environmental concerns, such as soil fertility management, land degradation (water erosion), crop suitability/evaluation for sustainable utilization of the land resources. The project will extrapolate the results of the demonstration sites to county and provincial level, indicate sound land uses of these demonstration sites, and disseminate information about improved land management, including soil conservation, soil fertility and alternative crops.

Institutional arrangement
Executing agency
China International Centre for Economic and Technical Exchanges (CICETE)
Implementing agencies
Chinese Academy of Tropical Agricultural Sciences (CATAS)
Institute of Soil Science, Academia Sinica (ISSAS)
Cooperating agency
International Soil Reference and Information Centre (ISRIC)

Project duration
1 December 1997 - 1 December 2001

Main project activities and results
1. Hainan SOTER Information System
The proposed Hainan Soils and Terrain Information System (HSIS) will contain a comprehensive soil and terrain database linked to a land-unit map. ISSAS and CATAS will both work on the establishment of the Hainan SOTER Information System. ISSAS will be responsible for the development of the Hainan SOTER Information System (HSIS) at the provincial level at a scale of 1:250,000, and CATAS for the County SOTER Information System (CSIS) at county level at a scale of 1:50,000.

2. Application tools
Specific application tools (software programmes) will be developed, which objectives are to translate the data in the HSIS and CSIS databases into meaningful information for agricultural planning and research agencies, soil and land conservation services and nature conservation services at provincial and county level. Three fields have been specified for these tools:

a) Land evaluation on issues related to sustained agricultural production, with focus on tropical crops, fruits, vegetables and seed production.
b) An interpretation of land degradation vulnerability and risk assessment with emphasis on soil erosion hazard under various land management scenarios.
c) An analysis of the present soil fertility status and the need for fertilization to underpin the present

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nutrient mining of the soils under current land use.

3. SOTER derived products

At the moment some examples of possible project deliverables are given here.

i) A series of thematic maps, easy to derive directly from the databases, such as terrain form, land cover, soil parent material, slope gradient class, soil reaction, organic matter content, plant nutrients, etc.

ii) A series of thematic maps showing results from the applications tools, presented in the form of wall maps, (electronic) atlas, CD-rom or other media. Examples of such maps are:
   - Geographic distribution of the soils classified in prime land and land with specified major soil-related constraints.
   - Geographic distribution of classified risks of soil water erosion risk
   - 'Hot spot' analysis, such as on plant nutrient decline, acidification, etc.
   - Yield gap analysis (difference between potential and actual land productivity)
   - Agricultural production decline caused by simulated water erosion

iii) Extrapolation of the results of the four Demonstration Sites to the appropriate agro-ecological zones of Hainan.

4. Demonstration sites

Sustainable Land Management Demonstration Sites will be established in four counties to strengthen extension work. These sites will form the most detailed level of information, and are included in the County SOTER information system.

For a schematic view of the main components of the Hainan-SOTER Information System, information flows and feedback from user groups, see Figure 1.

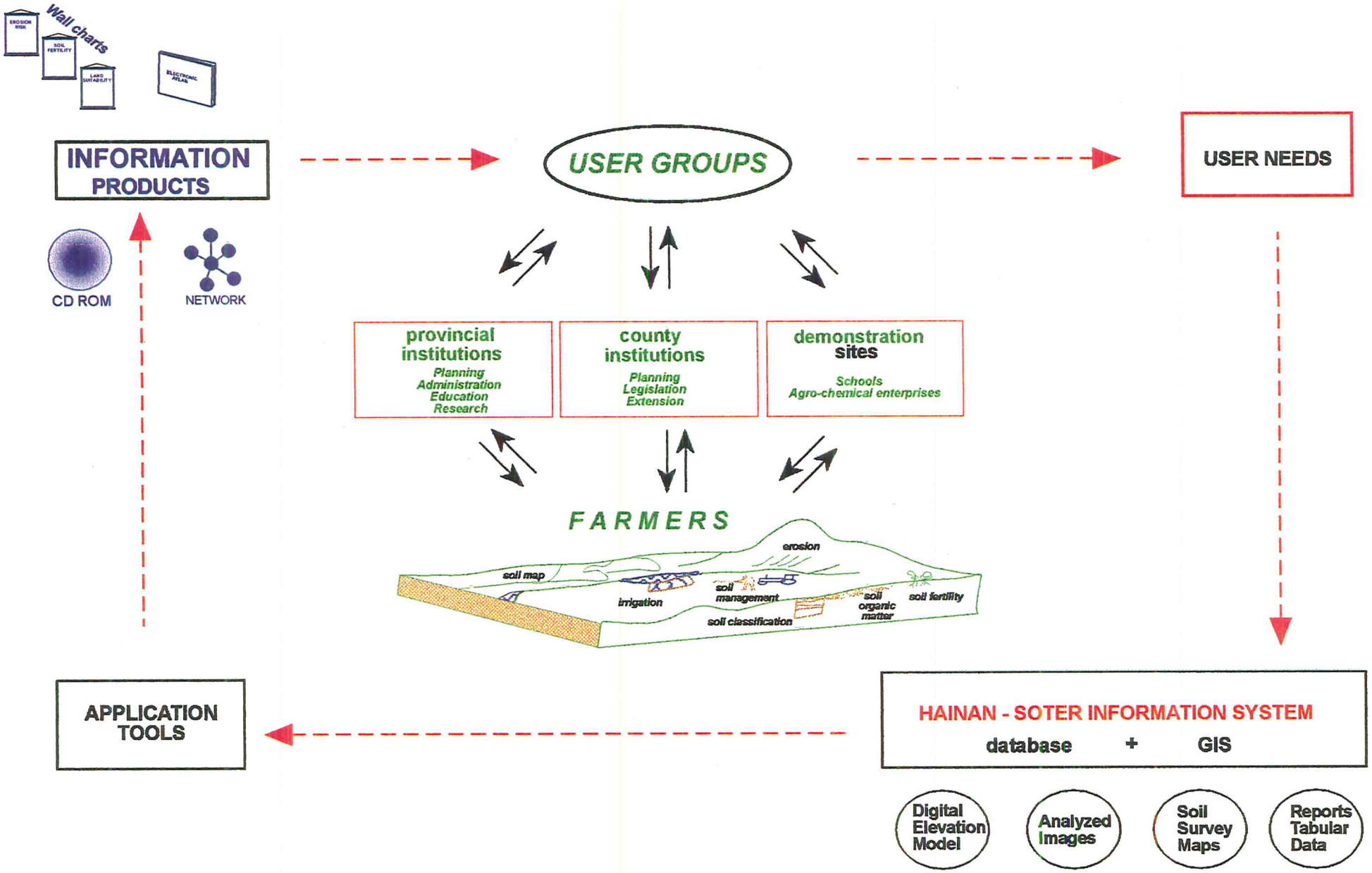

Figure 1 Main components of the Hainan SOTER System, information flows and feedback from user groups

1.2 TERMS OF REFERENCE OF THE MISSION

Terms of Reference for FAO STS Service to CRP/96/105: Sustainable Land Management for Agricultural Production in Hainan Province, PRC.

First mission for Land Management and Utilisation Consultant.

Tasks of the consultant:

- Visit and discuss with project staff of Institute of Soil Science, Academia Sinica (ISSAS) and Chinese Academy of Tropical Agricultural Sciences (CATAS) the issues related to establishing a Soils and Terrain Information System for Hainan (Hainan SOTER).
- In view of applications defined by user groups, evaluate the database structure, adequacy of land data components in the database and review progress of database development.
- Field visit to four counties where demonstrations sites are located; review and advise CATAS on a soils and terrain information system for the four counties in terms of adequate utilization for the user groups and their specific application requirements.
- Help CATAS/ISSAS in further contact with international institutions or organizations in environmental resources information system development.
- Advise CATAS/ISSAS in improving land database development and management by evaluating the following issues: present available hardware and software; the capacities of the ISSAS/CATAS project teams; contacts with holding institutions, relevant to the project; and contacts with relevant user groups.
- Prepare and submit mission report.

1.3 IMPLEMENTATION

The mission was implemented by making visits to the Chinese agencies responsible for the Hainan-SOTER project. It included a four-day visit to the Institute of Soil Science, Academia Sinica (ISSAS) in Nanjing, and a six-day visit to the Chinese Academy of Tropical Agricultural Sciences (CATAS) in Hainan. Both visits consisted of discussions with the project teams focusing on the capacities of the project teams to implement the project. The visits included a review of the progress made with the database and GIS components of the soils and terrain information systems in development, the required applications tools to generate useful information, and an analysis of the potential user groups and their involvement in the project. The visit to CATAS included also a technical training, field visits to two Counties, and a visit to an user group at County level. In addition debriefing visits to FAO and UNDP regional offices in Beijing and Bangkok were made The mission took place from 23 November to 10 December 1998. The itinerary of the mission is given in Annex 1.

In the beginning and at the end of the mission (de)briefing visits were made to the UNDP office in Beijing and the FAO offices in Beijing and Bangkok. These visits are summarized in this section.

FAO-Beijing office, 24 November
Meeting with Mr. Sun Yin Hong, programme officer for administrative and logistic issues. As recommended copies of the draft mission report prepared during the mission were handed over at ISSAS, CATAS, FAO and UNDP offices. The final draft report will be approved and distributed through FAO Regional Office in Bangkok to all agencies involved in the Hainan-SOTER project.

UNDP-Beijing office
24 November
Meeting with Mrs. Jia Lusheng, senior programme officer. The TOR of the mission was discussed, and an appointment with UNDP staf for debriefing was made for 7 December.

7 December

Meeting with Mrs. Lena M. Lindberg, Assistant Resident Representative of UNDP and Mrs. Jia Lusheng. Discussion about the main results of the mission. It was recommended that the active involvement of the user groups during the implementation of the project should be emphasized, and details on the recommendations for envisaged user group workshops should be specified in the mission report. In addition two other relevant project initiatives were mentioned, also on Hainan Island. One on biodiversity and another on remote sensing. Relevant documents will be made available.

A courtesy visit was made to Mr. Yannick Glemarec, Assistant Resident Representative of UNDP. The qualitative Land Quality Indicator approach for Vietnam was discussed. The possibility of using this approach, which is in a development stage, in addition to the presently planned land evaluation and soil erosion risk assessment will be verified by ISRIC.

FAO Regional Office in Bangkok, 7 December

Debriefing with Mr. Sunil Bhargava, Senior Country Project Officer. The draft mission report was handed over for approval and dissemination to the institutions involved in the Hainan-SOTER project.

2 MAIN FINDINGS AT THE INSTITUTE OF SOIL SCIENCE, ACADEMIA SINICA (ISSAS), NANJING

2.1 CONSULTANT ACTIVITIES

The consultant programme for the visit to ISSAS in Nanjing included the following activities:

25 November	Discussion on the activities of ISSAS in 1998
26 November	Visit to the digitizing office, discussions on the draft SOTER-unit map and the further use of the soil map
27 November	Demonstration and discussion on the attribute database files and software applications tools for the Hainan-SOTER Information System
28 November	Wrap-up session, afternoon free
29 November	Preparation of draft mission preparation report, flight Nanjing - Haikou

At ISSAS discussions were held with the following Hainan SOTER project team members:

Prof. Gong Zitong	Project coordinator
Mr. Luo Guobao	Team leader, database and applications
Mr. Zhang Ganlin	GIS and applications
Prof. Chen Hong Zhao	Consultant soil and terrain map
Mr. Duo Guohao	Consultant soil map
Mrs. Zhao Wenjuu	Database manager (analytical data)
Mr. Lu Chengwen	Database manager (terrain data)

2.2 REVIEW OF THE HAINAN SOTER INFORMATION SYSTEM (HSIS) 1:250,000

Mr. Luo Guobao presented a progress report of ISSAS activities in 1998 (see Annex 2). Based on this report it is concluded that ISSAS activities were executed in agreement with the timetable, except for a delay in the data entry (see section 2.4), and the overseas study tour, which is now planned in 1999. The computer hard and software were ordered through CICETE and so far no limitations or defects have been reported. Technical assistance was given by national consultants and by ISRIC staff during two SOTER workshops. It is recommended that attention will be given to a timely GIS training of ISSAS team members in early 1999. More information on the ISSAS progress report are is given in Annex 2.

A review could be made of of the Hainan SOTER Information System (HSIS) at a scale of 1:250,000, based on demonstrations by the ISSAS project team and technical discussions. The review is presented in three sections: the available data sources used, the status of the database and GIS components, and the applications for the HSIS system.

2.2.1 Data sources

Data sources for the HSIS include spatial information from various maps; attribute data extracted from soil survey reports and other soil research publications.

Spatial information

The construction of the SOTER-unit map is based on the following spatial information (all in Chinese):

- Topographic maps at scales of 1:100,000, 1:200,000, and 1:500,000, obtained from the Hainan Provincial Geometric Centre (HPGC) in Haikou.
- Geological maps at a scale of 1:200,000, published by Geology Publishing House, Beijing

- Soil map of Hainan Island at a scale of 1:200,000 published in 1991 by Soil Survey Office of Hainan Island, Soil and fertilization Station. Background information on this map was given by ISSAS staff member Mr. Duo Guohao. This map is based on the reduction of soil maps of Hainan Island at a scale of 1:50,000. The field work for this survey was executed in 1984 - 1987 by the Soil Survey Bureau of Guangdong Province. The map and report were made in 1988 - 1992. The Bureau of Agriculture of every county of Hainan is holding the soil maps at a scale of 1: 50,000 and the analytical data of soil profiles (see further section 3.2.2).
- Land Use Map at a scale of 1:100,000 of 1975 (not presented), published by the Guangdong Geographic Publishing House.
- Satellite images (Landsat TM?) of 1995. A brief demonstration was given of the satellite images on screen. Its main objective will be to verify the change in land use in comparison to the 1975 Land Use Map. A Land Use Map at a scale of 1:500,000 of Hainan Province, based on county data collected in 1994 and 1995, will be published by the China Land Surveying and Planning Institute in Beijing (see ISRIC Travel Report 98/08).

Attribute data
The attribute database will be derived from the following sources:
- Soils of South East China. Transect studies and development of classification criteria. Volkoff et al. 1995
- Reference profiles of Hainan Province. Soil Brief 7 & Country Report of China, published in 1995 by ISSAS and ISRIC.
- Soils of Hainan. Report accompanying the 1:200,000 soil map. Published in 1992 by Hainan Department of Agriculture, Soil and Fertilization Station (holding the information produced by the now extinct Soil Survey Office of Hainan).

A list of other publications was prepared by ISSAS, but could not be included in this report.

2.2.2 Maps, Database and GIS

The review of the progress made so far with the HSIS system is given based on the discussions of the consultant with ISSAS project team.

SOTER Procedures Manual (Chinese version)
An important contribution of ISSAS to the first SOTER training is the translation of the SOTER Procedures manual into Chinese. A draft version was distributed to the workshop participants. The final version will be published by ISSAS as a Hainan SOTER project document in 1999.

28 SOTER-unit maps 1:100,000
As an intermediate product 28 Landform/Lithology-unit maps at a working scale of 1:100,000 were produced. An explanation was given on the procedure of the manual delineation of Landform/Lithology-unit boundaries on the topographic 1:100,000, and the subsequent integration with the lithology boundaries of the geology map 1:200,000 and the soil map 1:200,000 (see below). The potential use of a Digital Elevation Model for the automatic classification of slope gradients, elevation and terrain forms was discussed. However, the price of a DEM from the Hainan Provincial Geomatics Centre (HPGC) appeared to be the main bottleneck.

Four SOTER-unit maps 1:200,000
Discussions were held with Prof. Chen Hong Zhao and Mr. Luo Guobao. The 4 Landform/Lithology-unit maps of 1:200,000 are the result of the reduction and subsequent digitizing of the above mentioned 1:100,000 Landform/Lithology-unit maps. A transparent topographic base map at a scale of 1:200,000 was purchased from HPGC. The digitizing of this base map and the boundaries of the reduced Landform/Lithology-unit map of 1:200,000 was executed on contract base by the Nanjing Geophysical

Technology (NGT) company A visit was made to NGT and a first print of the Landform/Lithology-unit map and legend was made for verification by ISSAS project staff.
The uncontrolled draft map legend includes 112 units consisting of various combinations of 10 main terrain forms and 9 main lithological formations. The Landform/Lithology-unit map contains some large units. A review of the soil map 1:200,000 showed that the spatial resolution in the lower elevation part of Hainan Island could be improved by transferring relevant boundaries of the soils map to the Landform/Lithology-unit map. It was recommended to scrutinize the soil map for this purpose and the following procedures were proposed:

- Relevant boundaries are possibly between major soil classification groups, and between those related to valley boundaries, e.g. elongated valleys along streams with poorly drained paddy soils (Gleysols).
- For small not-mappable units, generally below the minimum SOTER unit size of 0,25 cm^2, a decision should be taken to incorporate this information either as *soil component* in the SOTER-unit (mainly restricted to well drained soils) or as *terrain component* (mainly poorly drained valley soils).
- Boundaries on the soil map related to lithology should not be transferred, because the SOTER unit map contains already this information.
- Soil map boundaries based on land use differences should also not be transferred, because a separate overlay of land use will be accommodated in HSIS.

Soil analysis
Chemical and physical analysis of about 250 soil samples of the 50 reference profiles taken during the fieldwork in 1998 are analyzed at ISSAS soil laboratory. This data will be added to the attribute files (see below).

SOTER attribute database
A SOTER attribute database is in development. Two out of six main attribute database files were demonstrated (*TERRAIN and REPHORIZ* DBF files), which at present hold 43 complete and 18 incomplete reference profiles. It is therefore estimated that maximally 1/4 of the inputting work has been realized (assuming the total of reference profiles between 175 and 200). A quick perusal of the two available DBF files reveals that verification and completion is needed. For example, missing are data on soil structure, horizon depth and for a few reference profiles bulk density and moisture characteristics. Additional data input to complete the other four attribute files will be required.
It was recommended to complete the 6 main attribute files of the present 43+18 profiles before the third SOTER workshop, as the main objective of this workshop is the integrity checking of the attribute and spatial information.

Data consistency was discussed with database manager Mrs. Zhao Wenjuu. For example the question is how to convert textural classes fine silt to total silt, and clay (< 1 micron) to clay (<2 micron)? It was decided to input the data as published in the reports, and to label those differing from the SOTER standard by:
(i) using the existing laboratory identification label (lab_id), and
(ii) expanding the horizon file with a note field for short remarks on the conversion problem.
With this approach, decisions about (automatic) transfer procedures can be implemented at an appropriate moment, after consensus by ISSAS, CATAS and ISRIC on the kind of procedures.

The terrain database file was briefly discussed with Mr. Lu Chengwen. Upon request, some examples were given to clarify the distinction between a SOTER-unit, a terrain component and a soil component.

As indicated above, it was recommended to have the required 6 attribute files completed for about 30% of the database (about 60 to 70 profiles), and send these files and the ArcInfo files of the SOTER-unit map to ISRIC for preparatory work required for the third SOTER workshop.

It is envisaged that the attribute database will be expanded in 1999, aiming at a total of about 200 complete reference profiles extracted from the data sources as indicated above. It was concluded that substantial input work is required.

Land Use data file
Available is the Land Use map of 1975 and the interpretation of satellite imagery. No input of data was made so far.

Climatic data file
No data file has been prepared so far. Climatic data will be obtained through CATAS.

2.2.3 Applications

A discussion was held with Mr. Zhang Ganlin on the application tools (software programmes) to be developed or to be adapted for HSIS. The three main applications are general land evaluation, soil fertility and land degradation risk assessment, as mentioned in the project document. Copies of the report "User group Enquiry for the Hainan SOTER information system" were handed over. This report gives more information on the capabilities, needs and expectations of the user groups at provincial level, based on interviews with these groups in January 1998.

There is an urgent need information on the definition of the Land Utilisation Types (LUTs, according to FAO Framework for Land Evaluation) and crop growth requirements for most applications programmes to be developed or to be adapted to agro-ecological conditions of Hainan. The LUTs should included information on technology level, input level, market situation, farmers knowledge and skill level and husbandry practices. ISSAS preparation work will include the collection of relevant documents, especially those from which to extract crop growth requirements. ISSAS will prepare a summary of this crucial information and send it to ISRIC for comments before the SOTER training at ISRIC. A data requirement list for five potential application programmes was handed over (which included the programmes: ALES, WOFOST, QUEFTS, PLANTGRO and SWEAP). A decision on the period of this training in The Netherlands will be made during the third SOTER workshop. Prerequisite for this training is the availability of an attribute database, completed for about 60 to 70 %, and suitable for testing the applications programmes for the various agro-ecological zones of Hainan island.

3 MAIN FINDINGS AT THE CHINESE ACADEMY OF TROPICAL AGRICULTURAL SCIENCES (CATAS), HAINAN

3.1 CONSULTANT ACTIVITIES

The consultant programme for the visit to CATAS at Hainan included the following activities:

29 November	Flight Nanjing - Haikou, by car to Danzhou
30 November	Discussion on work programme with the team, cont. preparation of the draft mission report
1 December	Review of the terrain form map of Dongfang and Qiongshan Counties
2 December	SOTER programme installation, demonstration and exercises; review terrain form map of Danzhou County
3 December	Fieldwork in Dongfang County; at the end of afternoon database session
4 December	Continue database session; technical and planning discussions; Visit to Bureau of Agriculture of Danzhou County
5 December	Fieldwork in Danzhou County; by car to Haikou, preparation of draft mission report
6 December	Wrap-up session, Flight Haikou - Beijing

Upon request of the National Project Coordinator the mission programme was slightly modified. Based on the project team demand for technical support, the modified programme included more discussions with CATAS project team. As a consequence the number of field visits was reduced to two counties instead of the four mentioned in the mission TOR.

The discussions were held with the following project team members:

Prof. Chen Qiubo	National project coordinator
Mr. Qi Zhiping	Team leader
Mr. Lin Dian	SOTER-unit map delineation
Mrs. Peng Jinlian	Database manager
Mr. Li Chaohui	Database manager (not present at the moment of the mission, he replaced the former project team member Mr. Zhou Chihui)
Mr. Zhou Jiannan	Translator

The discussion with the Bureau of Agriculture of Danzhou County was held with:

Mr. Wu Manfeng	Director agro-technical extension centre

3.2 REVIEW OF THE COUNTY SOTER INFORMATION SYSTEM (CSIS) 1:50,000

Project activities are presented in CATAS Annual Project Report of 1998. Comments and recommendation on various activities and results is included in section 3.3. Here only two activities are mentioned.

Training of CATAS project team members

Training of the CATAS project staff in 1998 included the hands-on training during the two SOTER workshops by ISRIC and during consultancy visits of ISSAS staff. During this mission the project staff was also trained in several aspects of the SOTER software (see section 3.2.2).

So far the CATAS project staff has not been trained in GIS programmes. It was recommended that the

CATAS project staff will be trained in GIS techniques, because several present activities of the team are related to GIS programme requirements. For example, at least one staff member should be trained in ArcInfo, because this is also used by ISSAS. It is assumed that this basic training in ArcInfo will need about 2 to 3 months, which training can be realized by HPGC or another national institution. In addition it was recommended that most project team members will be trained in the use of ArcView, which will require a national training course of about 2 weeks.

One team member has a moderate capability of spoken English, others virtually none. English proficiency will be needed for the SOTER training in The Netherlands, therefore, language training was recommended.

Computer equipment
Computer equipment has been ordered through CICETE but not received so far. This has been discussed during the tri-partite review.

Below a review of the County SOTER Information System (CSIS) at a scale of 1:50,000 will be given, based on demonstrations by the CATAS project team and technical discussions. The review is presented in three sections: the available data sources used, the status of the database and GIS components, and the user groups for the both the HSIS and CSIS systems.

3.2.1 Data sources

Data sources for the County SOTER Information System (CSIS) include spatial information from various maps; attribute data extracted from soil survey reports.

Spatial information
The construction of the SOTER-unit map is based on the following published maps (all in Chinese):
- 125 topographic maps, at (working) scales of 1:25,000 and a contour line interval of 5 meter, of the Counties Danzhou, Dongfang, Baoting and Qiongshan.
- A topographic base map at a scale of 1:50,000 is needed, but has not been purchased so far.
- Enlarged lithology unit maps at a scale of (approximately?) 1:100,000, derived from 1:200,000 geological maps, published by the Geology Publishing House, Beijing. It is questionable whether this information should be used for the County SOTER unit maps, because the county soil maps at a scale of 1:50,000 contains probably more detailed lithological information. Moreover, it was expected that these maps have inadequate topographical reference information for the exact transfer of boundaries.
- Soil maps of the Danzhou, Dongfang, Baoting and Qiongshan Counties at a scale of 1:50,000. These maps were published in 1984 and 1985 by the Soil Survey Office of these Counties (at present these maps are held by Bureaus of Agriculture of the respective Counties, because of closing of the project based Soil Survey Office).
- Land use maps at a scale of 1:50,000 are probably also available for all four counties, but have not been purchased so far.

Attribute data
The attribute database will be based upon the following publications (all in Chinese):
- Soil survey report of Danzhou County, *Guangdong Province* (now Hainan Province). Published in 1984 by Danzhou Soil Survey Office.
- Soil survey report of Dongfang County, *Guangdong province* (now Hainan Province). Published in 1985 by Dongfang Soil Survey Office.
- Soil survey report of Qiongshan County, Hainan Province. Published in 1988 by Danzhou Bureau of Agriculture.

- Soil survey report of Boating County (not yet purchased).

3.2.2 Maps, Database and GIS

Below a review of CSIS project output in 1998 is given based on the discussions of the consultant with CATAS project team. The consultant activities included also an on-the-job training of the CATAS project team in the functioning of the SOTER attribute data input and edit programme.

Terrain form maps (working scale 1:25,000)
Progress on CSIS include the delineation of major terrain forms according to the SOTER guidelines on 125 topographic maps at a scale of 1:25,000. Results of selected areas of three counties were discussed with the project team. Main results and comments include the following.

Dongfang County
For terrain form units composed of two major terrain forms it was recommended to code provisionally according the dominant main form. For example:
- a map unit with 2/3 steep mountains (TM) and 1/3 steep hills (TH) will be coded as steep mountains TM (TH-33)
- a map unit with 80 % steep hills (TH) and 20 % steep mountains (TM) will be coded as steep hills TH (TM-20).

It is noted that this is only a provisional work map code, because the SOTER-unit will be uniquely coded with only 4 digits (from 1 > 9999). Further description of such complex SOTER units can be made by recognition of 2 or more terrain components.

The production of the final SOTER-unit map needs the integration of the terrain form maps with the lithology and relevant information of the soil map. The County soil maps hold also detailed geological information. Therefore, it is recommended to use this information, and, as indicated in section 3.3.1, not to use the enlarged information of the geological maps.

Similar to the ISSAS work, the spatial resolution of the terrain form map can be considerably improved by transferring relevant boundaries from the soil map, resulting in a SOTER-unit map (see further Qiongshan County for more information).

Qiongshan County
In comparison to the other Counties, Qiongshan County has a rather plain-like appearance. The project team proposed a subdivision of the plain terrain form (LP) into three sub-divisions according to three dominant slope gradient classes (<2 %, 2-5 % and 5-8 %). These subdivisions appeared to be too subjective for visual analysis and manual delineation. An exact boundary of such narrow slope classes can not be consistently traced all over the map, because of the continuous grading of contour intervals. The use of a Digital Elevation Model (DEM) is therefore recommended as an objective solution for the less exact manual delineation. However, the high purchase costs appeared to be the bottleneck.

Together with the project team, a manual delineation exercise was made and the results compared with the soil map at 1:50,000. The following conclusions were made:
- The soil map does not show the obvious and significant boundaries of main terrain forms such as hill and plain units as delineated on the topographic map.
- The soil map, however, showed a much higher and presumably (awaiting field check, see section 2.4) more reliable spatial resolution within the plain unit, but also in other units. This means soil units are potential mappable SOTER-units.
- The very detailed subdivision of the soil legend units are not in all cases meaningful. Moreover, insufficient attribute data are available to cover the large number of all these small units.

It was therefore recommended to aggregate the lowest level soil legend units into larger units. Provisionally some suggestions were given (conditional to a consensus between the CATAS and ISSAS teams):

- The 73 valley/depression 'paddy' soil types can be grouped into 5 major paddy soil classes, which are related to the topographic position, i.e. from relatively dry to very wet paddy soils.
- The 50 upland soil types can be grouped into 10 major soil units, which are determined by relevant lithology groups.

Danzhou County

The main terrain forms of Danzhou County include plain, low gradient and steep hills. Similar conclusions as in the Qiongshan County analysis were made:

- The plain subdivision into three narrow slope classes did not work out accurately.
- The soil map does not show the meaningful terrain forms as delineated on the topographic map. However, it include a much larger spatial resolution, which can be used for the division of the (very) large terrain form unit.
- Similarly to the Qiongshan soil map, the legend of the soil map of Danzhou County can be simplified in major soil types.

Boateng County

A brief review of the terrain form and soil maps of Boateng County showed similar conclusions and recommendations as for the other counties.

Various

Because all soil survey reports are in Chinese, for communication with ISRIC, it was recommended to make a summary of the procedures for the soil map unit delineation, as well as for the soil analytical work.

It was recommended to add a topographic overlay of 1:50,000 to CSIS. This topographic base should include the roads, rivers, and villages and other relevant topographic marks, in order to make reference possible for the users of the CSIS thematic maps. It is observed that the county soil maps have insufficient topographic information such as secondary roads. Therefore soil units can not always be easily located in the field.

The map review of all four counties indicated the necessity to construct a SOTER-unit map by correlating and integrating the terrain form units, terrain components and soil components. It was recommended that ISSAS will assist the CATAS team in this work, especially for the aggregation of the soil map legend units and the reclassification of the soil types. The third SOTER workshop should also include this aspect.

Attribute data input

During several sessions CATAS project staff was trained in the various aspects of the SOTER software. This included the installation of the SOTER programme and demonstration and exercises in data input, editing, and direct manipulation of the SOTER attributes files with the database programme FOXPRO. In addition, the SOTERLAC[3] Viewer was demonstrated to become familiar with SOTER-derived thematic maps such as terrain form, lithology, hypsometry and the accompanying soil and terrain attribute datafiles.

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3 SOTERLAC is the recently established Soil and Terrain database for Latin America and the Caribbean, developed by FAO, UNEP and ISRIC. The SOTERLAC Viewer can be captured from the ISRIC website.

The four soil survey reports, accompanying the 1:50,000 county soil maps, include field and analytical information of an estimated 500 soil profiles, of which the exact locations are indicated on the soil maps. For the proposed "window" areas of 25x25 km of each county (see section 3.3), the number of reference profiles are: 24 for Danzhou, 25 for Qiongshan, 63 for Dongfang and still to be determined for Baoting County.
The collection of these soil maps and soil survey reports, which are very crucial for the development of CSIS, took more time than foreseen. Therefore, the input of the attribute data of the reference profiles was delayed. With the present training of the project staff this work can now be initiated and it is expected that the input of the approximately 100 to 125 soil reference profiles (for the proposed window areas) will be ready in 2 to 3 months.
Data input should consider the following:

= Codes should follow the following rules:
  - Each county should be a separate SOTER project.
  - SOTER unit IDs will be numbered from 1 to 9999
  - Terrain and Soil components will be numbered 1 to 9
  - Soil Profile IDs will follow the number as given in the soil survey report, preceded by two capital letter indicating the respective county (DF=Dongfang, DZ=Danzhou, BT=Baoting, QS=Qiongshan).
= Codes of the SOTER-unit polygons, terrain and soil components are not soon available, awaiting the final SOTER-unit map construction for the window areas. Therefore input work for these databases (TERRAIN, TERRCOMP and SOILCOMP) has to start at a later date. However, it is recommended to start the input of the soil reference profiles immediately (REPHORIZON and PROFILE), see further section 3.3.
= Transfer of the data of the soil survey reports to the SOTER standard will need substantial time, because for example:
  - The need to reclassify the outdated classification names in the soil survey reports to the FAO and the new Chinese classification systems.
  - Boundaries for the sand, silt and clay fractions differ considerably from the international SOTER standard. Similar to the ISSAS situation, it was recommended to input the data as published in the soil survey reports. Decisions on (automatic) transfer procedures can be implemented at an appropriate moment after consensus on the kind of procedures by ISSAS, CATAS and ISRIC.
  - Transfer from Chinese information to English SOTER codes. It was recommended to use the standard SOTER data entry forms as given in the appendix of the SOTER procedures manual.
= Missing data will be a common feature, however, a part of the mandatory data is included in the County soil survey reports.

Other attribute data
There was no time to discuss in detail the land use data files. So far these data are not yet collected, but there is an indication to get them on time. Also monthly climatic data of several elements will be collected for the relevant major ecological zones of Hainan. Daily rainfall data will be required for quantitative simulation models, however it is said that such data are very costly to obtain. Nevertheless, it is expected that for 2 to 3 stations this will be possible (at least for CATAS own meteorological station at Baodao Xincun).

3.2.3 Field visits to Dongfang and Danzhou Counties.

The mission time allowed for field visits to Dongfang and Danzhou Counties. These visits were made to verify the map units with focus on recognition of delineated boundaries and soil units in the field. The findings of these visits reconfirmed the analysis and recommendations as given before. For example:

- Major terrain forms can be accurately delineated on the topographic maps (1:25,000). For example, low gradient and steep hills (SH) are clearly distinguishable SOTER units. Generally, these units can be more exactly delineated on the topomaps. The plain subdivisions (LP1, LP2 and LP3) tend to

be exaggerated and can therefore be somewhat lower graded. However, as indicated before these boundaries of subdivisions should not be transferred to the SOTER unit map.
- Valley units are well delineated and clearly distinguishable soil units, which can be delineated on the SOTER unit map.
- Relevant soil map boundaries are potential SOTER-unit boundaries.

3.2.4 Proposed workplan

It is recommended that the input work of attribute data to the SOTER database should be continued with priority, with focus on the selected "window" areas (see below). It is estimated that more than 500 soil reference profiles are contained in the four county soil survey reports. The input and verification of this large number of profiles is a substantial workload.

There is also substantial work involved in the finalization of the SOTER-unit maps. The following activities are foreseen:
- Review and corrections of the delineation of the draft Terrain Form maps, as delineated on the 125 topographic map sheets at scale 1:25,000.
- Copying the boundaries of these 125 sheets to a transparent base (1:25,000).
- Reducing this base to an estimated 32 sheets at a scale of 1:50,000 (also on transparences)
- Transfer of relevant soil boundaries as discussed before to these sheets, which will result in 32 final SOTER-unit map sheets (1:50,000). This should also include the transfer of the locations of the more than 500 reference profiles.
- Digitizing of the 32 SOTER-unit maps. This should be carried out on a contract basis outside CATAS, as done by ISSAS.

It is estimated that the completion of the above shortly described activities for the four counties is a heavy workload for the present 3 CATAS team members. The time schedule for the team members, having also other duties, can therefore not be overseen. It is therefore recommended to divide the work practically in two steps:

Step 1 Execute the work of both attribute file and SOTER-unit compilation for selected areas of 25 x 25 km each, around the demonstration sites in each county. Such a "window" area will cover about 1/4 of each county. This will therefore also approximately reduce the total workload to about 1/4. It is noted that the proposed "window" areas are included in the definition given in the project document.

Step 2 Expand the work for the SOTER-unit maps and the accompanying attribute files of these windows to the full County size, depending on the availability of time and budget.

Step 1 will quickly result in SOTER-unit maps and attribute files, which subsequently can be verified and correlated with the 1:200,000 SOTER-unit map of ISSAS during the third SOTER workshop (assuming this workshop will be held in March 1999). Once this phase is concluded the expansion to the full County size can be made with more confidence and reliability.

3.3 EFFECTIVINESS OF THE INFORMATION SYSTEMS

It is the project's objective to design the information products to be generated by the project in consultation with potential user groups, because consensus between producers and users of information is essential for the effectiveness of the use of the project results.

3.5.1 User groups at provincial level

Detailed information on the potential user groups at provincial level is given in project report 3: "User Group Enquiry for the Hainan SOTER Information System". This enquiry is based on interviews with 8 user groups, which were made directly after the Inception Workshop in January 1998. This enquiry shows the interest of these users in the soils and terrain information to be included by HSIS. All user groups have recently established computerized facilities and are able to work with map and attribute data. The user groups confirmed the interest in the envisaged three main application fields: land evaluation, soil fertility assessment and erosion risk assessment. In view of the rapid changes in the agricultural sector as well as in the information technology communication sector at Hainan it is recommended to have active involvement of the main user groups during the project execution.

3.5.2 User groups at county level

The mission programme allowed to visit to Bureau of Agriculture of Danzhou County as one of the potential county user groups for CSIS. An meeting was held with Mr. Wu Manfeng, the Director of the Agro-technical Extension Centre (AEC), which forms part of the Bureau. The meeting should be seen as a first step in the recommended user group enquiry at county level.
The extension service of the Bureau of Agriculture was established in 1960. Institutional changes are the separation of the forestry section, which forms now part of the Bureau of Forestry of Danzhou county, and later also animal husbandry section becoming autonomous. A second fundamental change from extension point of view was the transformation of the farmer communes into individual farmer villages.

At present the Agro-technical Extension Centre (AEC) has about 100 staff members, of which half at the main office in Na-Da town and the other half in about 50 townships in Danzhou County. The AEC gives regularly extension and training courses at the level of township technicians, aggregated villages and small or "natural" villages (the former production brigades).

Examples of training topics include the growing of "winter" vegetables, planting practices, disease and pest control, nursery practices and soil fertilization. However, irrigation and water erosion issues are not the mandate of AEC. Irrigation is the responsibility of the Bureau of Water Conservation and soil erosion of the Bureau of Forestry.

The sustainable land management demonstration site at Meiwan Xincun, oriented by CATAS, is already incorporated in the extension programme of AEC.

Three main topics of concern of the farmers were mentioned: the need of obtaining good varieties, the training in suitable cultural practices, and more frequent advisory services.

At present the distribution/selling of fertilizers, seed and farm tools and equipment is an estimated 60 % through state cooperatives and 40 % through commercial firms.

The AEC is very interested in the information in CSIS, related to topics such as land evaluation and soil fertility recommendations. Although CSIS can partly fulfil the information needs of AEC, it has been emphasized that at the scale of 1:50,000 no specific recommendations can be given for individual farms.

3.5.3 Proposal for strenghtening user group involvement

Information collection and establishing the HSIS and CSIS information systems is initiated and after nearly one year it can be concluded that good progress has been made, and the ISSAS and CATAS teams have confidence to complete this technical task within the project workplan. Based on the discussions with the teams, the user group enquiry at provincial level and the brief consultation of one user group in one county it appears that communication with the user groups should be strengthened. The effectiveness of information products to be delivered to the user groups depends on a sound communication with user groups. Therefore, the following two activities are proposed:

a Execute an user group enquiry at County level. The interview with the AEC indicated already the following potential user groups at county level:
   - Bureaus of Agriculture (extension services)
   - Bureaus of Forestry
   - Bureaus of Water Conservation Services, and possibly the
   - Commercial agro-technology sector.

b Organize workshops at Provincial and County level to show intermediate information products. Such an intervention will give the project teams a first hand insight in how the first results are received by the user groups and what kind of modifications are needed in functionality, effectiveness, and easy data handling from the users' point of views.

With the present progress and the workplan for 1999, it is expected that intermediate products for these proposed workshops can be ready by the end of 1999 or beginning 2000.
A detailed proposal should be submitted to UNDP, because these two activities are not foreseen in the project document.

4. MAIN CONCLUSIONS AND RECOMMENDATIONS

4.1 General

All tasks as specified in the TOR of the mission (section 1.2) could be realized during the mission. On request of CATAS a modification was made in the programme at Hainan. Instead of field visits to four counties, these visits were limited to two counties. This made it possible to programme more time to discussions with the project team on the County-SOTER system. In the following the specific conclusions and recommendations are given separately for ISSAS and CATAS.

4.2 ISSAS

The main conclusions and recommendations for the Institute of Soil Science, Academia Sinica (ISSAS), Nanjing ISSAS relate to the Hainan SOTER Information System (HSIS) at a scale of 1:250,000.

In 1998, substantial progress has been made with the HSIS system. Two SOTER training workshops and various national consultancies enabled the ISSAS project team to make a draft SOTER-unit map and to realize the input of attribute data of about 1/4 of the soil profiles. The main recommendations, as discussed in section 2, are summarized here.

Project team
Strengthen the project team capacity in GIS techniques, by realizing a national training in ArcInfo and ArcView in the beginning of 1999.

Database and GIS components
- Improve the spatial resolution of the draft SOTER-unit map by transferring relevant boundaries of the soil map at a scale of 1:200,000.
- Give priority to complete data input of the six attribute datafiles of those SOTER-units, in which the presently 60 reference profiles occur, and then to continue further expansion of the database to the estimated 175-200 reference profiles. A realistic workplan should aim to finalize this substantial workload in the first quarter of 1999.
- Focus the third SOTER training workshop in Nanjing on quality control and integrity checking of both spatial and attribute information in the office (followed by field checks in Hainan, see below). Procedures of linkage between spatial and non-spatial information files should be included in the programme.

Application tools for HSIS
In the beginning of 1999 make a summary of the available information relevant to the application programmes (software tools) for HSIS, with especial attention to the crop growth requirements for main crops, as proposed by the user groups at provincial level.

4.3 CATAS

The main conclusions and recommendations for the Chinese Academy of Tropical Agricultural Sciences (CATAS) refer to the Hainan County SOTER (CSIS) Information System at a scale of 1:50,000 and to the interactions with the user groups at both provincial and county level.

Substantial progress has been made with the development of the County SOTER Information System

(CSIS). Crucial information for CSIS has been collected by CATAS, which consist of county soil maps at a scale of 1:50,000 and soil survey reports with a large number of soil profile data. In addition, a draft delineation of terrain forms on 125 topographic maps at a scale of 1:25,000 has been realized. The main recommendations for CATAS, as discussed in section 3, are summarized here.

Project team

- Strengthen the project team capacity in GIS techniques, by organizing for CATAS team members a required national training in ArcInfo and ArcView in the first half of 1999.
- Where relevant, schedule English language training for study tour and other visits abroad.

Workplan

Divide the work for the compilation of the four County SOTER-unit maps and related attribute files in two phases. Firstly, execute the work in selected window areas of 25 x 25 km around CATAS demonstration sites, and secondly expand this work to the full county size, once work on the selected window areas is completed.

Database and GIS components

- Improve the spatial resolution of the draft County SOTER-unit maps by transferring relevant boundaries of the county soil maps, including lithology information, at a scale of 1:50,000.
- Give priority to finalize the data input of the 6 attribute datafiles of the estimated 100 to 125 reference profiles of the four window areas. Expansion of the database to the four full counties will require a further input of an estimated 400 soil reference profiles.
- Use the SOTER input forms for the transfer of attribute data from the soil survey reports, and follow the accorded coding rules.
- Focus the third SOTER training workshop in Hainan on field correlation and quality control of both HSIS and CSIS Systems. As mentioned before, this should include the correlation between the SOTER-unit maps, while database integrity checking should be realized at ISSAS in Nanjing.
- Start the collection of land use and climatic data, and the soil fertility experiments for the proposed main crops relevant to the application programmes, with especial attention to the crop growth requirements.

User groups for HSIS and CSIS

Strengthen user group involvement by (i) realizing an user group enquiry at county level, and (ii) by organizing workshops to discuss intermediate Hainan-SOTER project results with invited user groups, in order to guarantee functionality and effectiveness of information products to be generated by the project. A proposal for these activities should be made and submitted to UNDP.

ANNEX 1 - ITINERARY

November
23-24 Amsterdam - Beijing
24 Beijing, visit to FAO and UNDP offices
24 Beijing - Nanjing
25-29 Nanjing, meetings at ISSAS
29 Nanjing - Hainan
30 Danzhou, meetings at CATAS
December
1-2 Danzhou, cont. meetings at CATAS
3 Dongfang County field visit
4 Danzhou, cont. meetings
5 Danzhou County field visit; Danzhou to Haikou
6 Haikou to Beijing
7 Beijing, visit to UNDP office
7 Beijing - Bangkok
8 Bangkok, visit to FAO Regional Office; reporting
9 Bangkok, visit to DLD and IBSRAM; reporting
9-10 Bangkok - Amsterdam

Detailed information on the programme of the meetings at ISSAS and CATAS is given in sections 2 and 3.

ANNEX 2 – Summary of ISSAS activities as reported by Mr. Luo Guobao in the 25 November session at ISSAS

First SOTER training workshop (activity 1.3.1)[4]
ISSAS organized the first SOTER training workshop from 18-22 January 1998 in Nanjing. The training was given by ISRIC staff member Mr. Vincent van Engelen.
Participants included 8 CATAS staff members and 15 ISSAS staff members. Another 10 participants came from institutions of 10 regions/provinces, who are interested to introduce the SOTER methodology in their institutions.

Purchase of computer equipment and satellite images (1.3.3 a,b)
Computer equipment according to the specifications of ISSAS Annual Work Summary report includes: overhead projector, fax machine, slide projector, air-conditioner, 2 sets of PCs (PII/300), 3 sets of portable PCs (4000 CDT), 2 digitizers Calcomp 32180 and 34600, digital camera (DS-210), a workstation (SUN), plotter (HP2500CP), scanner (ARTEC AT1). The software includes the Geographic Information System programmes ArcInfo and ILWIS, and the satellite images processing programme ERDAS. All materials were purchased through CICETE in Beijing. So far no limitations or defects have been reported.

National consultancy for ISSAS (1.5.1)
A national consultant gave technical assistance to ISSAS for the installation of the hardware and software. All software is operational and no limitations were reported. Also consultancy was given for the interpretation of the satellite images. A report in Chinese on the latter and an English abstract are available.

ISSAS consultancy for CATAS (1.5.1)
In April and May, ISSAS gave technical assistance to CATAS in Hainan for the production of the SOTER-unit map delineation at county level scale 1 : 50,000. Guidelines in Chinese were prepared, which included the procedures for base map production: delineation of terrain form on topographic maps 1: 50,000, overlaying this with the lithology, and when available with soil maps. According to ISSAS, the CATAS team should be trained sufficiently to accomplish production of the SOTER-unit maps at county level at a working scale of 1:25,000, which will be reduced to the scale of 1:50,000.
During April-May period substantial fieldwork was executed by ISSAS and CATAS, which included study and sampling of 50 reference sites. These sites were selected to cover those map legend units without soil observations. Soil analysis of these samples is executed by the ISSAS soil laboratory in Nanjing.

Second SOTER training workshop (1.3.4)
CATAS organized the second SOTER workshop at Hainan from 22 -31 May. Mr. Vincent van Engelen of ISRIC provided training and backstopping assistance. The workshop included discussions at CATAS Danzhou offices and four days of field visits. Main objective was the correlation and verification of the delineation of the SOTER-unit map at a working scale of 1:100,000 and the content of the legend units. This work was mainly restricted to the verification of terrain forms and lithology. It appeared that the sloping and steep landforms as defined in the SOTER Procedures Manual required some minor modifications in order to be applicable at the working scale of 1:100,000.

ISSAS consultancy for CATAS (1.5.2b)
Ad-hoc technical assistance given by ISSAS to one CATAS staff member during his visit to Nanjing in October. Several questions were discussed, which are related to overlay-process of the terrain form map

[4] The number between the brackets refer to the activity number as given in the project document

onto the lithology map, transfer of geology to lithology map, coding and reclassification from old to new Chinese soil taxonomy.

Overseas study tour (1.2.2)
The overseas study tour planned in 1998 has been postponed to 1999. This will not limit progress of the project. A final decision for location(s) to be visited will be taken in the beginning of 1999. Possible candidates are institutions in Kenya, Hungary and Uruguay. ISRIC will keep CATAS and ISSAS informed about new developments of national and regional SOTER activities, such as those in South and West Africa.

Third SOTER training workshop (1.3.2)
The third SOTER training workshop will be organized by ISSAS in the first quarter of 1999.