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PROCEEDINGS OF THE INTERNATIONAL WORKSHOP ON PROCEDURES MANUAL REVISIONS for the GLOBAL SOILS AND TERRAIN DIGITAL DATABASE

(Wageningen, 24-26 April 1990)

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1. INTRODUCTION

1.1 History

The proposal for the development of a World Soils and Terrain Digital Database at a scale of 1:1 M, the SOTER Project, was officially endorsed during the 1986 Congress of the International Soil Science Society (ISSS) in Hamburg. The primary aim of the SOTER Project is to develop a worldwide computerized database of soils and terrain attributes with the ultimate view of providing decision- and policy-makers with a wide range of accurate, timely interpretative analyses. The resulting database will further serve as a basis for updating the Soil Map of the World at a scale of 1:1 M (see SOTER 1986b).

In short, the SOTER database will have the following characteristics:

a) average scale of 1:1 M
b) compatible with global databases of other environmental resources
c) amendable to updating and purging of obsolete and/or irrelevant data
d) accessible to a broad array of international, regional and national decision- and policy-makers responsible for the development, management and conservation of national resources
e) transferable to developing countries for national data base development at larger scales.

Research, development and testing of methodologies were the main technical activities during the first phase of SOTER (see SOTER 1986a, 1988a, 1988b, 1989). Preparations for developing a universal legend were initiated in January 1986. The first draft of the "SOTER Procedures Manual for Small Scale Maps and Database Compilation" was completed in 1988 and widely circulated for comments (Shields and Coote, 1988a). These procedures were tested for their applicability and usefulness in the first pilot area which comprises parts of Argentina, Brazil and Uruguay (LASOTER). Based on the field experience gained in using the procedures some modifications to the manual were proposed (see Peters, 1988) which resulted in the publication of the second draft (Shields & Coote, 1989). The concepts were further tested during pilot studies carried out in the NASOTER (USA/Canada) and BRASOTER (Central Brazil) areas.

Meanwhile, the basic requirements of the Relational Database Management System (RDBMS) and Geographic Information System (GIS) of the SOTER "computer" were identified (see Pulles 1988, Van Engelen 1989). Benchmark testing of several GIS systems for their usefulness in SOTER context, using the digital data base created for the LASOTER area, pointed at the need for some changes in the original database structure and hence legend concepts and definitions. The resultant third revision of the SOTER procedures manual (ISRIC 1990, alias SOTER 90/2) was widely circulated for comments amongst a broad spectrum of international scientists. Their constructive comments were discussed in plenary sessions during the international "SOTER Workshop on Procedures Manual Revisions" which was convened in Wageningen from April 24-26, 1990, at the International Soil Reference and Information Centre (ISRIC).

1.2 Objectives of workshop

The main objectives of the workshop were to:

1. Discuss the revised legend concepts and definitions (SOTER 90/2) with a view to reaching a consensus about the final format of the database.

2. Invite comments and criticism on the SOTER Procedures Manual from a wider group of experts than those who have been directly involved in developing SOTER.

3. Review progress of activities carried out in the respective study areas.

4. Discuss future activities of SOTER.

2. SOTER PROCEDURES AND ATTRIBUTE CODING

2.1 General

The workshop was opened by the chairman, Dr. Sombroek, who welcomed the participants (see Appendix I) and gave a review of the achievements to date of the SOTER Project. Dr. Oldeman, the Project manager of SOTER, subsequently presented the agenda (see Appendix II).

The main proposed changes in database structure, concepts and definitions were reviewed by van Engelen. They include (see SOTER 90/2, Chapters 1/3):

- The use of terrain units (sensu SOTER mapping units) instead of the originally introduced "unique polygons" (see Shields & Coote 1988). In the revised approach one or more "polygons" can be delineated for each terrain unit. Inherently, these "delineations", or "series of polygons of identical content", will have identical attribute data.

- A change in the strict requirements for the maximum (4) number of terrain-soil components that may be defined within a terrain-unit.

- A modification in the database structure which was mainly made with a view to ensuring better data storage/retrieval efficiency (see Figure 1).

- A change in the number and format of the SOTER attribute data and rearrangement thereof within the respective data layers.

- The use of numerical data, in case of quantifiable attributes, instead of the originally used numerical class-values.

- The introduction of the concept of a generalized or synthetic profile, with accompanying confidence limits, to characterize the dominant soil of a given terrain-soil component.

2.2 Discussion and recommendations

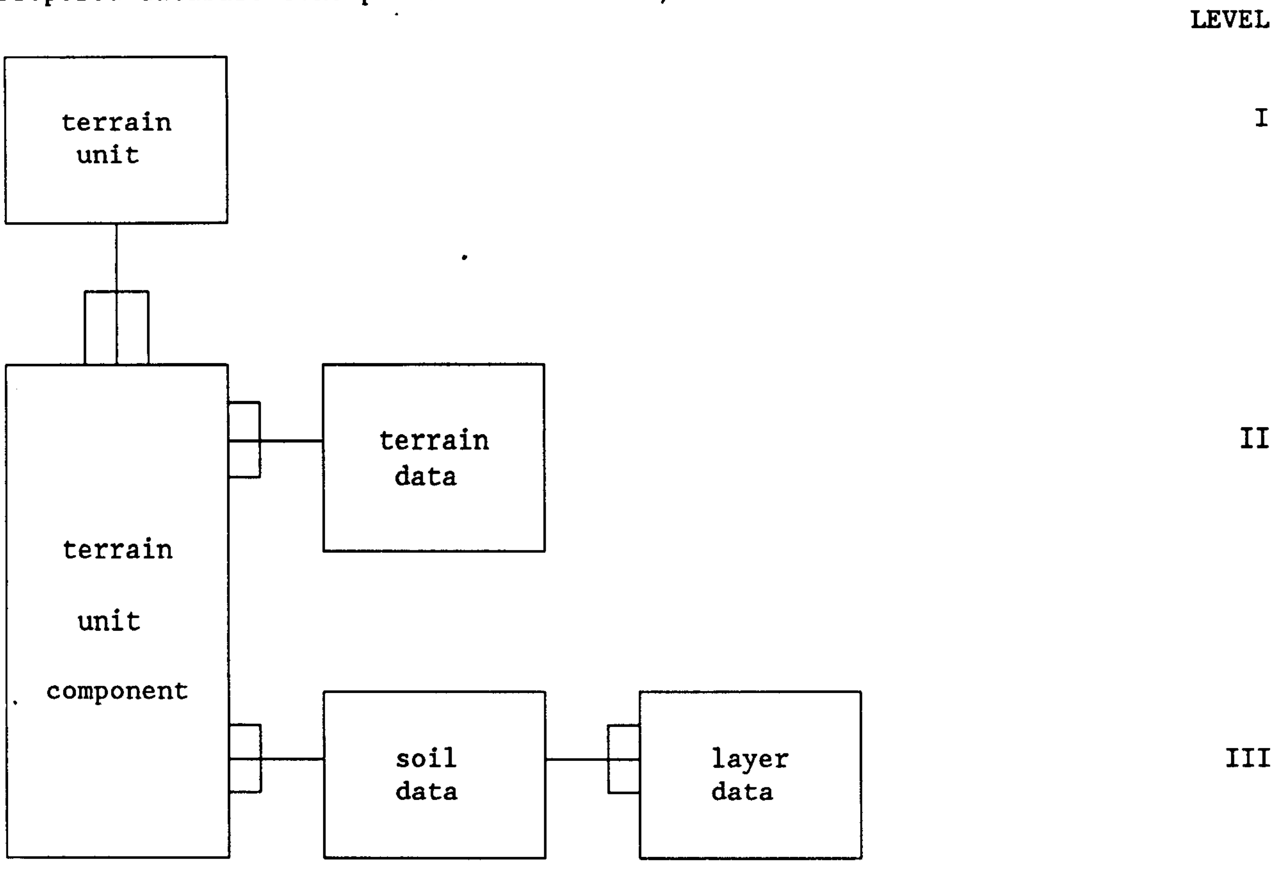
The revised version of the SOTER Procedures Manual was scrutinized during a number of sessions. The main discussion points and recommendations are summarized in this subchapter.

<u>Terrain and soil database</u>

1. Doubts were expressed as regards the pretended "scale independency" of the SOTER database. What is meant is that the structure of the database can be used at different scales (up to 1:0.25 M). The SOTER database proper, however, is primarily being developed for applications at a scale of 1:1 M. It may also be used to aggregate datasets to smaller scales.

2. The hierarchical structure of the database is depicted in Figure 1.

Proposed database concepts SOTER manual 90/2



Proposed database concepts SOTER Workshop April 1990

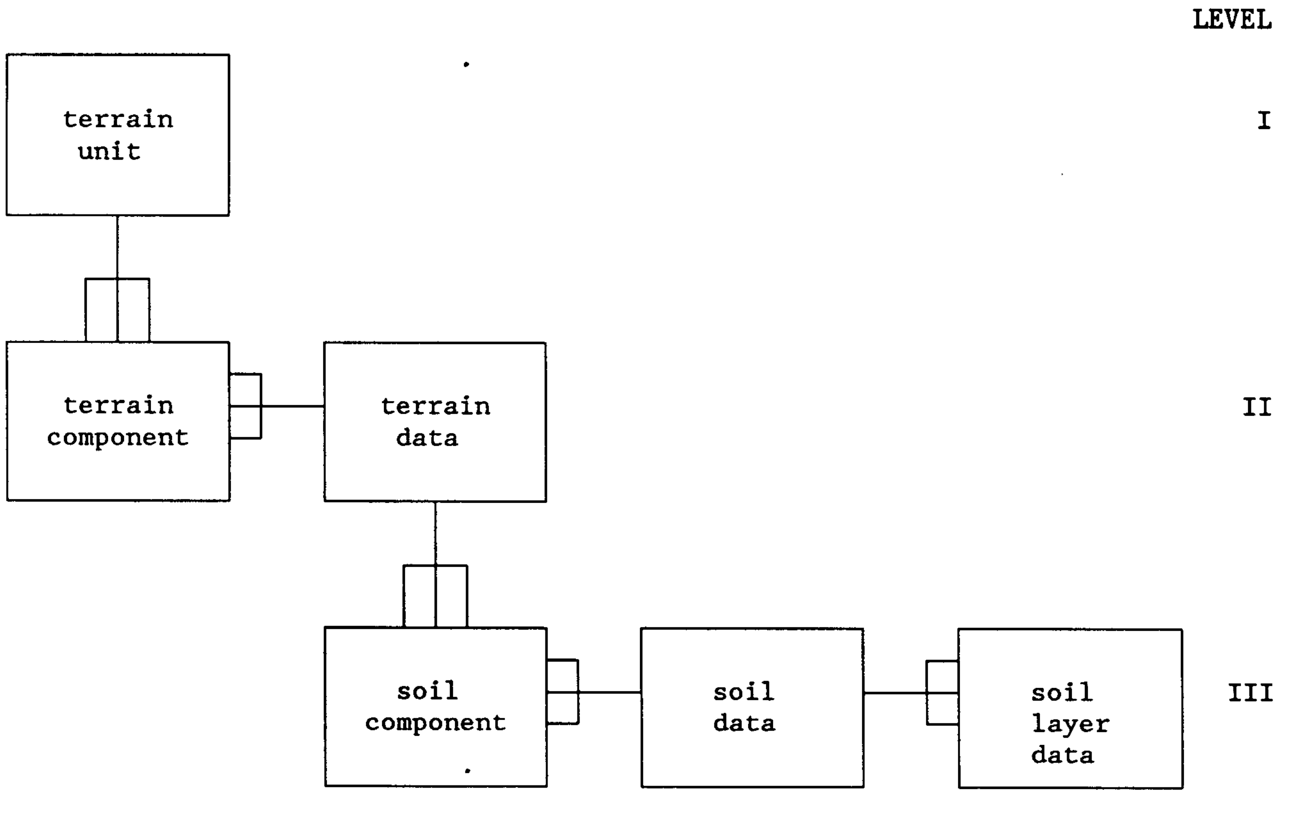


Figure 1. Hierarchical structure of the SOTER database.

3. When defining the database structure one should first look at the relevance for the user (land management units) and thereafter at the way the data can be processed with the computer.

4. The question was raised whether it would be possible to use a "structured" approach to data storage. In such an approach agro-economically important areas could be described in greater detail than areas that are considered to be of lesser importance. No final decision was taken on the subject.

5. Where quantitative attribute data are available they will be entered as such in the database. The mean of established classes will be stored in case of missing data, unless expert-estimates are considered more accurate. The two types of estimated data are labelled in the database.

6. Clear disadvantages are associated with the use of "generalized" profiles; averaging of soil data from a range of profiles may result in a "monster-soil" whose attribute data are likely to be of limited use for interpretative analyses. Hence the recommendation that data from real soil profiles, as collected during past surveys, be stored in the SOTER database. Each major soil will be characterized on the basis of one representative profile.

7. Each representative profile is chosen from amongst a number of reference profiles (see 8). SOTER will rely on the selection of the original surveyor(s). Attribute data for these reference profiles should be stored in national soil databases (e.g. FAO/ISRIC Soil Pedon Database format). The SOTER database will include a key to these databases.

8. The SOTER data base will include a code showing how many reference profiles were used to select the respective, representative profiles:
   1: expert-estimate
   2: single observation
   3: 2-5 observations, "reconnaissance"
   4: 6-10 observations, "semi-detailed"
   5: > 10 observations, "detailed"

9. The following key can be used to determine whether soils are considered to be similar/dissimilar in SOTER context:
   - If traditional mapping units are defined only till the second level category of the FAO Legend or third level of Soil Taxonomy (i.e. great-group), then separate entries have to be made in each terrain-unit.
   - If the classification is given down to the equivalent of the USDA subgroup level or comparable (e.g. third level of FAO Legend plus phases), then reference to one entry elsewhere in the database is permissible.

10. If there are gradual lateral changes in landscape features, new terrain-units have to be delineated when the following criteria are met: "If any one terrain-component of a terrain-unit changes in area by more than 50% then there is sufficient quantitative change to define a new terrain-unit."

11. The core-group agreed that: "several terrain-components may be defined within a given terrain-unit, without any limitation pertaining to the percentage of occurrence of the respective terrain-components". In other words, the "20% requirement" (see SOTER 90/2, p. 5) is no longer valid.

12. In general, there will be 4 or less terrain-components to each terrain-unit and 2 or less soil-components to a terrain-component, but other combinations may occur as well. It is however recommended that the total number of (dominant) soils per terrain-unit should be kept as small as possible.

13. After intensive discussions the following hierarchical structure was adopted for the database (see Figure 1):

    level 1: Terrain unit

    level 2: Terrain component ---> terrain identification
    ---> terrain data (description of surface features)

    level 3: Soil component ---> soil identification
    ---> general features (e.g. slope position, depth, drainage)
    ---> soil horizon data

14. It was observed that the geographical link to other global databases will always be at the terrain-unit level. Climate, landuse and farming systems often transgress the SOTER terrain units. The fact that several themes are "bundled" in SOTER may prove to be a potential shortcoming for the database, because it may reduce the range of applications for which the database can be used. No clear consensus was reached as to the advantages/disadvantages of using a "holistic" versus a "thematic" approach to database development in SOTER context.

15. The recommended changes in the list of SOTER attributes and attribute codings are documented in Appendix III. The final regrouping of attributes between the various files will be worked out by the SOTER database development group.

16. The Procedures Manual will specify which attributes have to be entered on a mandatory or optional basis (see Appendix III).

17. With reference to the revised Procedures Manual (SOTER 90/2) it was suggested that the percentage of non-allocated soils within a given terrain-component should be indicated in the database. The SOTER database development group will assess whether this modification is still necessary in case of the revised database structure (see item 13).

18. The original depth requirements for "layers" have been waived (see SOTER 90/2, p.5). From now on the term "soil layer" should be read in the sense of master horizon. Generally, the representative profiles can be characterized using up to 4 master horizons. Data for selected sub-horizons may be entered in the SOTER database if the need arises. The

general objective, however, is that the total number of horizons is kept to a minimum.

19. Members of the SOTER core-group referred to identical concepts using a wide range of terms (e.g. polygon, mapping unit, terrain unit). It is important that everybody adheres to the SOTER terminology so as to avoid a babylonian confusion of terms.

Land use database

Although several modifications to the land use database were proposed, no final decision was taken on the matter. SOTER will assess in how far the proposed changes can be accomodated:

1. The same hierarchical names - class, sub-class and group - should be used in the "hierarchy of vegetation" and the "hierachy of land use" (see Annex 3 and 4 respectively in SOTER 90/2).

2. The subdivisions for "forestry" (see Annex 3 in SOTER 90/2) need to be expanded, possibly on the basis of the work of K.D. Singh (FAO).

3. Additional subclasses should be defined for the land use class "mixed farming".

4. It has been recognized that there is a clear need for a separate land use database. Pending the availability of such a database, it should be assessed how information on land use and vegetation can be recorded in SOTER. It is anticipated that this will be done in a separate "land use/vegetation" file.

5. The information on land cover (see 4 resp. 6) may be stored according to the following general format:
   - natural vegetation (sub-class code and % of terrain component (TC))
   - land use (sub-class code and % of TC)
   - exposure of bare soil (number of months and percentage of year).

   The density of the vegetation cover could be indicated by a code, as follows:
   1: <=5%; 2:5-10%; 3:10-25%; 4:25-50%; 5:50-75%; 6: >75 percent.

   The percentage of the year during which the soil is exposed could be coded using the following classes:
   1: <=25%; 2: 25-50%; 3: 50-75%; 4: >75 percent.

6. The following definitions have been proposed for land use and land cover:
   - Land use refers to "a series of activities carried out to produce crops or products for own use or sale."
   - Land cover encompasses a "description of the physical cover supported by the soil".

Climate database

1. Some minor ammendments are to be made in the database structure:
   - The risk of occurrence of severe hail-storms and hurricanes needs to be specified together with the most probable month of occurrence of these phenomena.
   - The dominant wind direction must be specified.

2. It was recommended that the attribute data for the climate database of SOTER should be derived from existing computerized databases. The databases of organizations such as WMO (e.g. CLICOM), CIAT and FAO could be used for this purpose.

3. PLENARY SESSION

In order to broaden the scope of the discussions a wide range of invited scientists, who had not been directly involved in the development of the SOTER Procedures (see Appendix I), were invited to give their comments on three themes:

Theme 1: Database structure and definitions
Theme 2: Soil and terrain attributes: reliability and availability
Theme 3: Data requirements for user-oriented interpretations.

The respective themes were introduced by one of the invited guests (Driessen and Houba) after which animated plenary discussions developed. In a number of cases, similar issues were addressed under the different themes. The main discussion points are summarized below:

1. In his introduction to theme 1 Driessen questioned the fact whether the SOTER approach can be termed "scale-independent" and whether "generalized" profiles should serve as the basis for storing soil data in SOTER. Many participants gave their views on these two subjects. It soon appeared that there was some sort of confusion: the invited participants were not informed of the changes which had been accepted by the SOTER core-group during the previous session. Once these changes were conveyed to the participants, much of the original criticism ebbed away.

2. Numeric data are needed for modelling. "Calculate first, then average" is a commonly expressed view amongst some modellers. Whereas the latter require point-data, information about ranges in characteristics will be of more practical use to the land use planner. The SOTER database proper only contains attribute data for major soils which are characterized using one representative profile.

3. Information about the range of characteristics of the major soils - representative profile plus the set of reference profiles from amongst which it was selected - will be stored in national databases (e.g. FAO/ISRIC Soil Pedon Database format). SOTER will include a key to these databases. The national databases may thus serve as the basis for more detailed modelling exercises.

4. When using the SOTER database one should keep in mind which kind of interpretative studies will be feasible/permissible at a scale of 1:1 M.

5. A wide range of attributes that are needed to assess the risk of soil acidification in the European Communities (1:1 M) can be stored in SOTER. The usefulness of SOTER for this kind of studies will further increase once information about the organic litter layer has been added to the database. The terminology/categories of the Technical Paper of the TROPENBOS programme could be used in this respect.

6. It is anticipated that class limits/definitions and diagnostic features as stored in the SOTER database will change in time. Who is going to update the SOTER database as such changes arise? So far no decision has been taken in this respect in SOTER context: "these institutional matters still have to be addressed".

7. What is the relevance of the data that are stored in the SOTER database? Most soil data have been collected from the point of view of the soil-taxonomist. Such data are not necessarily suitable for making interpretative analyses of land use performance. Hence the possible danger that less will be possible with the database than is generally thought.

8. A number of "dynamic" soil attributes, i.e. attributes that are readily changed by management practices, are stored in the SOTER database (e.g. bulk density, P-Olsen, hydraulic conductivity). Several participants recommended that only "land" dependent and time independent attributes should be accounted for in SOTER. No general consesus could be reached on the matter.

9. Soil attribute data for SOTER are derived from existing survey reports. Soil sampling, pre-treatment and analytical procedures can vary widely both at the national and international level. Cross-border correlation of analytical results will often be difficult as a result. Standardized analytical procedures for well defined purposes should be added to the SOTER manual. It was suggested that the procedures of the International Standards Organization (ISO) could be used for this purpose. The standardization of analytical procedures in SOTER context can be seen as a long term objective.

10. In case of missing values the SOTER Procedures Manual indicates that labelled, expert-estimates should be given. Several participants argued that databases should be kept "clean", i.e. that they should only contain actually recorded/measured data. Such databases can provide the basic data for deriving a wide range of pedo-transfer functions.

11. A separate database should be prepared for land use. The following hierarchy of terms, which is under development at FAO, was proposed:

Farming System (= household units)	"social context"
Land Utilization Type	"physical contex"
Production System (individual crops)	"biological context"
Sequence of land management activities/ operations	"seasonal context"

It is anticipated that the above structure will allow for modelling of multiple scenario's, such as economic input/output studies and environmental impact assessments.

12. Has there been a marketing study as to the potential users of the SOTER database? Is the SOTER structure flexible enough to accomodate a wide range of users? The answer to these questions was that "conceptually, SOTER should provide the best information that is possible at a scale of 1:1 M for a broad array of potential users" and that it is "up to the user to identify possible applications". The above should be seen as an evolutionary process, since new types of data/interpretations will be needed as new problems arise (e.g. soil pollution). The SOTER database is flexible enough to accomodate such changes.

13. The effect of land degradation should be considered in relation to its effect on land productivity.

14. Several participants noted that there is an imbalance in terms of the number of various attributes which are stored in SOTER. Whereas over 50 attributes can be specified for each soil "layer", there is almost no information on hydrology and land use.

15. A database of the type developed by SOTER is needed at this very moment; a wide range of users will want to have access to it. Initially, the minimum data requirements for quantitative modelling may not be met. As a starter the SOTER database could be used to prepare "intermediate" maps for the respective land qualities as defined in the FAO Framework for Land Evaluation. These qualitative maps will be of great value to planners who operate at the global level.

16. The invited participants agreed to prepare a list of the "miminum data sets" which they would require to run their specific applications (e.g. acidification, crop productivity).

4. POSSIBLE/POTENTIAL USES

The SOTER core-group made an inventory of the possible/potential uses of the SOTER database for user oriented applications. The following statements were recorded:

1. The overall aim of SOTER is to implement a general database that will be flexible in its applicability, both laterally (geographically) and vertically (degree of detail). At the national level, the main objective of SOTER is to implement a rapidly accessible resources database linked to a GIS facility. The GIS facility will permit interactions with other national or international databases (e.g. land use, settlements, infrastructure, hydrology).

2. The SOTER database can provide the basic data sets required for a wide range of user-oriented applications. These may range from the assessment of land suitability, potential crop productivity, and irrigable acreage to the quantification of soil acidification and soil degradation hazards, as well as the monitoring of global change.

3. SOTER provides an improved digital soils and terrain database for the agro-ecological zoning (AEZ) approach developed by FAO. It provides detailed information on a wide range of land characteristics, a level of detail that cannot be provided by any other database. As such SOTER is likely to become "the" most sought after Global Agricultural Resources Database.

4. From the above it follows that SOTER is an indispensable tool for natural resources management and conservation planning. It provides the essential basis for identifying projects suitable for external funding. Such projects will leave behind a group of national staff competent in natural resources management.

5. With SOTER the basis for combining physical and socio-economic issues has been established; this has never been realized before in a quantitative manner!

6. No country will be spared form the effects of global climate change and environmental impact (e.g. soil pollution, acidification, toxic waste). SOTER can provide the basic data for quantitative studies and monitoring of these phenomena, both regionally and internationally.

7. SOTER provides a basis for promoting cooperation and transfer of knowledge between countries with similar climatic and soil conditions.

8. Due to its accessibility and efficient use SOTER permits the rational combination of natural resources information available within countries, such as soil survey, remote sensing, land use information and climate.

Brabant gave an example of what is feasible with SOTER using a test case from Cameroon. The discussion pertained to one single terrain unit. At the level of the terrain-unit both the actual and potential suitability for major kinds of land use can be determined and mapped. At the level of the terrain-component different growing periods can be defined, allowing for the assessment of individual crop suitabilities. This information is provided in tabular form, since individual terrain-components are not spatially referenced at the specified scale (1:500,000). It can however be shown cartographically after remote sensing using the recorded terrain component attributes.

5. PROGRESS REPORTS ON PILOT AREAS

5.1 LASOTER

An overview of the activities carried out in the Latin American pilot area, which covers parts of Argentina, Brazil and Uruguay (LASOTER), was provided by Peters and van Engelen. Fieldwork in the LASOTER area was carried out according to the principles of the first Procedures Manual (see Shields & Coote, 1988). The SOTER concepts and definitions were thouroughly discussed during the Montevideo Workshop (see SOTER 1988a). National correlation teams for the three participating countries were appointed to collect the required terrain and soil attribute data for their study areas. Possible differences in interpretation and application of the SOTER procedures were identified and discussed during two joint-field trips to the area (see Peters, 1988). During the field trips the procedure for mapping the status of human induced soil degradation in the LASOTER area was standardized.

The terrain and soil database is mainly the result of collation of existing data. The amount and quality of the source data varied somewhat in the three countries. When using the SOTER approach one will have to accept that some correlation problems will occur along country borders. Correlation meetings will be needed to ensure that a standardized approach is used. It is anticipated that such meetings will provide a stimulus for updating "scarce" data at the national level.

Argentia, Brazil and Uruguay each have their own set of analytical procedures. Cross-border correlation of results proved to be difficult. It is anticipated that similar problems will occur in new study areas which encompass several countries. It is not clear how this problem can be resolved in the short term because most data sets for SOTER are derived from existing survey reports.

The names of the participating laboratories have been documented in the database; they form the key to the respective analytical procedures.

The final "terrain unit" map of the LASOTER is being fair-drawn at ISRIC, Wageningen. The overall database for the LASOTER area has been created at ISRIC, using the data files which were submitted by the three participating countries. The climatic database for the LASOTER area was created at ISRIC.

So far, the LASOTER database has been used during the "SOTER-GIS" benchmark tests (see Van Engelen 1988). A wide range of thematic maps will be generated as soon as the GIS (PAMAP) is installed at ISRIC. This exercise can als be used to develop a training programme.

Quantitative attributes for the LASOTER area have been stored as numerical class-values (see Shields & Coote, 1988). It was recommended that all class-values should be converted into the mean of the corresponding classes.

The three participating countries have expressed interest for continued SOTER activities at the national level (see 5.4).

5.2 BRASOTER

Cochrane gave an overview of the activities that were carried out within the framework of the so-called Brazilian SOTER (EMPRAPA/CPAC) in the economic zone of the new capital, Brasilia. In this project it was crucial that an operational system be established within a six-month timeframe, that local staff be trained in using the data base and that a range of thematic maps be produced for reporting purposes. Basically, the methodology of the first procedures manual was used for the survey/compilation work. Research was carried out on the availability of inexpensive, commercially available software packages that can be run on small personal computers. It showed that the minimum system requirements would be satisfied by the following software combination:

a) Microsoft Works, which is an integrated database management system
b) IDRISI, a grid based Geographic Analysis System which was developed at Clark's University, Massachusetts (see IDRISI, 1988).

Testing of the system showed that MS-WORKS/IDRISI is readily learnt by staff having little or no computing background. Several thematic maps were produced for the BRASOTER area. The low cost and ease of handling of the software, coupled with limited hardware requirements, make this system readily accessible to users who operate at e.g. the provincial level.

Databases created in IDRISI can be off-loaded to a wide range of systems. This means that MS-WORKS/IDRISI can be used as a stepping stone in the process of installing a more elaborate GIS/RDBMS at the national level.

5.3 NASOTER

The progress report for the NASOTER area was presented by Shields. The map for the NASOTER area has been completed and will be digitized in April.

The terrain and soil attribute files for the US sector have been completed and computerized. Validation of this database will be completed before the end of April.

The terrain- and soil-component files for the Canadian sector have been completed. The "soil layer" file will be completed using regular CANSIS input (June).

The soil degradation files for the Canadian sector of NASOTER are being compiled. The reporter could not inform the participants about the status of the soil degradation files for the US sector. The existing erosion-algorithms will be applied to the NASOTER data (see Shields & Coote 1988).

5.4 Discussion and recommendations

Similar themes were addressed during the discussions that followed the progress reports. The main issues are summarized below:

1. Argentina, Brazil and Uruguay are interested in continuing with SOTER activities at the national level. Project proposals to this avail have been submitted to FAO. It would seem that the prospects for funding are most positive for Argentina. Uruguay has also indicated its interest for a regional SOTER "computer" training course from December 1-15, 1990.

2. The databases for LASOTER and BRASOTER have been completed, while the database for the NASOTER area should be ready by the end of June. At this stage it is important that a number of thematic maps is generated for the respective study areas. Some of these maps should be displayed during one of the poster sessions of the 1990 Congress of the International Society of Soil Science (Kyoto, Japan). They could also be included in a pamphlet which is to be issued by SOTER.

3. A poster for the BRASOTER area will be presented in Kyoto. The abstract has been sent to ISSS, Japan.

4. One staff member of SOTER has been trained in using PAMAP. The software/hardware of the SOTER "computer" will be installed at ISRIC upon receipt of additional funding.

5. In view of the above, it was recommended that SOTER staff should digitize the LASOTER basemap at an organization with an operational and compatible GIS. Organizations that can be approached include FAO (Rome), UNEP (Geneva), SCET (Paris), the Winand Staring Centre (Wageningen) and the International Training Centre (ITC) at Enschede. ISRIC's SOTER staff will follow up on this matter.

6. The present workload of the members of the NASOTER team is such that they will not be able to prepare a poster for the Kyoto congress.

6. FUTURE DEVELOPMENTS

6.1 Possible alternatives for SOTER software

SOTER HQ will not impose its choice of software/hardware on participating countries. The latter are left free in their choice, in so far their systems are compatible with ORACLE and PAMAP. No major limitations are anticipated in this respect in view of the wide flexibility (compatibility) of both systems.

SOTER HQ staff will assess which alternative database management/GIS systems are considered suitable for first-time users.

6.2 Training needs

There is a clear interest for regional training programmes in using the SOTER database annex GIS. So far, Uruguay has requested a training course which is to be given in the first weeks of December 1990. It is critical that such courses are implemented as a matter of priority. During the training programme a wide range of thematic maps and tabular output can be produced. These will demonstrate the usefulness of the SOTER approach to regional policy-makers and decision-makers, and as such provide the basis for a potential follow-up at the national level.

The training programme will be developed at ISRIC as soon as PAMAP and the required peripherals have been installed. One member of staff of SOTER has received two-weeks of PAMAP training in Canada. The database for the LASOTER area will serve as the basis for developing a series of "hands-on" exercises for the training programme.

Potential participants for the SOTER training progamme must be familiar with the use of PC's.

6.3 New SOTER areas

The SOTER procedures have been successfully tested and fine-tuned in three pilot areas. As such, SOTER is ready to proceed to the implementation phase during which it will develop digital soils and terrain databases in a wide range of countries. In other words, the programme is declared "operational". So far, the following activities have been initiated:

a) WASOTER

The main scope of the WASOTER project is to develop a digital terrain and soil database for parts of Benin, Burkina Faso, Ghana, Niger, Nigeria and Togo. The project proposal for WASOTER has been sent to the European Communities. Problems arose as to the identification of a "Regional Authorizing Officer"; ICRISAT was not in a position to accept the coordinating role.

b) CESOTER

The project proposal for CESOTER, the acronym for Central European SOTER, which will cover parts of Austria, Hungary and Tchecoslovakia has been prepared. CESOTER can serve as a computer-storage "window" for the expansion of the 1:1 M Soil Map of the European Communities (EC) to Eastern Europe. The project proposal has been sent to EC/PHARE, Brussels. An alternative may be to seek funding through FAO's Regional Programme for Eastern Europe.

c) Coastal zone of Mediterranean

The main objective of this project is the mapping of water erosion in non-contiguous areas bordering the Mediterranean Sea. SOTER staff have been involved in the intial workshops (e.g. SOTER 1988b). Subsequently, project formulating missions, including delegates form the Regional Activity Centre of the Priority Actions Programme (PAP/RAC), the "Instituto Nacional para la Conservacion de la Naturaleza" (ICONA), FAO and ISRIC, were proposed to visit Spain, Tunesia and Turkey (see UNEP, 1989). SOTER, however, has not been invited to the last 3 regional fact finding missions.

d) CASOTER

The aim of the Central-American SOTER is to develop a digital terrain and soils data base for Belize, Costa-Rica, El Salvador, Guatemal, Honduras and Nicaragua. CIAT from Colombia cannot actively participate in the project for the time being. Cooperation with FAO has been suggested. The project proposal has also been submitted to the Directorate General for International Cooperation (DGIS) of the Netherlands Ministry of Foreign Affairs. DGIS may be interested in funding the CASOTER project as soon as it has been shown some results from the LASOTER area.

e) Other areas

All participating members of the LASOTER group are interested in continuing with SOTER related activities at the national level. At the regional level, Argentina, Brazil and Uruguay wish to use the SOTER approach for the "Rio Plata Project".

Project proposals for the implementation of SOTER databases in the Middle East (MESOTER), South-west Asia (SWASOTER) and Sout-east Asia (SEASOTER) will be prepared. Preliminary contacts have been established with regional CGIAR's such as CIAT, ICARDA, ICRISAT and IRRI.

A marketing officer will be needed to promote the SOTER product.

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APPENDICES

Appendix I: List of participants

Full time participants

Name	Affiliation
N.H. Batjes *(rapporteur)*	SOTER guest researcher
M.F. Baumgardner	Purdue University, USA
P. Brabant	ORSTOM, Paris, France
T. Cochrane	Agrotech. Amazonica S.A., Bolivia
V. van Engelen	SOTER/ISRIC
R. Oldeman	ISRIC
W.L. Peters	LUZ Agronomia, Maracaibo, Venezuela
J. Pulles	SOTER/ISRIC
J. Shields	Land Resource Research Centre, CEF, Ottawa Canada
D. Sims	Land and Water Development Division, FAO, Rome, Italy
W.G. Sombroek *(chairman)*	ISRIC
G. Varallyay	RISSAC, Budapest, Hungary

Invited participants (Plenary session of April 25, 1990)

Name	Affiliation
W. Andriesse	Winand Staring Centre, Wageningen, the Netherlands
H. van Baren	International Soil Reference and Information Centre (ISRIC), Wageningen, the Netherlands
E. de Boer	GLASOD Project (ISRIC)
A. Bos	ISRIC
C. van Diepen	Winand Staring Centre
P.M. Driessen	Dept. of Soil Science and Geology (AUW)
L. Eppink	Agricultural University Wageningen
R. Hakkeling	Winand Staring Centre
G.B. Hoogmoed	Agricultural University Wageningen
V.J.G. Houba	Dept. of Soil Science and Plant Nutr. (AUW)
J.H. Kaufman	ISRIC
N.T. Konijn	Dept. Soil Science and Geology (AUW); IIASA
W. de Vries	Winand Staring Centre
C.T. de Wit	Theoretical Crop Production Department (AUW); CGIAR-TAC
R.F. van de Weg	Winand Staring Centre

Appendix II: Programmé of SOTER Workshop

Tuesday, 24 April

09.00-12.30 - Welcome address by the chairman, Dr. W.G. Sombroek
- General SOTER concepts: legend concepts and definitions (Procedures Manual, Chapters 1/3)

14.00-17.00 - Progress reports on pilot areas (LASOTER, BRASOTER, NASOTER)

Wednesday, 25 April

09.00-12.30 - Plenary session with invited participants
Theme 1: Database structure and definitions
Theme 2: Soil and Terrain Attributes: reliability, availability
Theme 3: Data requirements for user-oriented applications

14.00-17.00 - Attribute coding (Procedures Manual, Chapter 4)
- Land use and Climate Files (Proc. Man., Chapter 5 & 6)

Thursday, 26 April

09.00-12.00 - Possible/potential uses of the SOTER database

14.00-17.00 - Future developments :
- choice of SOTER software
- training needs
- new pilot areas
- financial consequences
- Closing remarks and word of thanks by the chairman

Appendix III: Tentative list of attributes for terrain and soil data files.

TERRAIN UNIT

Terrain unit ID	M(andatory)
Year	M
regional landform	M
dominant elevation	M
relief intensity	M
general lithology	M
permanent water surface	M
density of drainage lines	O(ptional)
average distance between places of	O
permanent water surface (%)	M

TERRAIN COMPONENT

terrain unit ID	M
terrain component ID	M
proportion of terrain unit	M
surface form	M
micro-relief	M
length of slope	M
predominant slope gradient	M
parent material	M
texture group of non-consolidated parent material	M
frequency of flooding	M
start of flooding (month)	M
duration of flooding (in days)	M
mean highest groundwater table	M
mean lowest groundwater table	M
electrical conductivity of ground water	M
surface drainage	M
surface rockiness (% coverage)	M
surface stoniness (% coverage)	M
size of stones	O
depth to consolidated parent rock	M
(predominant land use/vegetation ?)	M

SOIL COMPONENT

- soil data

Terrain unit ID	M
Terrain component ID	M
Representative profile ID	M
% of terrain component occupied by soil component	M
internal drainage	M
infiltration rate	O
rootable depth	M
soil development (dominant process)	M
thickness of org. litter at surface	M
degree of decompostion of org. matter/litter on the surface	O
propensity to capping	M

- layer data (sensu master horizon)

Representative profile ID	M
master horizon number (subhorizon if needed)	M
lower depth of horizon	M
abruptness of lower horizon boundary	M
colour, moist	M
colour, dry	O
structure, form	M
structure, size	M
structure, grade	M
zoological activity	O
clay mineralogy	M
carbon content	M
total nitrogen content	M
P-Olsen	O
P-retention	O
CEC soil (NH_4OAc buffered at pH7)	M
ECEC	O
AEC	O
exchangeable-Ca	M
exchangeable-Mg	M
exchangeable-Na	M
exchangeable-K	M
exchangeable-Al	M
exchageable-Mn	O
Fe, dithionite extractable	O
Al, dithionite extractable	O
Fe, oxalate extractable	O
Al, oxalate extractable	O
pH-H_2O	M
pH-KCL	M
ECe	M
Calcium carbonate content	M
Gypsum content	M

coarse fragments, volume %	M
coarse fragments, size	O
texture class (USDA)	M
total sand	M
very fine sand	M
fine sand	M
silt	M
clay (pre-treated)	M
natural (water dispersible) clay	O
volume % water held at field capacity	O
volume % water held at permanent wilting point	O
bulk density	M
saturated hydraulic conductivity	O
diagnostic horizon	M
diagnostic property (dominant ?)	M

Other changes:

- The new definition for "dissected" (see miscellaneous landforms, SOTER 90/2 p. 10) becomes: "A dense pattern of natural drainage lines deeper than 5 m".

- The abbreviation "R" has been used twice under the heading "surface form" (see p. 10, op. cit.).

- As above, but for "G" under "micro-relief" (see p. 11, op. cit.). Further, a new category (A for absent) should be included under the same heading.

- The new definition for "very rapid" (see surface drainage, p. 13, op. cit.) now reads: "Excess water drains very rapidly".

- A description for "moderately well drained" will be included under internal drainage (p.15, op. cit).

- Criteria for defining class boundaries for "zoological activity" may be derived from the TSBF-manual.