SOTER Report 4e

International Society of Soil Science (ISSS)
Association Internationale de la Science du Sol (AISS)
Internationale Bodenkundliche Gesellschaft (IBG)
Sociedad Internacional de la Ciencia del Suelo (SICS)

Proceedings of the Second Regional Workshop on a Global Soils and Terrain Digital Database and Global Assessment of Soil Degradation

12-15 December 1988
at
Faculdade de Agronomía
UFRGS
Porto Alegre
Brazil

Workshop organised in the framework
of the GLASOD project of UNEP-ISRIC

UNEP

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Related Publications.....

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TABLE OF CONTENTS

1.0 INAUGURAL ADDRESSES

1.1 Welcome
Abilio Baeta Neves

Gentlemen, representatives of the ISSS, ISRIC, FAO, Secretary of Agriculture of Rio Grande do Sul State, delegations of Argentina, Uruguay and Brazil and others present, the Federal University of Rio Grande do Sul is honoured to be host of this Second Regional Meeting on a Global Soils and Terrain Digital Database (SOTER) and Global Assessment of Soil Degradation (GLASOD) within the Pilot Area located in Latin America for two main reasons.

One because it confirms the high standards of its staff not only on regional level but also international, because if this would not be so this meeting would not be held in this University. Two because the main objective of the meeting is extremely important for our state, country and continent where large areas of this natural resource are suffering degradation as a negative consequence of agricultural production and loss of environmental equilibrium.

We hope and expect that the objectives of this meeting and of the project will be met so that this problem will be solved by a better understanding of the problem and by creating alertness between authorities and users of soil resources. In this way we express our welcome to the participants, we hope you have a good stay with us and that the objectives of the meeting will be met completely.

1.2 Welcome
Marion F. Baumgardner

Welcome to this meeting to review and discuss the progress and status of the GLASOD/SOTER Project. Since the Workshop in Montevideo in March 1988, many interesting Project activities have moved forward.

On behalf of the International Society of Soil Science, and especially on behalf of Dr. Wim Sombroek, I wish to express warm greetings and to thank each of you for your enthusiastic participation in this Project and for your attendance at this review.

The SOTER concept continues to capture the imagination of scientists around the world. Since our meeting in Montevideo, I have given presentations about SOTER at international symposia and/or national conferences in Budapest, Hungary; Tylney Hall, England; Wageningen, the Netherlands; Nagpur, India; Karlsruhe, West Germany; and Baltimore, USA. Everywhere the reaction is the same. Many are surprised at the boldness of the idea; most agree that such databases are needed. The SOTER concept is an idea whose time has come.

As members of the first generation to see the Earth as a whole, we are also the first to have the tools which make it possible to design and develop a world soils and terrain digital database for both spatial and attribute data. I congratulate you for your vision and innovation in recognizing and using these tools in the first pilot area of the SOTER Project.

I also wish to thank and congratulate the United Nations Environment Programme (UNEP) for joining us in this effort and supporting GLASOD in this first demonstration of the SOTER concept. As I said at the beginning of the Workshop in Montevideo, I believe this small group of cooperating soil scientists from Argentina, Brazil and Uruguay, working with the International Society of Soil Science and the International Soil Reference and Information Centre and with support from UNEP, are making history. We are daring to do something soil scientists of the world have never been able to do before.

Already we are in the process of expanding the SOTER Project to other regions of the world. It is anticipated that SOTER activities will begin in two new Pilot Areas in 1989. Discussions are proceeding for a Pilot Area which will include parts of six countries in West Africa-- Benin, Burkina Faso, Ghana, Niger, Nigeria and Togo. An area in western North America has been defined for a Pilot Area to include portions of Montana, USA, and of Alberta and Saskatchewan, Canada. Other possibilities for Pilot Areas to begin within the next two years include India, the Middle East, and another in South America.

A big challenge before us is to complete the SOTER Database for the Pilot Area we are reviewing this week and then to test the database and demonstrate its utility in producing valuable thematic maps and tabular data for decision-making and policy-making in land resource management.

I wish you well in your deliberations this week, and in your formulation of plans for completing the current Project. I challenge you to find the means, even after this Project is completed, to continue to add to the SOTER database until the soils and terrain of your entire country have been mapped, digitized and the data entered into the Database.

1.3 Inauguration
Francesco Palmieri

First we like to welcome the participants and express our gratitude to the Federal University of Rio Grande do Sul for its hospitality and for the organization of this Second Meeting of the Working Group.

At the same time we wish to thank the International Soil Reference and the information Centre for giving us the privilege to participate in this important project of the assessment of soil degradation on a global level.
Because of the nature of the information obtained that is fundamental for the assessment of the actual status of soil degradation and that is essential to achieve a better management of soil resources and to assess the environmental impact, we like to call the attention of the financing organizations, to the necessity to provide the countries involved with the basic equipment (hardware and software) necessary to carry out this kind of project on a national level. At the same time because the countries involved have financial problems we ask support to be able to continue the project on national level.

1.4 Man Induced Soil Degradation in the Pilot Area
Wilhelmus Peters

Introduction

The main objective of the GLASOD-SOTER Project on world level is the strengthening of the awareness on the dangers resulting from inappropriate land and soil management to the global well being. Within the South American Pilot Area located between 54° and 60°W and 28° and 32°30' S covering parts of Argentina, Uruguay and Brazil soil degradation phenomena were observed partly caused by natural processes, partly by man. Man induced soil degradation is the process describing the phenomena caused by man which lower the current and/or future capacity of the soil to support human life. In many cases it is difficult to separate natural degradation processes from those induced by man and in many cases an overlap exists.
Previous information on the pilot area described mainly the effects of water erosion and this is the main degradation type together with physical degradation, closely related to it, that has been studied and assessed on pilot area level.

The three countries involved in this project present different natural conditions of climate, terrain and soils and also different land use systems, that make an overall general view difficult, but nevertheless some general tendencies do exist in degree and rate of soil degradation that will be discussed and illustrated with some examples.
Soil degradation phenomena within the pilot area were studied in the field,evaluated and coded according to the SOTER Manual.

General aspects

The principal factors intervening in soil degradation are the following:

1. Climate (Rainfall, mainly intensity and duration and total)
2. Terrain (Relief and slopes)
3. Soils (Erodability of soil material, infiltration)
4. Land use systems.

1. Climate

The determining climatic element in water erosion is rainfall, and its most important aspects are intensity and duration which determine run off and rainfall erosivity.
Maps of the average yearly rainfall and of run off of the River Plata Watershed show a clear tendency of increasing rainfall from the South West, 900 mm in Entre Rios Province in Argentina, through the Northern part of Uruguay to the North East, 1600 mm in Southern Rio Grande do Sul in Brazil. The mean yearly run off follows more or less the same pattern from 200 mm in Argentina to 600 mm in Brazil.

According to investigations in Argentina and Uruguay rain erosivity shows the same tendency.
This very well defined climatic sequence from the South West to the North East already gives a general idea of what to expect in the pilot area as far as soil degradation by watererosion is concerned.

2. Terrain

A very important element in water erosion is the terrain component, slope, in its two aspects, degree and length. Within the pilot area in a very general way the regional land forms and surface forms encountered show a tendency of increasing slope degree again from the South West to the North East, from the flat to slightly undulating plains of the Entre Rios Province in Argentina, through the undulating and rolling plains and uplands of Northern Uruguay to the undulating, rolling and even hilly controlled uplands of Rio Grande do Sul State in Brazil.
Slope length is variable within the same area being longest the slopes encountered in the aeolians deposits in Argentina. Combining this general tendency of slope degree with the climatic pattern discussed before an increasing erodablity potential in the pilot area can be expected from the South West to the North East.

3. Soils

In the flat or gently sloping plains in the Western part of the pilot area covering the Entre Rios Province in Argentina and the North Western part of Uruguay the most important soils belong to the orders Vertisol in the almost flat areas and Mollisol (Brunizem or Brunosol) in the more undulating areas. Within this same area Alfisols (Planosols) are found and within the valley of the Uruguay River some sandy alluvial soils, Inceptisols and Entisols.
To the East in Uruguay Alfisols (Planosols, Argisols, Luvisols) and Ultisols (Acrisols) are found characterized by a more pronounced relief that passes into Brazil where in the Northern part of the pilot area Oxisols are found (Latosol vermelho y vermelho oscuro) and to the South Ultisols (Terra Roxa Estruturada and the extreme poor and sandy Podzolicos) and Litosols.
In general the soil distribution pattern shows in the flat and gently sloping areas soils that are very stable under natural vegetation and more delicate soils in the undulating, rolling and hilly areas.

4. Land Use system

The decisive factor in human induced soil degradation is the land use which has effects on certain soil qualities. The traditional land use in the pilot area has been extensive grazing until the beginning of this century when gradually the land use became more intensive. Systems of annual cropping introduced by European immigrants became common and this development was very important

in Rio Grande do Sul, less in Uruguay and in Entre Rios, Argentina, where this kind of landuse became common only after the Second World War.
The annual cropping systems of the last 40 years included use of machinery and this has been the main cause of the problem of soil degradation as encountered in the pilot area especially in Rio Grande do Sul where agricultural development has been most intensive with severe consequences. The introduction of chemical fertilizer converted the poor latosols in highly productive soils, but the use of machinery causes compaction of the subsoil and infiltration rates of the soil are reduced to less than 10% of the original ones in a very short time. This favours run off and in springtime when the soils are uncovered water erosion will begin immediately mostly in the undulating areas with highly erodable soils.

Argentina

Degradation problems within the Argentinian part of the pilot area occur mainly in the area covered by Brunizems under annual crops (wheat, rapeseed and corn). Almost 50% of the Brunizem area has suffered slight degradation problems mainly compaction and sheet and rill erosion. Slopes of more than 2% are considered critical for water erosion in the case of Brunizems under annual cropping systems. A rotation system with pasture is a very important conservation practice. The Vertisols do not suffer main degradation problems because the common land use system is grazing. Within the Uruguay river valley the sandy soils under irrigated citrus are suffering slight water erosion. In general according to the GLASOD-SOTER definitions, the degradation problems within the Argentinian part are of a slight degree and a slow rate with variable percentages of the land affected.

Uruguay

In the Brunozol area under annual crops (wheat and sugarbeets) degradation by rill and gully erosion was observed in some small areas. The degree of water erosion was evaluated slight to moderate with a slow to medium rate. In the Argisol, Luvisol and Planosol area to the North East (Melo) severe effects of watererosion were observed as a consequence of overgrazing and annual cropping (soybean) up to a point where various "chacras" or farms had to be abandoned because of degradation problems. The water erosion had resulted in gullies that are very difficult to eliminate and in many cases productivity is down to a zero level. In these situations the degree was considered moderate or even severe with a medium rate and varying percentage of the land affected.

Brazil

The most severe degradation phenomena were encountered in Rio Grande do Sul where an intensive annual cropping system was introduced about thirty years ago. In the Northern part of the pilot area with the deep Oxisols (Latosol) that present excellent

physical qualities under natural vegetation and that can be highly productive soils under adequate management loss of top soil was calculated to be about 20 to 30 cm by sheet and rill erosion and this loss of topsoil combined with a compacted plow layer had reduced productivity and increased production costs so enormously that many farmers cannot produce economically any more.
An even worse situation is encountered in the southern part of the pilot area with the sandy highly erodable Ultisols (Podzoles) where under annual crops (wheat and soybean) a bad land formation began which has resulted in gullies of more than 20 meters deep impossible to recuperate.

Final remarks

At the beginning the main objective of GLASOD SOTER was cited and without any doubt man in the pilot area is aware of soil degradation problems. This awareness is a very important step but it is not enough if there is not a follow up that includes effective measures of a consistent policy of soil conservation that is supported by governmental action. The solution is in the hands of policy makers and this problem is not so much a problem of today, because the living generation will survive, but of tomorrow for the coming generations that will be deprived of the most important inheritance of all: a producing earth, if adequate measures will not be taken immediately.

2.0 PROGRESS REPORTS

2.1 Progress report GLASOD and SOTER
Roel Oldeman

The Latin American soils and Terrain digital Database project is to be considered as a very important first step towards our objective for the development of methodologies to compile a World Soils and Terrain Digital Database and towards testing the uses of this database. The acquired and digitized information should allow an objective extraction of those attributes needed to prepare single-value maps and tabular data from the database. An immediate objective of GLASOD is an estimation of soil degradation status and risk using the SOTER database.

The SOTER Procedures Manual, adopted during the first workshop in Montevideo provides keys for three files: a polygon file, a terrain component file and a soil layer file. In addition a soil degradation status file and a separate climate file (see 3.1) was developed. The main objective of this workshop is the discussion of the progress reports of the three correlation teams that have acquired the essential input data and transformed them on coding sheets.

Meanwhile a database management group at ISRIC has developed a database structure based on the SOTER procedures manual in order to enter the data in a relational database management system ORACLE5. This will be discussed later this week by Vincent van Engelen (see 2.2). At this stage of the project no decision has yet been taken on a particular Geographic Information System (GIS). As stated in the SOTER Project Proposal a careful assessment by independent specialists should be made of the capabilities and costs of available GIS hard/software. Therefore an ad-hoc committee was formed to advice the project on the most suitable system for SOTER. Marion Baumgardner will discuss the activities of this committee (see 3.2).

During the Montevideo workshop a special working group discussed at length methodologies for assessing soil degradation risks. This part of the manual has now been revised by Dick Coote, who will discuss the updated version later this week (see 3.4). Here we should keep in mind that methodologies are needed that can make optimal use of the information stored in the database and the separate climate file.

The concluded agreement between UNEP and ISRIC calls for exploring possibilities to initiate other pilot areas. We have prepared a project proposal for a West African SOTER (WASOTER), including portions of four francophone countries (Benin, Burkina Faso, Niger, Togo) and two anglophone countries (Ghana, Nigeria). The project proposal has been introduced recently during a workshop of the West African Soil correlation Committee in Cotonou, Benin as well as at the ICRISAT Sahelian centre in Niamey, Niger. We are presently exploring possible donors for such a project in West Africa. A third pilot area may commence in 1989 in an area in North America (portions of the U.S.A. and Canada), while CIAT (Centro International de Agricultura Tropical) has indicated interest for a pilot area in equatorial South America (portions of Brazil, Bolivia and Peru). There appears to be a growing interest in SOTER world wide.

With regard to the other component of activities of GLASOD: the preparation of a Global Soil Degradation Status map at an average scale of 1:10 Million, the following achievements can be mentioned. After the Montevideo workshop a final version of the Guidelines for a General Assessment of the Status of Human-Induced Soil Degradation was edited. We then commenced discussions and negatiations with regional institutions and individual specialists for the preparation of soil degradation status maps and complimentary data sets at an average working scale of 1:5 Million. We have divided the world in a number of regions and have reached agreements with 21 institutions/individual experts to prepare these soil degradation maps. We have already received first draft maps of some of the regions and expect to be able to commence with the map compilation early 1989. All depends here on the cooperation of these 21 contractors. We hope to publish a world soil degradation status map in full colour by early 1990.

In conclusion it can be said that significant progress has been made during 1988. The GLASOD project could not have achieved such a progress without the continuous and positive support from the international soil science community in general and of those soil scientists in the first pilot area in particular.

2.2 SOTER database progress (Attribute and point data)
Vincent van Engelen

Introduction

The general objective of the SOTER project as stated in the proposal for a World Soils and Terrain Digital Database (SOTER 1986) is described as follows:
"... to utilize emerging information technology to produce a world soils and terrain digital database containing digitized map unit boundaries and their attribute data, and supported by a file of chosen point data ....".

Specific short term objectives of the first phase (year 1 and 2) in the field of database development are:

"... 4.2.1.5. To develop a detailed set of specifications and logic which define the minimum set of capabilities/functions required of a World Soils and Terrain Digital Database....

4.2.1.8. To input data, including digitizing maps, into the Database

4.2.1.9. To test and demonstrate the reliability, accuracy and utility of the Database

4.2.1.10 To conduct an assessment of current geographic information systems (GIS) and provide the optimal system to use (by acquisition or contract) in order to meet the specifications defined in 4.2.1.5...."

Several activities for the development of a SOTER database have taken place during the second half of 1988. Two groups of activities can be distinguished:

- all activities pertaining to the digitizing of the geographic component of the SOTER data (topology), for convenience here called GIS activities
- all activities related with the development of a database for three non-topological data (attribute data).

This paper limits itself to the second group of activities for three aspects in which the following items can be separated:

1. **Soils and Terrain database**

a. choice of database software
b. development of a database structure for SOTER attributes (polygon, terrain, soil)
c. testing of the database structure
d. input of the first set of attribute data from the pilot area
e. output format of attribute data
f. possible improvements

2. **Point data (climatic database)**

a. database structure
b. input
c. output

3. **Organizational aspects**

a. general
b. pilot area data input.

1. Soils and Terrain database

1.1. Choice of database software

Although it is beyond the scope of this workshop to discuss fundamentally the various database structures, it might be of interest to show the main types. Three major structures exist:

1. hierarchical, well known in taxonomy
2. network
3. relational

A comparison between these three database structures came out positively for the relational database. In its simplest form it has no pointers nor hierarchy. The data are stored in simple records, known as tuples. The relational database has a structure in which the relations between the attributes are grouped together in two-dimensional tables known as relations. Each table or relation is usually a separate file. In order to identify the records in each file, identification codes are used as keys. They comprise e.g. in the SOTER case the polygon number, terrain number and soil number, giving each record a unique identification. These are the so-called primary keys.

A relational database has several advantages:

1. very flexible structure
2. easy to modify or to update
3. easy to enlarge with other tables/relations
4. maintain integrity.

These four considerations are of utmost importance for the SOTER project. As the SOTER database is in its initial stage, it not possible to foresee which attribute data will be needed for future uses of the database and are now missing or which attribute data are obsolete, incorrect or irrelevant. Only during the use of the database such shortcomings will become evident. Changes in the relational database structure can be easily made by simple adding or dropping of tables. Modifications in tables can also be made instantaneously without affecting the structure of the database. An example can clarify this.

Most of the soil degradation attributes are not yet available and therefore not entered in the database. As the final concepts about the degradation data which are of importance for SOTER will hopefully crystallize during this meeting it will be easy to add a soil degradation table with all the relevant facts to the database without having to modify the overall structure of the database.

A major disadvantage of a relational database is, however, the repetition of the keys in all the tables/relations. This creates a redundancy in data which will increase the processing time of sequential searches. However, the query time can be shortened somehow by indexing of the keys. E.g. the polygon number is present in all tables and forms some redundancy, but thanks to indexing the searching time is reduced.

Most of the professional Geographical Information Systems use a relational database to store the attribute data. One of the commonly used relational database management systems (RDBMS) is ORACLE5. Interfaces to couple it to various GIS like ARC/INFO, INTERGRAPH, DELTAMAP, ILWIS and others are on the market.
ORACLE5 has the advantage that it can be run on a range of computer types: from the "small" IBM AT compatible (80286 processor with 1.6 Mb extended memory) to minis and mainframes. Linkages to other environmental resources databases which use a RDBMS (like UNEP/GRID) can also be made. ORACLE5 for PC uses about 900 Kb of extended memory and 80Kb of the standard memory. The use of ORACLE5 in developing countries should not be a constraint with the version for the PC now available. The previous version of ORACLE (v. 4.1.4) could run on a common PC without an extended memory. Unfortunately this version is not any longer on the market.

1.2 Development of a database structure for SOTER

A preliminary database structure for the attribute data according to the "Soter Procedures Manual for Small Scale Map and Database Compilation" (ISRIC, 1988) was developed by John Pulles as part of his MSc thesis (Pulles, 1988). The functions of this database structure are:

- input, update and deletion of data at a micro computer
- retrieval of data, e.g. in tabular form
- maintain data integrity

Basic in his approach are the three attribute files - polygon, terrain and soil as they are defined in the Manual. A logical data structure is shown in fig. 1, where the relationships between the various entities are indicated.

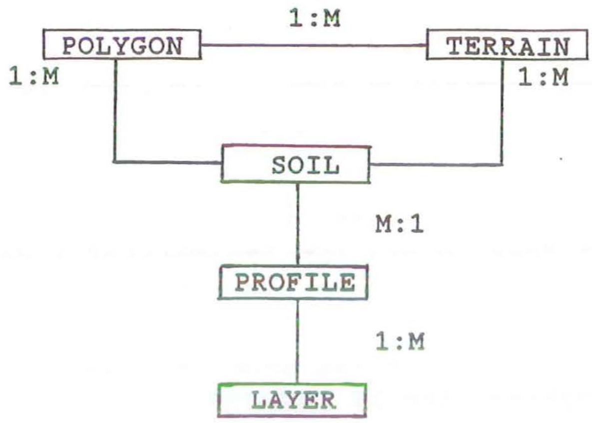


Fig. 1. Entity-relationship diagram for the entities of the data model for the SOTER database (after Pulles, 1988).

The polygon file comprises all polygon data (15 fields, including one key field). A field "Recording year" has been added in which the year of collection or compilation of the field data can be indicated. The terrain file has room for all the terrain attribute data (24 fields, including two key fields).

The occurrence of six terrain/soil combinations within one polygon can be realized in two ways:

- inclusion of the attributes soil-proportion, slope-position and profile-id in the terrain table for each soil component
- creation of a separate table that contains the polygon-id, terrain-number, soil-number, soil-proportion, slope-position and profile-id.

The first solution does not need a separate soil table. However, most terrain components have only one soil, which makes the attribute fields for the other components redundant. The second option has been chosen because of it advantages of increased flexibility of the data structure and limited redundancy.

Therefore the soil file has been split into three: soil, profile and layer. The soil table/form holds information on the proportion of the soil component in the terrain component and its slope position (5 fields, including 2 key fields). If the soil component refers to a previous polygon and soil, this can also be entered. The profile table/form comprises information concerning the entire profile like drainage and soil classification (6 fields, 2 key fields), while the soil layer table/form holds data of each individual layer (59 fields, including 3 key fields).

Definitions and descriptions of the codes are stored in special tables called domains. During input codes are constantly checked against these stored codes. The domains are also used when output is needed is a comprehensive form and they can also be completed with descriptions in other languages to permit output in other languages.

Data integrity or accuracy/validity of data consists of two types: entity integrity and referential integrity, concerning primary keys and foreign keys respectively. Date (1986) defines a foreign key as an attribute in one relation whose values are required to match those of the primary key of another relation. A primary key is e.g. polyid (polygon number), an example of a foreign key is terrain.polyid to polygon.polyid.

Entity integrity is ensured for each table by giving all primary key fields a 'not null' requirement and a unique index. Constraints are build into the database to execute internal checks for several attributes/tuples/tables to ensure validity of the data. In this way entered data are checked against permissable ranges, relations with other data etc. (e.g. soil depth between 0-150 cm, and depth layer n+1 > depth layer n).

The first pilot area which amounts to 250,000 km² could have a maximum of 2,500 polygons with the minimum size of a polygon set at 1 cm² at a scale of 1:1M. Each polygon (15 entries) has a maximum of 3 terrain components (24 entries) and 3 soils (66 entries). Maximum total storage for the attribute data of one polygon is than 3 Kb. For the whole pilot area an ultimate storage of 2,500 x 3 = 7.5 Mb is needed. This can be handled by normal hard disk capacity.

Security of the database is an important aspect, especially when the database will be accessible by various users. Security refers to the protection of data against unauthorized disclosure, modification or destruction. ORACLE5 has the possibility to authorize users for different kinds of access to specified tables.

1.3 Testing of the database structure

The first data were entered in the database in order to test it. Several modifications in the structure were introduced and some are still to be executed. What is still in development is the 'labeling' of fields to distinguish between measured values and 'expert estimates' and between 'non applicable' and 'no data'.

As the domain tables are not completed yet, additions have to be made. The complete definitions of the codes in the languages to be used by SOTER must be entered.

After the input of a certain amount of data optimalization of the database structure has to be done, to speed up queries etc.

1.4 Input of the first set of data from the pilot area

In November the structure of the database was considered satisfactory and input of the coded data received from the three countries started.

Special screens for input are developed with the ORACLE5 'SQL Forms' facility (see figure 2). It is expected that these input screens will be also used in the future as coding forms for the data. The transfer of data from the coding sheets currently in use (80 columns) towards the computer input screens is a rather cumbersome one.

A total of 109 polygons (4 from Brazil, 101 from Argentina and 4 from Uruguay), mostly with one terrain component and several soils, has been input into the database.

1.5. Output format of attribute data

With the query language used by ORACLE5 output can only be generated in tabular form. Therefore programs (in C) are developed for standard polygon/terrain/soil descriptions. An example will be shown later. The C-compiler for the PC version of ORACLE5 became available recently. It lies in the program of work to develop standard output for polygon/terrain/soil descriptions in C.

For the attributes which are related to soil degradation special query programs have to be developed. This is also valid for other standard queries which still have to be defined.

Within ORACLE5 the possibility exits to use a spreadsheet facility (SQL-Calc) in which the data can be manipulated. A report writer facility (SQL-Report) can generate data in a report format. However editing facilities are primitive.

1.6 Possible improvements

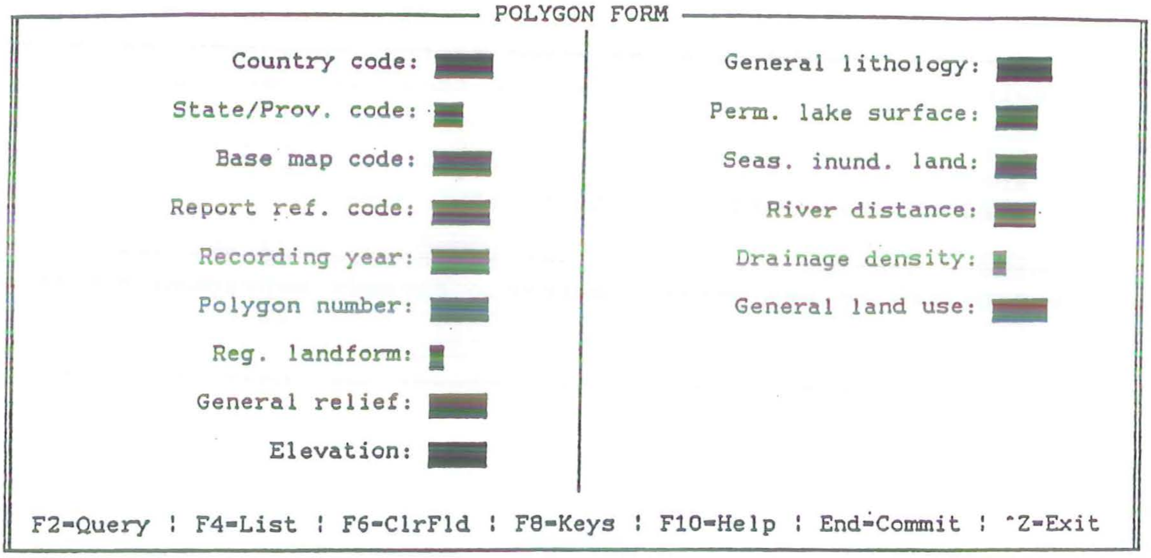
1.6.1 Use of the database

After input of all the data collected by the three countries, use of the database for various queries can be tested. If required, modifications or additions to the database structure or contents can be made.

Especially with large databases it is important for the performance to optimize the data structure with regard to the main transactions that are to be done on the database. Unfortunately, not all transactions can be foreseen at the moment. Therefore optimizations will be necessary after some time.

Output either in tabular or report format should also be possible in various languages. However, the coding of data should still be done in one format.

At the moment queries to the database are poorly defined. It is one of the tasks of this workshop to define some uses of the database, especially in the field of soil degradation.

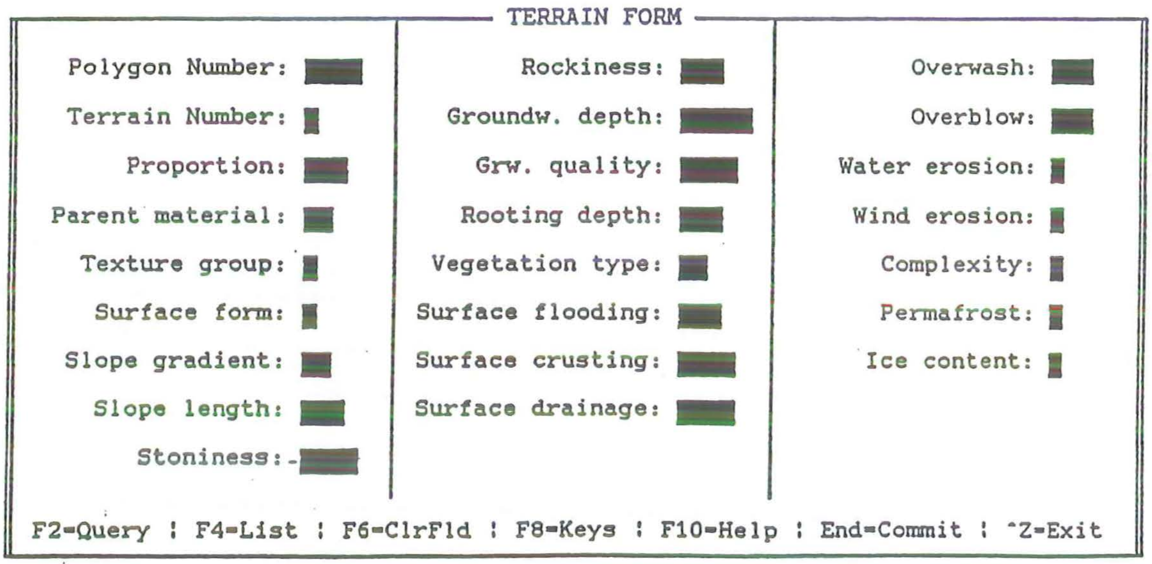


POLYGON FORM

Country code:
State/Prov. code:
Base map code:
Report ref. code:
Recording year:
Polygon number:
Reg. landform:
General relief:
Elevation:

General lithology:
Perm. lake surface:
Seas. inund. land:
River distance:
Drainage density:
General land use:

F2=Query ¦ F4=List ¦ F6=ClrFld ¦ F8=Keys ¦ F10=Help ¦ End=Commit ¦ ^Z=Exit



TERRAIN FORM

Polygon Number:
Terrain Number:
Proportion:
Parent material:
Texture group:
Surface form:
Slope gradient:
Slope length:
Stoniness:

Rockiness:
Groundw. depth:
Grw. quality:
Rooting depth:
Vegetation type:
Surface flooding:
Surface crusting:
Surface drainage:

Overwash:
Overblow:
Water erosion:
Wind erosion:
Complexity:
Permafrost:
Ice content:

F2=Query ¦ F4=List ¦ F6=ClrFld ¦ F8=Keys ¦ F10=Help ¦ End=Commit ¦ ^Z=Exit

Fig 2

1.6.2. Correctness of the data

During input of the terrain and soil data it appeared that various data are originally absent in the national data sets that have been used to fill the forms. They have been estimated by expert judgement. Although it was proposed during the correlation trip in June to label these data, e.g. by yellow marker, this was not consequently done.

A thought should also be given to the necessity to fill in missing data by expert judgment if these data are lacking in all three countries. This concerns especially data on trace elements/toxicity and permeability. Do we really need them in the database or do we expect to receive them in other countries and so need the reserved room for them?

Another problem related to the correctness of the data is the variability in analytical methods, already mentioned during the correlation meeting, leading to data which cannot be interpreted in a simple way. So far no provisions in the database have been made to indicate the analytical methods that have been used. That needs to be done somehow.

Problems related to inconsistency in the data (e.g. soil drainage is indicated in one profile as "well" while in another polygon/terrain/soil component reference is made to the same representative profile but soil drainage in the coding sheet is "mode(rately)") can be overcome by the proposed input forms where a more logical input sequence has been maintained.

2. Climatic database

Most items related to the climatic database will be handled by Roel Oldeman so only those which are of interest to the database structure will be discussed here.

2.1 Database structure

Justifications for the use of ORACLE5 DBMS are identical to those stated under Soils and Terrain. In addition to the soils and terrain database also a start was made with the development of a structure for the climatic database, according to the proposals of Roel Oldeman. This proved to be a much simpler task as only two tables were to be declared, one holding the meteorological stations's particulars, the other the climatological data.
Key fields are the country code and the station code which constitute the connection between the two tables. Complete explanations of the codes used for the climatic parameters are entered in separate tables, called domains. These definitions can also be used for output activities.

Integrity is maintained by assigning a unique index to country and station code. Various constraints ensure validity of the data, e.g. average maximum temperature > average minimum temperature.

2.2. Input

Climatic data which were already available at ISRIC (FAO agro-climatological data for S-america) were also input into the climatic tables with the help of three input screens.

45 climatic stations from the pilot area which is extended with one degree have been entered, with a various number of climatic parameters.

2.3 Output

Output of the climatic database in tabular form is a rather simple activity in SQL. Manipulations of the data can also be done be exporting the required to a spread sheet facility of ORACLE5 (SQL-Calc) and execute them there. Complicated ones should better be written in C.

As the climatic data have already a geographical component in the form of coordinates output can be directed towards a contouring program (SURFER) which can generate single value contours of a climatic parameter.

3. **Organizational aspects**

3.1. General

Acquisition of a GIS facility, and thus also of the database facility which is part of it, should not be done without seriously considering the ways in which they will affect the rest of the organization. Some organizational aspects will be discussed in short.

For the whole database certain procedures have to be set up for the administration and management of the data. At the lowest user level responsibilities have to be defined in the fields of entering, modifying and retrieving of data. In other words: who has permission to look at the data, who is going to enter data and who is altering or deleting data? Higher up in the authority structure lies the next item. Modifications in the database structure which will have repercussions for the whole SOTER project can only be executed or granted by the highest authority: the database administrator, who also is also the person who grants authorizations to other users.

At each site were data are entered backup procedures must be defined, in which frequencies scopes and executing staff of backup activities must be specified.

The current database structure is developed for a single user situation. In this respect user names/passwords can be easily managed. When the system will be working in a multi-user environment, it will be necessary to revise the current applications concerning safety and concurrence. This will be the case when data will be entered by the various countries themselves and be managed by a central database management facility.

3.2 Pilot area data input

A procedure for checking of the database by the participating countries has to be set up. It is proposed to sent to each of the countries a hardcopy output of their data, together with remarks about lacking or incorrect data, after the whole set of data has been input into the database. Improvements should than be sent by the three countries to ISRIC for input, after which a hardcopy and if hardware will be available also on disk will be returned.

Conclusions

The database structure is now suitable to store all attributes as defined in the 'Procedures Manual'. Improvements should be made concerning the labeling of 'expert estimates' and 'real value' data. Output format should also be made n the language required by the operator.

In order to optimize query operations this workshop should also define some uses of the database, especially in the field of soil degradation.

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2.3 Progress Report "Pilot Area"
Wilhelmus Peters

Review

During the first SOTER Meeting held in Wageningen, the Netherlands, in January 1986 the South American Pilot Area located between 28 and 32° and 54 and 60°W already got a high priority and this was confirmed during the second SOTER Meeting in Nairobi, Kenya, in May 1987. The main reasons for this high priority were:

1. Availability of basic information
2. Interest shown by regional and national organizations
3. Availability of national soil resources inventories

In September 1987 an agreement was signed between UNEP (United Nations Environmental Programme) and ISRIC (International Soil Reference and Information Centre) to carry out the GLASOD Project (Global Assessment of Soil Degradation) on world level and within this framework do a more detailed study of the South american Pilot Area at a 1:1.000.000 scale with special emphasis to man induced soil degradation.

Pilot Area Project Activities

1) **First Regional Workshop on a Global Soils and Terrain Digital Database and Global Assessment of Soil Degradation.**

This meeting was held in Montevideo, Uruguay, from 20 to 25 March 1988 with participants from each of the three countries involved in the Pilot Area Project: Argentina, Brazil and Uruguay. Other participants were representatives of ISRIC, ISSS, ITC, SCS, FAO and the authors of the SOTER Manual proposal.

The main objectives of this workshop were:

a. Discuss the Procedures Manual proposal for organizing, correlating and coding the basic information on soils and terrain.
b. Make an inventory of available information on soil and land resources of each of the participating countries to see if it will be necessary to produce additional information.
c. Make an inventory of the use of databases and the availability of facilities of data processing and of highly qualified personnel within the pilot area.
d. Form correlation committees on national and regional level and establish responsibilities.
e. Establish cooperative working arrangements on national and regional level.
f. Discuss the Procedures Manual proposal for the assessment of the status (type, degree and rate) of man induced soil degradation.
g. Elaborate an implementation plan including methodologies, time scale, output and financial aspects.

The most important conclusions of this very successful meeting were the following:

1. The three countries involved in the Pilot Area Project have shown a great interest in it, a great willingness to support it and a complete openness concerning the availability of information.
2. The information that is available seems to be adequate.
3. The legend part of the SOTER Manual proposal will be used with some minor changes.
4. The degradation part of the Manual proposal will be rewritten and adapted to the Guidelines of the GLASOD Project.
5. The climatic information will be organized and coded separately.

During the final meeting working groups in each of the three countries were formed, letters of intent were prepared and the following time scale was approved for the activities of the Pilot Area Project:

1 April - 5 June :	Gathering and organization of existing information and generation of essential information that does not exist
6 June - 19 June :	First Correlation Meeting - Field Trip to adapt Manual to local conditions
20 June - 13 Nov. :	Continued organization of information
14 Nov. - 21 Nov. :	Final Correlation Meeting
22 Nov. - 31 Dec. :	Preparation of final output. Maps, reports and coded information for database ready by 31 December 1988.

2) Progress of the Pilot Area Project

1. 1 April - 5 June. As was agreed at the Montevideo meeting during this period the existing information of a small preselected area within the pilot area in each of the three countries was organized and coded according to the SOTER Manual in order to be discussed during the First Correlation Field Trip and Meeting.
   Each of the three national working groups did the adapting and coding of the available information independently interpreting the SOTER criteria in its own way. This was done on purpose to see if the descriptions of attributes and classes by the Manual were sufficiently clear to guarantee a uniform approach on regional level.

2. 6 June - 19 June. Between 6 and 19 June the First Correlation Field Trip and Meeting took place with the participation of 2 representatives of each country, the regional GLASOD SOTER correlator and the author of the legend part of the Manual. The field trip covered parts of the Pilot Area in the three countries with participation of national experts. The main objective of this meeting was the testing of the methodology and critera proposed by the SOTER Manual and during the field trip the problems that had

arisen were discussed and solved. The most important conclusions of this meeting were:

1. The experience obtained using the legend part of the SOTER Manual shows that it is both workable and applicable.
2. This kind of correlation field trip is absolutely necessary to get a clear idea of the concepts, definitions and characteristics of the Manual to guarantee a uniform approach.
3. The available information is sufficient and can be secured on.
4. The synthesizing and unifying action generated by the application of the Manual was evident because although each country worked independently with its own information the results were similar.

During this same meeting the following constraints were discussed:

1. Laboratory analysis. The methods used for soil analysis in the three countries are different and the interpretation of data is variable complicating correlation and comparison.
2. Degradation assessment. Although the assessment of the status of man induced soil degradation was in its initial phase because of the process of rewriting the degradation part of the Manual, it was evident that obtaining adequate information is difficult and that in many cases local experts must by consulted ("expert system"). At the same time to get a better idea of the definitions of the status (degree and rate) of man induced soil degradation a field trip through the pilot area was recommended.
3. Time. Although the time scale for the activities in the pilot area seems to be adequate, problems could arise that might cause some delay, like organizing and coding climatic data and the degradation assessment by the "expert system".

During the final meeting the changes to be introduced in the legend part of the SOTER Manual were discussed and approved.

3. 20 June - 24 August. In this period the national working groups continued their activities of organizing and coding the information and most of the basic information was processed and coded according to the criteria of polygon file, terrain component file and soil layer file.
During this same period the first rewritten chapters of the degradation part of the Manual came out and the first steps were taken to use this new approach of man induced soil degradation assessment.

4. 25 August - 1 September. As had been recommended during the First Correlation Field Trip and Meeting a Second Correlat-

ion Field Trip took place through the pilot area. Each of the three working groups participated in it and like the first trip this one included those parts of the three countries located within the pilot area. The main objectives of this Second Correlation Field Trip and Meeting were:

1. Discuss and solve the problems that might have come up during the application of the SOTER Manual by the national working groups.
2. Discuss and unify the evaluation of man induced soil degradation status (degree and rate) according to the last version of the Manual.
3. Discuss and prepare the objectives and the programme of the final correlation meeting to be held in Porto Alegre, Brazil, in December.

The most important conclusions of this meeting were the following:

1. The applicability of the degradation part of the Manual is evident in spite of the qualitative approach and the small working scale, but a lot of fieldwork is necessary in order to characterize with precision the degradation aspects of the different polygons.
2. The vital importance of this kind of correlation meeting was clear once more in order to visualize and unify the norms of the Manual.
3. The participation of experts of each country is essential for completing the detailed description and the characterization of the different aspects of each polygon.

During the last meeting of this very important and successfull field trip the final correlation meeting was discussed and planned for the period between 12 and 15 December 1988. A tentative programme was prepared.
Bilateral correlation meetings between the participating countries in their border areas were organized.
The final touch of the correlation procedures was planned for the December meeting where in two working groups the final legend of the polygon map and the degradation map of the pilot area to be presented will be defined.
It was expected that about 80% of the recollecting, organizing and coding of the basic information would be ready before the Porto Alegre Meeting.

5. 2 September - 11 December. The most important activity in the pilot area during this period was the systematic coding of information for the SOTER polygon, terrain component, soil layer and degradation files. A begin was made with the coding of climatic data on special separate coding forms.
The assessment of man induced soil degradation and its coding according to the Manual received special attention.
In this same period bilateral correlation meetings were held between Brazil and Uruguay, 26-30 September, and between

Argentina and Uruguay, 18-20 October. The meeting planned between Brazil and Argentina had to be postponed because of some unforeseen problems, but it will be held as soon as possible.
Part of the completed coding forms were sent to ISRIC, Wageningen, and to Purdue University to be used in the development of the database and to be introduced into it.
The national working groups of Argentina, Brazil and Uruguay will present their progress reports afterwards with detailed information on their activities up to date.

3) **Forward Planning**

During this Final Correlation Meeting of Porto Alegre the last details of the legend of the polygon and degradation maps will be discussed and immediately afterwards the final phase of the pilot area activities will begin.
The correlation meeting between Argentina and Brazil will be held as soon as possible and after completing it the elaboration of the polygon and degradation maps of the parts of Argentina, Brazil and Uruguay, components of the pilot area, will be completed and the final report will be written according to the guidelines discussed during the second correlation meeting.
It is expected that the three national groups will finish their activities on pilot area level before the end of January 1989 and that the maps and report will be delivered before the end of February 1989.

This way the information part of the pilot area activities will be finished with only a slight delay caused by some unforeseen problems and without any doubt the decisive factor in this success has been the professional quality and the motivation, dedication and enthousiasm of the members of the working groups of Argentina, Brazil and Uruguay.

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2.4 Progress Report Argentina

Carlos Scoppa, Juan Salazar, Rosa Maria di Giacomo, Ruben Godagnone, INTA.

Polygon map and coding

The first step of the methodology used in the Argentinian part of the pilot area was a review of the existing information. The total area is covered by soil surveys at a 1:500,000 scale and about 50% of it by more detailed ones (1:100,000 and 1:50,000). Next the SOTER methodology was analysed and interpreted in order to be able to carry out the adaptation of the information to it. The first results were a preliminar map and the first coding forms. A field trip that was considered undispensable was carried out in order to verify, interprete and correct the information. Afterwards the correction was done in the office and the first approximation of the SOTER Map and coding forms was prepared.

An international correlation meeting was held with the working groups from Brazil and Uruguay to homogenize the information and at the end of this meeting a field trip was organized for the final determination of the units and its characteristics. During this same meeting the activities of the GLASOD Project were initiated using the same procedures of the SOTER programme.

After that meeting a field check was carried out and the corresponding corrections were done in order to produce the map and the final coding.

Soil degradation

In the area several kinds of soil degradation processes caused by human rural activity are found. The ecological environment of each region is conditioning strongly the type of agricultural exploitation or grazing and at the same time presents several degrees of degradation susceptiblility according to climate, soils and relief.
Man induced soil degradation is a process that causes a reduction of its production capacity and that is a result of interactions between human activity and the climate, soils, relief and vegetation resources.
In general terms the degradation process can be represented by the following formula:

$$D = f\ (CSRVH)$$

D = Soil degradation
C = Climatic agressivity
S = Soil susceptibility
R = Relief
V = Vegetation cover
H = Human action

On the Soil Degradation map of the Argentinian part of the pilot area the mapping units represent areas where different types and

degrees of degradation processes and/or combinations of them occur.
The legend was prepared according to the Guidelines edited by L.R. Oldeman, ISRIC, Wageningen, April, 1988, N° 88/3.
The map and legend give information on the location of the degraded area, the degradation type and its degree, causing factors, percentage of the area affected and recent rate.

Conclusions

- From all the available information on the soils of the pilot area at different scales (1:500,000; 1:100,000 and 1:50,000) the soil maps at 1:500,000 were selected of each of the provinces involved because this information was considered sufficient to meet the SOTER requirements.
- The reduction of the original soil map to a 1:1,000,000 scale made necessary some adaptation because some mapping units had to be eliminated, because they became smaller than the basic mapping units, in order to maintain a good legibility.
- The texture of the map which means the size, pattern and form of the mapping units, was taken into account to evaluate the final map. Its texture is homogeneous, except in areas of complex landscape and soils patterns, like those with pronounced slopes or undulating landscapes where a major density of limits occur or on the contrary large units in areas with similar characteristics like extensive plains and fluvial terraces.
- A total of 264 polygons corresponding to 115 Soil Units integrated by 101 Taxonomic Units.
- The 264 polygons were grouped in 46 different combinations of the 7 selected attributes to integrate the map symbols. These 46 combinations were put together in 8 groups based upon soil development characteristics.
- The attributes to be used were discussed in the field taking into account the specific conditions of the country. In the case of regional landform only Plains and in some cases Valleys were separated each with one Terrain component because of the very homogeneous parent material except in the case of one polygon on a terrace of the Uruguay River with two different parent materials (aeolian and alluvial). This case has been correlated with our collegues from Uruguay. Soil development, parent material and textural class did not cause any problems in coding. Because of some very particular conditions of drainage it was necessary to separate internal from external drainage in the surface form.
- The map elaboration was a very precise job mostly in relation to the numerical identification of the polygons.
- Filling out the SOTER coding forms was a job that took a great effort and dedication because of the type of work, registering real and coded data in a quadrangular matrix.
- The data selected to complete the coding forms were provided by the reports of the soil maps and in some cases experts were consulted.

- The guidelines, methodology and Manual of GLASOD to evaluate degradation caused by man did not offer the same facilities and precision as the SOTER Project. The evaluation in the field to get the information for coding forms was difficult.
- The "expert system" was indispensable in the case of the assessment of man induced degradation because the available information on the subject was not adequate.
- The predominant degradation types are water erosion (sheet erosion and gully erosion with terrain deformation) and physical degradation (compaction and crusting). These processes have caused degradation of a slight degree according to the scale of values used in the GLASOD methodology. This slight degree of degradation is due to the extensive land use that is mainly forestry and perennial crops like citrus, tea, "mate" and others. On the other hand the general relief is undulating to level and the soils are moderately susceptible to erosion with rainfall of a moderate to high aggressivity. These factors configure a general view of a low degradation risk, except in those areas where the relief is more pronounced and the climate more aggressive. As a consequence in general the degradation rate is slow to medium.
- The proposed and applied methodology is original and permits counting on an advanced technology of information based upon digitized maps and databases. This system is functional because it integrates the natural resources of an area in different files and in this way it permits recuperating the necessary information for preparing different studies for instance the planning of use and management of a natural resource on regional level.
- The working group to carry out this task was formed by 5 members who dedicated 10 months to it. The support came from one cartographer and two secretaries. Eight local experts were consulted and four experts took care of the climate file.
- This technique is considered excellent to be used treat on national level for the whole territory, almost 300,000,000 Has that is completely covered by soil surveys of a 1:500,000 and 1:1,000,000 scale or may be less ambiciously to do the Pampa region where grazing is concentrated and in this way count on the complete information of about 55,000,000 Has indispensable to study management, conservation and productivity of resources on regional level.

Recommendations

According to the experience obtained in the pilot area the personnel in charge of carrying out the tasks of the GLASOD-SOTER Project must be specialized and experienced in the different fields where the methodology requires information.

- As a consequence the formation is suggested of interdisciplinary working groups of soil scientist, botanists, agronomists, climatologists, geographers and hydrologists.
- If no specialized personnel is available training courses

must be organized to guarantee an adequate integration of the GLASOD-SOTER Manuals.

- The consulting and technical assistance of international correlators is of utmost importance in order to obtain homogeneous results. At the same time the implementation is suggested of correlation between countries of analytical methods, taxonomy and evaluation of natural resources.
- The participation of a representative of each of the three countries together or alternately in other pilot areas in the world is considered very important because of the experience obtained by the different working groups in implementing and applying the GLASOD-SOTER methodology.
- When the SOFTWARE is available for the working groups of each country the training in the specific programme is suggested for at least one member of each team.
- The GLASOD-SOTER Methodology was used in an area where the soils have udic and aquic soil moisture regimes with good drainage and a humid climate, characteristics quite different from the rest of the country. About 75% of the national territory cannot be represented by the information obtained in this area and therefore it would be interesting to apply the guidelines and procedures in arid and semi-arid areas and evaluate in those areas not only soil degradation but also the degradation of natural pastures.

2.5 Progress Report Uruguay

Leonel Aguirre, Juan Molfino, Cesar Alvarez, Carlos Clerici
MGAP, Dirección de Suelos

Objectives

The Dirección de Suelos of the Ministerio de Ganadería Agricul-turay, Pesca in charge of the Uruguayian part of the GLASOD-SOTER Project defined as its first objective to adapt the Reconnais-sance Soil Survey Map at a 1:1,000,000 scale taking into account the regional aspect of the Project.

Methodology

1. Elements taken into account when defining the units of the Reconnaissance Soil Survey Map.

   The most important criterion was the grouping in associat-ions of soils or to be more precise associations of families. Within each association the dominant component occupies more than 50%, the associate between 10 and 40% and the accessory less than 10%.
   The taxonomic system used was published in 1976 and since then in use in the country. Within the Uruguayian part of the SOTER pilot area 40 units of the Reconnaissance Soil Survey Map 1:1,000,000 are represented.

2. Elements taken into account to define the SOTER polygons.

   According to the SOTER Manual the principal elements for defining the polygons are the following:

   - Landscape (Regional and Local Forms)
   - Slope (Grade)
   - Parent material
   - Textural class of parent material.

3. Adaptation to the SOTER norms

   The units of the Reconnaissance Soil Survey Map were redefined because of the difference in objectives and norms used to define the units of this map and the SOTER Project. This way within the Uruguayian part of the pilot area, 83 polygons were coded that were grouped in 24 units with similar characteristics. Although some synthesizing was done no information got lost because every time it was necessary the possibility that offers the manual to include up to three terrain components and three soils per polygon, was used. The most representative soils were coded in each case.

4. Sources

   The following sources were used for coding the soil layer attributes:

- Tomo III Appendice de la CRS, Uruguay, 1979 "Descripción, datos físicos y químicos de los suelos dominantes"
- Archivos de la D.S.-MGAP: Cartas detalladas y semidetalladas (varias escalas) de suelos de la parcela SOTER.

5. Field work

To verify the SOTER Manual three kinds of fieldtrips were carried out:

1. SOTER-GLASOD Trips in June with participation of J. Shields and W. Peters in order to adjust the SOTER Manual including chapter 14 and 15 on Degradation.
2. National trips to check the workability of the Manual in the field and to gather complementary information.
3. Bilateral trips with colleagues from Argentina and Brazil to check the limits in the border areas and to adjust the definition of the polygons and of the degradation aspects.

6. Normalization and coding of the polygons according to the SOTER Manual

The normalization and coding of the data (attributes of polygon, terrain component and soil layer files) was carried out according to the definitions of the Manual.
Afterwards the information was introduced in a database using dBase III.

7. Map and legend

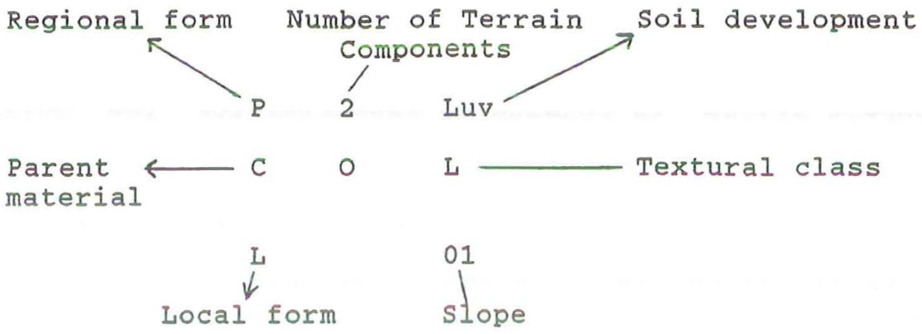
For the base map ONC sheets Q 27 - Q 28 and R 24 were used:

Symbols were used according to the SOTER Manual for:

- Regional land form
- Number of terrain components
- Soil development
- Parent material
- Textural class of parent material
- Local form
- Slope

In the case of soil development the predominant pedogenetic process was chosen.

The next formula is used:



Soil Degradation

1. Application of chapters 14 and 15 of the SOTER Manual.
   The coding of representative and contrasting polygons was done in the office in order to be able to check during the fieldwork.

2. Fieldwork
   In August 1988 a fieldtrip with the three groups and W. Peters was organized to see and discuss degradation phenomena in Argentina, Uruguay and Brazil and the guidelines proposed by the Manual were tested.

3. Normalization and coding of the degradation sheets.
   After the correlation meeting all the polygons of the Uruguayian part of the pilot area were evaluated in the office, taking into account water erosion and its rate and hazard fundamendally.

4. Map and legend
   To elaborate map and legend the following elements were taken into account:

   a. Existence or not of erosion
   b. Sheet or gully erosion or a combination
   c. Surface affected and degree
   d. Cause of erosion.

5. Database and calculation of rate and risk.
   An intent was made to characterize 25 different polygons including some with more than one soil and landuse type.

Conclusions

- The SOTER MANUAL has shown in general its applicability and workability on national level.
- The use of the Manual proved its flexibility and at the same time the logical order of its structure.
- At the beginning of the SOTER Project in Uruguay information on soils at a 1:1,000,000 scale was available but nevertheless fieldtrips were very important to refine the application of the Manual and to put the data in logical order.

- The bilateral trips to check the limits in the border areas helped to verify criteria on regional level mainly in the cases of regional and local forms.
- The "expert system" is considered essential for the SOTER Project, in order to organize, adapt and complete the existing information according to the Manual.
- The flexibility that offers the manupulation of the components in the definition of the polygons was evident. Nevertheless the possibility to use more than 3 components would enrich the characterization of the landscapes.
- The same goes for the possibility to use more than 3 soils.
- On national level it could be important to change the ranges established in the Manual for instance for cation exchange capacity, base saturation etc.
- The major part of the physical properties has not been coded in this first approach. Only the analytical data that could be used for normalization afterwards have been used. The rest will be brought into the database with the help of existing information and mathematical models.
- After the trip through the three countries and the work in the office it became clear that it is necessary to define key cases in degradation (for instance degrees zero and slight in Argentina, moderate in Uruguay and extreme in Brazil).

Recommendations

- The creation of a Regional Centre is necessary for the managing of the information in coordination with the World Centre but being free to use it according to the necessities. In this sense Montevideo is proposed as seat of this Regional Centre.
- The translation in Spanish of the SOTER Manual is recommended in order to verify the work in the pilot area. This does not imply the translation of the terms used in coding that will stay as they are to facilitate normalization.
- Sampling of representative profiles of polygons in the border areas is recommended to be analysed in each country to adjust the analytical techniques to facilitate comparison an classification of the results.
- Because of the physical potential of the pilot area it is recommended to produce, thematic maps of multiple use expanding the GLASOD-SOTER Project.
- It is important that ISRIC within the SOTER framework supports a consulting in Uruguay of about a month to train local personnel in the use of the informatica.
- The evaluation of point cases f.i. farmers fields, pastures is not sufficient for degradation assessment taking into account the scale, but the combined effect of the process, must be visualized for the whole polygon taking into account the dominant land use.
- A correlation between, the definition of the polygons and the coding of degradation must exist (for instance taking into account the components of the polygons).
- The precise characterization of production systems and land

use and its intensity is suggested and although these attributes are not coded in the SOTER Manual they would be very important elements for coding degradation rate.

- The use of the methods proposed by the Degradation Manual of the FAO (1980) is suggested to assess the degradation of physical properties and in this way unify the comparison within the pilot area. At he same time a method to evaluate loss of organic matter could be useful, because in some polygons the degradation processes are related to physical properties and organic matter.
- It is suggested to take into account the loss of topsoil as a percentage of the total solum and of the surface horizon in order to assess sheet erosion. In those cases where this is difficult the states of the vegetation can be used.
- Visual methods can be adjusted in each country to evaluate the natural vegetation (status and condition) in order to evaluate loss of natural fertility.
- From the coding process of the polygons in Uruguay the importance of fieldtrips for their verification became evident. It would be necessary to develop a methodology for this that would include as basic instrument the sampling of an area with detailed analysing and taking into account data on land use. (f.i. natural system, agricultural system, grazing system).

2.6 Progress Report Brazil

Francesco Palmieri, Jorge Olmos, Pedro Fasolo, Reinaldo Põtter, EMBRAPA

Methodology

The material used for the delimitation of the polygons was the 1:1,000,000 soil map of the exploratory soil survey of the Uruguaiana sheet carried out by the SNCLS (Serviço Nacional de Levantamento e Conservaçao de Solos) of EMBRAPA (Empresa Brasileira de Pesquisa Agropecuaria) and the RADAM BRASIL Project.

This material was completed with:

RADAR images	1:250,000
Photo index	1:250,000
Aerial photographs	1:110,000

Geological and Geomorphological maps
Reports of pedological, geological and geomorphological surveys
Climate data

After having studied the SOTER Manual in the office the soil map, the radar images and the Photo index were interpreted in order to identify those areas that could constitute polygons and at the same time plan the route and the stops of the first field trip. The main objectives of this first field trip were:

1. observe on the spot the characteristics of the area of the polygons defined in the office,
2. verify the workability of the SOTER Manual,
3. describe representative soil profiles and take samples for laboratory analysis.

After this first trip the available material was studied again and with the profile description on the laboratory analysis a second trip was made to the field to code the polygon terrain component and soil attributes.

Both fieldtrips served to get familiar with the ideas proposed by the GLASOD SOTER Project, the Procedures Manual and very important to prepare the international correlation trip.

During the correlation meeting and fieldtrip through Argentina, Uruguay and Brazil, the Manual was discussed, the difficulties were indicated, some doubts were cleared and some changes and conclusions in the Manual were proposed to adapt it to the different situations encountered in the field.
Afterwards a first approximation of the polygon map was prepared using the newly acquired knowledge and all the available material like geological and geomorphological maps radar images, photo index, aerial photographs and soil map. A transparent overlay was put on the soil map and on this the polygons were drawn using basically the soil unit boundaries. This procedure resulted in 32 cartographic units (basic polygons) subdivided in 110 polygons. During the following fieldcheck all the basic polygons were

visited and its number was reduced to 27. The final coding of these 27 basic polygons was done in the field.

At the same time the man induced degradation was coded in some terrain components in order to be discussed during the second international correlation trip. The main objectives of this trip were to discuss several aspects of the application of the norms for assessment of man induced soil degradation and to guarantee an uniform approach by the three national working groups.

During this second correlating trip after finishing the discussion, the conclusion was that loss of soil material by mechanical action and physical degradation were the most important degradation processes and that chemical degradation is related to loss of soil material.

According to the results of the second correlation meeting degradation was coded in the polygons. Correlation with Uruguay was carried out in the border area and polygons on both sides of the border were defined and some last problems were solved.
The last step was the drawing of the final polygon map on the cartographic base selected for the world map (ONC). The total number of polygons is 156. Its coding was checked and the final report was written according to the scheme approved before.

Conclusions

Although in Brazil pedological, geological and geomorphological information at 1:1,000,000 was available in the pilot area the composition and delimitation of the polygons created with this information were not sufficiently reliable in order to eliminate fieldwork.

To produce a reliable map the coding of the polygons and its components must be done in the field and the delimitation of the polygons from existing soil, geological and geomorphological maps.
The SOTER Manual for coding the polygon attributes is sufficiently workable to carry out the task, but the Manual for coding the information about soil degradation, in our case mainly chemical and biological degradation, is not while it is very difficult to use in the case of physical degradation.

Comments

1. The use in the database of very specific information, sometimes of only local importance and generally in detailed surveys seems strange like f.i. aggregate stability, infiltration rate, manganese, gypsum, micro-elements, clay mineralogy, Phosphorous fixation and water quality. In a polygon map at 1:1,000,000 the basic mapping unit of 1x1 cm represents 100 km^2 and this means that the generalization level is high and that the mapping units present a wide range of variation and are heterogeneous. Most of the characteristics mentioned above are used for homogeneous

units and this implies detailed soil surveys. We consider that a desequilibrium exists between the required laboratory information and the level of abstraction of the map. We have the same considerations in the case of the use of the USLE (Wischmeier) formula. The use of the nomogramme for Latosols gave erroneous results.

2. Profile descriptions and laboratory data are produced per horizon and not per layer except in alluvial soils. All pedological studies are based upon these soil horizons and its morphological, physical, chemical and mineralogical characteristics. Nevertheless the coding of the soil information is done per layers: two between 0 and 50 cm and two more between 50 and 150 cm. The 50 cm limit can or cannot concide with a soil horizon separation. If there is no coincidence the danger exists that important analytical data will not be taken into account (f.i. interchangeable Aluminium at toxical levels). It would be of interest if this limit at 50 cm would be made more flexible to let it concide with soil horizon limits and in the same way it would be recommendable to try and let soil horizon boundaries conmcide with soil layer boundaries in the other cases.

3. The analytical data produced by different laboratories show differences, but a good correlation exists. This was proven during two workshops held in Brazil in order to study several aspects of the implementation of Soil Taxonomy. The same soil samples analysed in Brazil and in the USA showed differences that could however be correlated. Other results obtained by ISRIC on world level show marked differences.

   We suggest that selected soil samples will be analysed in the laboratories of the three participating countries.

3.0 GENERAL SESSION PAPERS

3.1 Climate data File for Soil and Terrain Digital Database

Roel Oldeman, Jos Beemster, Vincent van Engelen, John Pulles

Climatic information is essential for an assessment of soil degradation risk and rate, which is one of the priority objectives of the Global Assessment of Soil Degradation project (GLASOD). Climatic data form also an inseparable part of the basic inventory of natural resources needed or land evaluation, for irrigation suitability, for crop productivity, etc.

Methodologies for soil degradation risk assessment and the climatic data needed are discussed in the Procedures Manual for Small-Scale Map and Database Compilation, chapters 14-21 (Shields and Coote, 1988). The SOTER Climate Files contain the most essential data, needed for this assessment.

1. SOTER Climate Files

This separate SOTER file contains two attribute files. The first file includes specifics of the climate station (such as name, latitude, longitude, altitude), while the second file gives numeric values of climate elements (such as precipitation, temperature, irradiance, humidity, wind speed and potential evapotransporation).

The climatic elements can be reported as annual, monthly, weekly, decade, pentade or daily values (averaged over a number of years, or as actual values for a series of years). Details of the various attributes in the two files are given in appendix A. The various codes are also indicated in this appendix as well as examples of coding sheets for the two files.

2. Status of Climate Database

Three sources of climatic information for the pilot area have been consulted so far:

a: Agroclimatic Data for Latin America and the Caribbean, 1985, FAO, Rome.
b: SAMMDATA, 1988, CIAT, Cali.
c: Jose A.J. Hoffman, 1975. Climatic Atlas of South America, WMO/UNESCO.

The first two sources contain mean monthly climatic data. These data have been entered in the climate database. A total of 45 stations are located within the pilot area, while another 21 stations, located within one degree from the pilot area, have been entered as well.

The third source gives a list of climate stations, used to prepare the various climatic maps of South America. There are 25 additional stations, located in the pilot area an 9 are located just outside the pilot area. Monthly climatic data from these additional stations should be collected by the regional correlation teams.

The summary table below indicated how these stations are divided per country.

	Within Pilot Area		Outside Pilot Area	
	Stored (source a,b)	to be collected (source c)	Stored (source a,b)	to be collected (source c)
Argentina	13	10	14	7
Brazil	5	6	2	0
Uruguay	6	9	2	2
Paraguay	0	0	3	0

Appendix B gives the complete list of all 79 climate stations with their latitude and longitude, while appendix C gives some hard copies of stored climatic data, that have been entered so far. Figure 1 shows the location of stations that have been identified within the pilot area. Together with the stations "to be collected" we have a well distributed network of climate stations.

3. Climatic database requirements for soil degradation risk assessment

Chapter 21 of the Procedures Manual discusses the climate data analysis for degradation assessment. A rainfall erosivity index Rt is required for water erosion risk assessments, a wind erodibility factor Cw has to be estimated for wind erosion, while a moisture availability index MAI is needed to estimate salinization, sodication and chemical degradation as a result of nutrient losses.

3.1 Rainfall erosivity index Rt

The preferred method is that developed by Wischmeier and Smith (1978). This method requires daily pluviographs for at least 10 years. This type of data is only available at climate stations with a self-recording rain gauge. Efforts should be made to retrieve these pluviographs from at least one station per country. Only pluviographs that show a rainfall intensity of at least 25 mm per rainfall event within 6 hours are considered erosive.

As best alternative method the method developed by Bols (1978) is suggested. For this method we need to collect from as many stations as possible the number of rain days per month and the mean maximum 24 hour precipitation for each month. This information is not available in the three sources mentioned in section 2, but should be available from the national meteorological services in the three countries. The other alternative, developed by Arnoldus (1977) requires only mean monthly rainfall. Figure 2 shows the first attempt to draw isolines of Rt values according to the Arnoldus method based on the presently available information.

LOCATION OF CLIMATE STATIONS (Pilot Area Latin America) - SOTER

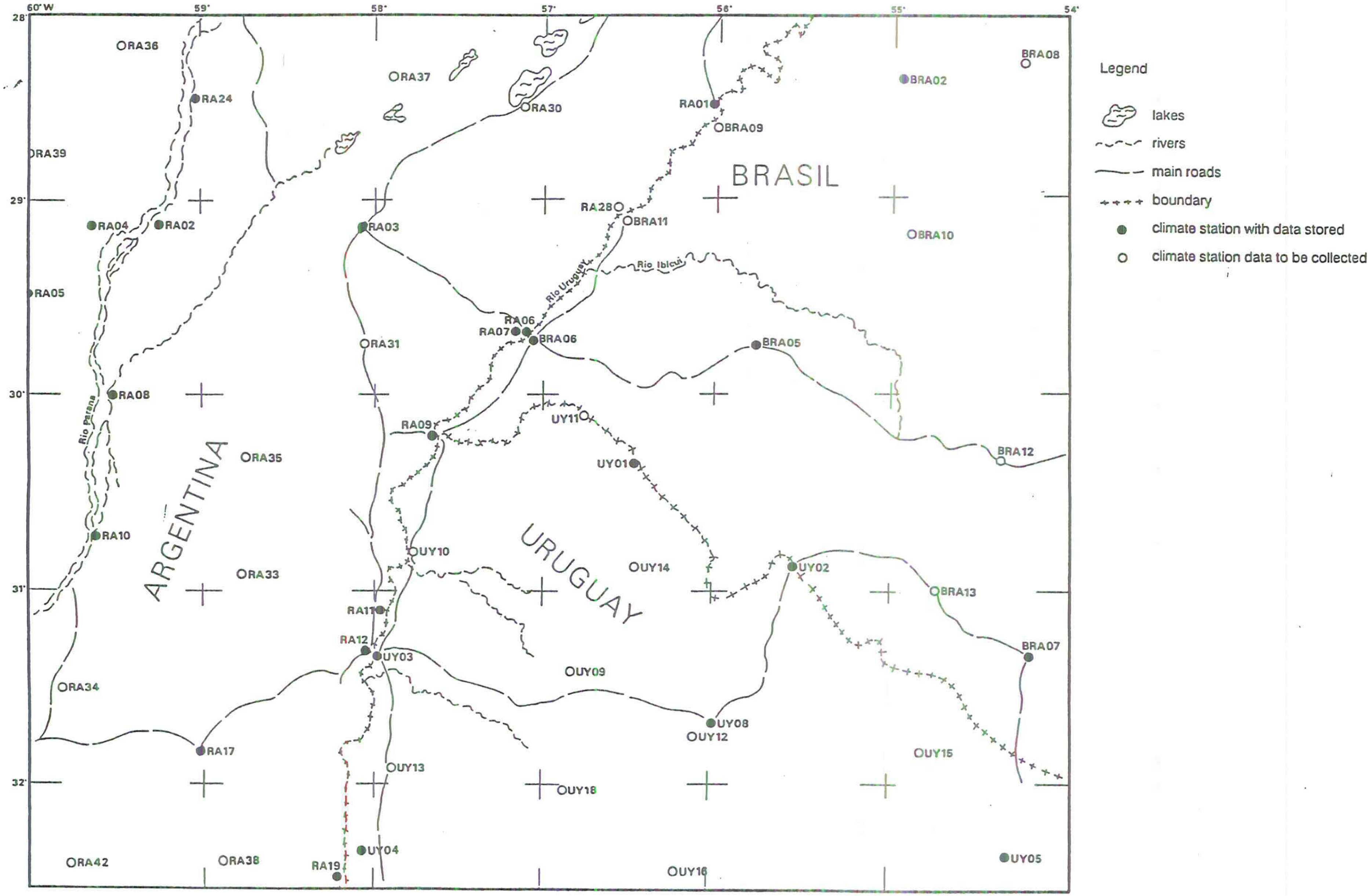
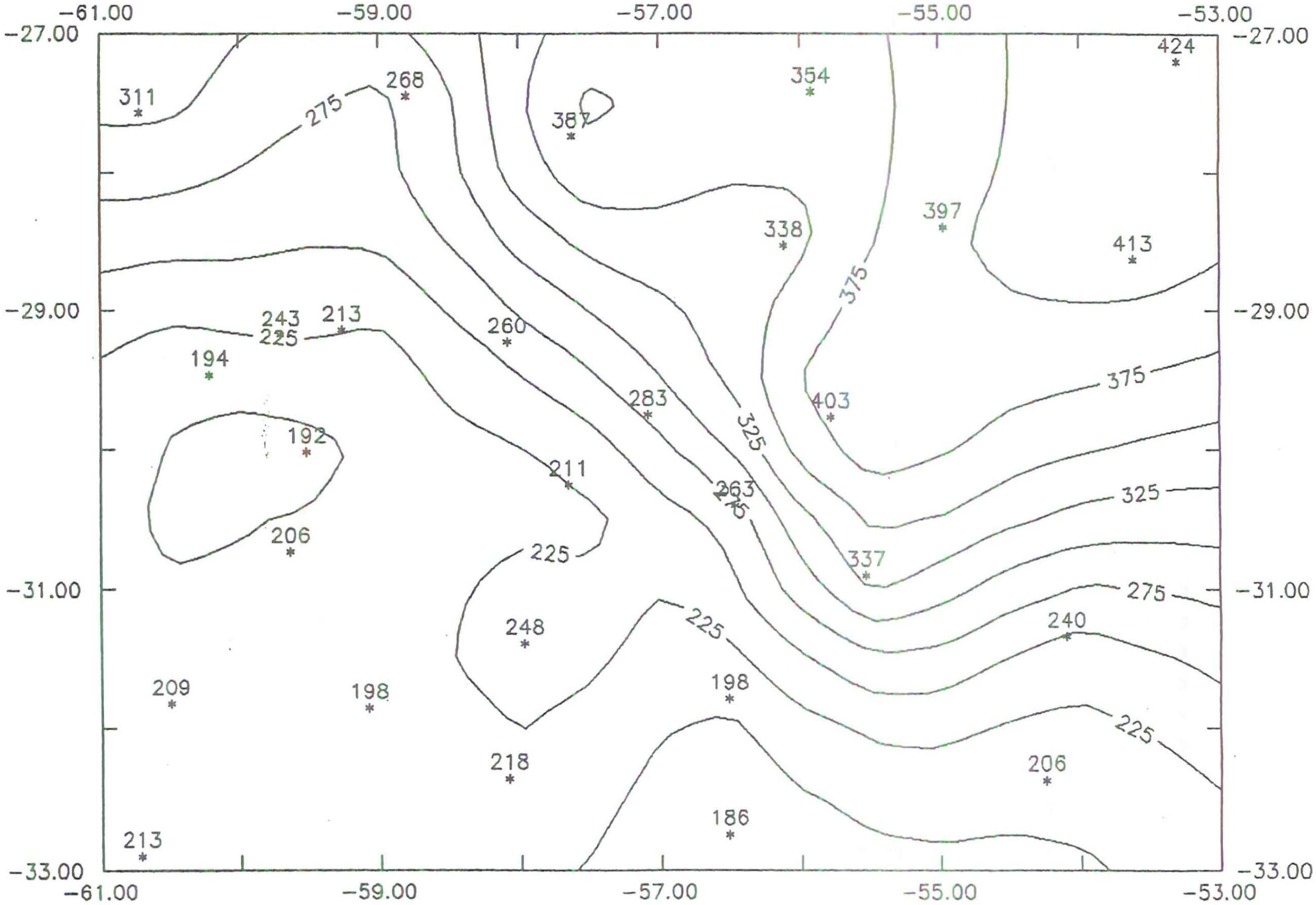


Fig. 2 R-values according to Arnoldus



3.2 Wind erodibility index Cw

The Cw factor requires information on monthly wind speed at 10 m height and calculation of the Thornthwaite precipitation-evaporation index, which is based on rainfall and mean temperature on a monthly basis. Although the Thornthwaite index may not be valid in the tropics it should be used to calculate Cw, which is based on this index. An alternative method is used by FAO (1979). In this method potential evapotransporation is estimated by the modified Penman equation (Frère and Popov, 1979), which has shown validity in the tropics. It is suggested to compare the two methods. The last method requires also information on total radiation an humidity, which is available for 25 stations in the pilot areas.

3.3 Moisture Availability Index MAI

This index is developed by Cochrane et al. (1985) for tropical America, and is based on the ratio between dependable precipitation and potential evapotransporation. The dependable precipitation is defined as that amount of precipitation that may be expected in at least three out of four years. In order to estimate this 75% confidence level, we need to obtain monthly rainfall totals for a continuous period of at least 25 years for a minimum of 5 climate stations per country. This information must be obtained from the national meteorological services or from the station records. The potential evapotransporation according to the Hargreaves method requires data on total radiation and temperature, which is available for 25 stations in the region. In the list of stations given in the appendix we have underlined these stations. They should be used to calculate the dependable rainfall.

4. Conclusions

Climatic stations in the pilot area are well distributed. Monthly climatic factors have now been collected for 45 stations. The following data are to be collected by the correlation teams:

1. Monthly climatic elements (at least data on rainfall) for an additional 34 stations (appendix B2).
2. Daily pluviographs for 10 years for at least one station per country (e.g. Allegrete in Brazil; Vera in Argentina; Cerro Largo in Uruguay).
3. Number of rainy days per month in as many stations as possible.
4. Maximum 24 hour precipitation per month in as many stations as possible.
5. Monthly rainfall for a continuous period of at least 15 years, but preferable 25 years, for 5 stations per country.

5. References

Arnoldus, H.M.J., 1977. Predicting soil losses due to sheet and rill erosion. FAO Conservation Guide no. 1, pp 99-124. FAO, Rome.

Bols, P. 1979. Bijdrage tot de studie van de bovengrondse afstroming en erosie op Java. Rijks Universiteit Gent.

Cochrane T.T., Sanchez L.F., Porras, J.A., de Azevedo L.G., and Gorver, C.L (1985). Land in tropical America (3 Vol). Cali, Colombia: CIAT, and Planaltina, Brazil.

FAO, 1979. A provisional methodology for soil degradation assessment. FAO, Rome.

Frère M. and Popov G.F., 1979. Agrometeorological monitoring and forecasting. Plant Production and Protection paper no. 17. FAO, Rome.

Wischmeyer, W.M. and Smith, D.C. 1965. Predicting rainfall erosion losses from cropland east of the Rocky Mountains. Agric. Res. Serv. USDA in cooperation with Purdue Agr., Handbook 282. Washington D.C.

Appendix A

1. SOTER climate files

The SOTER climate files are intended for multipurpose applications of the World Soil and Terrain Digital Database. For the Global Assessment of Soil Degradation Project (GLASOD) climatic data are essential for an assessment of the soil degradation risk. Climatic data form also an inseparable part of the basic inventory of natural resources needed for land evaluation.

The SOTER Climate Files consist of two attribute files.

1. SOTER climate station file.
   This file is a listing of the climatic stations with their local names, the exact location coordinates of the station and altitude.

2. SOTER climate attribute file.
   This file contains the numeric values of various climate elements per climatic station. The values can either be given as mean manual, monthly, 10-daily, weekly, 5-daily, or daily values, averaged over a specified number of years, or they can be given as actual values for a number of years. The format of the file indicates in which way the values are reported.

The various entries into the two database files are described in the following sections. The instructions for coding should be followed in order to have uniformity of reporting. Examples of the coding sheets are included.

2. Explanation of attributes

A: Country name. Maximal 12 characters. Indicate the abbreviated name in English. An alphabetical listing per continent according to FAO is given in appendix 1.

B: Country code. Maximal 3 characters. An alphabetic listing for most counties is given in appendix 2.

C: Station name. Maximal 20 characters. Give name under which climate station is know locally. Stations are usually named after the nearest village or city.

D: Station code. Maximal 3 digits. Each station should be given its unique number.

E: Latitude. A 5-digit number: the first two digits indicate the degrees, the second pair indicates the minutes. The last digit refers to the quadrant: + = North latitude; - = South latitude. Example: 1218 means 12 degrees 18 minutes South.

F: Longitude. A 6-digit number: the first three digits indicate the degrees, the second pair indicates the minutes, while the last digit refers to the West or

East longitude: - = West; + = East. Example: 06533+; 65 degrees, 33 minutes West.

G: Altitude. A 4-digit number indicating the actual elevation of the station above or below sea level in meters.

H: Kind of Data. A 2-digit number, indicating the kind of climatic element. The Kind of Data codes are given in appendix table 3a.

I: Time Interval. A 1-digit number, indicating over which time interval (monthly, weekly, daily) the climatic element is totalled or averaged. The Time Interval codes are given in appendix table 3b.

K: Time Period. A 2-digit number, indicating which time period is referred to within a particular month (e.g. for decade data a time period 2 means the period from the 11th to the 20th day of the month; for pentade data a time period 4 means the 4th pentade (day 16-20). See for Time Period codes appendix table 3c and 3d.

L: Unit of measure. A 2-digit number. Appendix 4 gives the unit of measure codes. Note that no decimal points are used (see also example under R1).

M: Years of record. A 3-digit number, indicating the total number of years of actual recording values, used to calculate mean values. If values are given on a year by year basis, insert N.A. (not applicable).

N.O: Observation Period. These 4-digit numbers indicate the first year and last year of record. If values are recorded on a year by year basis, insert N.A.

P: Year of Actual Record. A 4-digit number referring to the actual year of record. If values are given as means over a number of years, insert N.A.

Q: Source. Refers to the published climatic record. This published material should be listed in the references cited with a two digit number.

R1-R12: Actual values of climatic elements. All values should be written without decimal points. For example a temperature of 18.7°C is written as 187. This holds also for radiation if expressed in MJ/m^2 or in mm water; for hours of bright sunshine; actual vapour pressure in milibars; for wind speed in m/sec; and for potential evaporation given in mm/day. This implies that the original values of these elements should be given with a precision of one decimal. The unit of measure code takes care of this decimal point omission.

R13: Annual value. Annual values are also given without decimal points. Annual <u>total</u> values for precipitation; number of rainy days; potential evapotransporation. These are the sums of monthly values. Annual <u>mean</u> values are inserted for all other climatic elements. These are the averages of the twelve monthly values.
N.B. If decade, weekly, pentade, or daily values are given the annual values can be based on the sum/averages of all time period values. (e.g. if

reporting period is decades: annual value based on 36 decades; if reporting is weeks: annual value based on 52 weeks).
N.B. If certain values are not known indicate this with a "-" sign. If certain values are not applicable, indicate this with NA.

APPENDIX TABLE 1

COUNTRY NAMES

From FAO Production Year Book, Vol. 40, 1986.

To be used for SOTER Climate Files: Abbreviated name in English

Abbreviated name in English	English	Francais	Espanol
WORLD	WORLD	MONDE	MUNDO
AFRICA	AFRICA	AFRIQUE	AFRICA
ALGERIA	Algeria	Algère	Argelia
ANGOLA	Angola	Angola	Angola
BENIN	Benin	Bénin	Benin
BOTSWANA	Botswana	Botswana	Botswana
BR IND OC TR	British Indian Ocean Territory	Territoire britannique de l'océan Indien	Territorio británico del Océano Indico
BURKINA FASO	Burkina Faso	Burkina Faso	Burkina Faso
BURUNDI	Burundi	Burundi	Burundi
CAMEROON	Cameroon	Cameroun	Camerun
CAP VERDE	Cape Verde	Cap-Vert	Cabo Verde
CENT AFR REP	Central African Republic	République centrafricaine	República Centroafricana
CHAD	Chad	Tchad	Chad
COMOROS	Comoros	Comores	Comoras
CONGO	Congo	Congo	Congo
COTE DIVOIRE	Côte d'Ivoire	Côte d'Ivoire	Côte d'Ivoire
DJIBOUTI	Djibouti	Djibouti	Djibouti
EGYPT	Egypt	Egypte	Egipto
EQ GUINEA	Equatorial Guinea	Guinée équatoriale	Guinea Ecuatorial
ETHIOPIA	Ethiopia	Ethiopie	Etiopia
GABON	Gabon	Gabon	Gabón
GAMBIA	Gambia	Gambie	Gambia
GHANA	Ghana	Ghana	Ghana
GUINEA	Guinea	Guinée	Guinea
GUIN BISSAU	Guinea-Bissau	Guinée-Bissau	Guinea-Bissau
KENYA	Kenya	Kenya	Kenya
LESOTHO	Lesotho	Lesotho	Lesotho
LIBERIA	Liberia	Libéria	Liberia
LIBYA	Libyan Arab Jamahiriya	Jamahiriya arabe Libyenne	Jamahiriya Arabe Libia
MADAGASCAR	Madagascar	Madagascar	Madagascar
MALAWI	Malawi	Malawi	Malawi
MALI	Mali	Mali	Mali

Abbreviated name in English	English	Francais	Espanol
MAURITANIA	Mauritania	Mauritanie	Mauritania
MAURITIUS	Mauritius	Maurice	Mauricio
MAROCCO	Marocco	Maroc	Marruecos
MOZAMBIQUE	Mozambique	Mozambique	Mozambique
NAMIBIA	Namibia	Namibie	Namibia
NIGER	Niger	Niger	Niger
NIGERIA	Nigeria	Nigéria	Nigeria
REUNION	Reunion	Réunion	Reunión
RWANDA	Rwanda	Rwanda	Rwanda
ST HELENA	Saint Helena	Sainte-Hélène	Santa Elena
SAO TOME PRN	Sao Tome and Principe	Sao Tomé-et-Principe	Sao Tomé y Principe
SENEGAL	Senegal	Sénégal	Senegal
SEYCHELLES	Seychelles	Seychelles	Seychelles
SIERRA LEONE	Sierra Leone	Sierra Leone	Sierra Leone
SURINAME	Suriname	Suriname	Suriname
URUGUAY	Uruguay	Uruguay	Uruguay
VENEZUELA	Venezuela	Venezuale	Venezuela
ASIA	ASIA	ASIE	ASIA
AFGHANISTAN	Afghanistan	Afghanistan	Afghanistán
BAHRAIN	Bahrain	Bahraïn	Bahrain
BANGLADESH	Bangladesh	Bangladesh	Bangladesh
BHUTAN	Bhutan	Bhoutan	Bhután
BRUNEI DARUS	Brunei Darussalam	Brunéi Darussalam	Brunei Darussalam
BURMA	Burma	Birmanie	Birmania
CHINA	China	Chine	China
CYPRUS	Cyprus	Chypre	Chipre
EAST TIMOR	East Timor	Timor oriental	Timor oriental
GAZA STRIP	Gaza Strip (Palastine)	Zone de Gaza (Palestine)	Zona de Gaza (Palestin
HONG KONG	Hong Kong	Hong-kong	Hong Kong
INDIA	India	Inde	India
INDONESIA	Indonesia	Indonésie	Indonesia
IRAN	Iran, Islamic Republic of	Iran, République islamique d'	Irán, Republica Islámi del
IRAQ	Iraq	Iraq	Iraq
ISRAEL	Israel	Israël	Israel
JAPAN	Japan	Japon	Japón
JORDAN	Jordan	Jordanie	Jordania
KAMPUCHEA DM	Kampuchea, Democratic	Kampuchea démocratique	Kampuchea Democrática
KOREA DPR	Korea, Democratic People's Republic of	Corée, République populaire démocratique de	Corea, República Popul Democrática de
KOREA REP	Korea, Republic of	Corée, République de	Corea, República de
KUWAIT	Kuwait	Koweït	Kuwait
LAOS	Laos	Laos	Laos
LEBANON	Lebanon	Liban	Libano
MACAU	Macau	Macao	Macao
MALAYSIA	Malaysia	Malaisie	Malasia
MALDIVES	Maldives	Maldives	Maldivas
MONGOLIA	Mongolia	Mongolie	Mongolia
NAPAL	Nepal	Népal	Nepal
OMAN	Oman	Oman	Omán

Abbreviated name in English	English	Francais	Espanol
PAKISTAN	Pakistan	Pakistan	Pakistán
PHILIPPINES	Philippines	Philippines	Filipinas
QATAR	Qatar	Qatar	Qatar
SAUDI ARABIA	Saudi Arabia, Kingdom of	Arabie saoudite, Royaume d'	Arabia Saudita, Reino de
SINGAPORE	Singapore	Singapour	Singapur
SRI LANKA	Sri Lanka	Sri Lanka	Sri Lanka
SYRIA	Syrian Arab Republic	République arabe syrienne	República Arabe Siria
THAILAND	Thailand	Thaïlande	Tailandia
TURKEY	Turkey	Turquie	Turquia
U A EMIRATES	United Arab Emirate	Emirats arabes unis	Emiratos Arabes Unidos
VIET NAM	Viet Nam	Viet Nam	Viet Nam
YEMEN AR	Yemen Arab Republic	République arabe du Yémen	República Arabe del Yemen
YEMEN DEM	Yemen, Democratic	Yémen démocratique	Yemen Democrático
EUROPE	EUROPE	EUROPE	EUROPA
ALBANIA	Albania	Albanie	Albania
ANDORRA	Andorra	Andorre	Andorra
AUSTRIA	Austria	Autriche	Austria
BELGIUM-LUX	Belgium-Luxembourg	Belgique-Luxembourg	Bélgica-Luxemburgo
BULGARIA	Bulgaria	Bulgarie	Bulgaria
CZECHOSLOVAK	Czechoslovakia	Tchécoslovaquie	Checoslovaquia
DENMARK	Denmark	Danemark	Dinamarca
FAEROE IS	Faeroe islands	Iles Féroé	Islas Feroé
FINLAND	Finland	Finlande	Finlandia
FRANCE	France	France	Francia
GERMAN DR	German Democratic Republic	République démocratique allemande	República Democrática Alemana
GERMANY FR	Germany, Federal Republic of	Allemagne, République fédérale d'	Alemania, República Federal de
GIBRALTAR	Gibraltar	Gibraltar	Gibraltar
GREECE	Greece	Grèce	Grecia
HOLY SEE	Holy See	Saint-Siège	Santa Sede
HUNGARY	Hungary	Hongrie	Hungria
ICELAND	Iceland	Islande	Islandia
IRELAND	Ireland	Irlande	Irlanda
ITALY	Italy	Italie	Italia
LIECHTENSTEIN	Liechtenstein	Liechtenstein	Liechtenstein
MALTA	Malta	Malte	Malta
MONACO	Monaco	Monaco	Mónaco
NETHERLANDS	Netherlands	Pays-Bas	Países Bajos
NORWAY	Norway	Norvège	Noruega
POLAND	Poland	Pologne	Polonia
PORTUGAL	Portual	Portugal	Portugal
ROMANIA	Romania	Roumanie	Rumania
SAN MARINO	San Marino	Saint-Marin	San Marino
SPAIN	Spain	Espagne	España
SWEDEN	Sweden	Suède	Suecia
SWITZERLAND	Switserland	Suisse	Suiza
UK	United Kingdom	Royaume-Uni	Reino Unido
YUGOSLAVIA	Yugoslavia	Yougoslavie	Yugoslavia

Abbreviated name in English	English	Francais	Espanol
OCEANIA	OCEANIA	OCÉANIE	OCEANIA
AMER SAMOA	American Samoa	Samoa américaines	Samoa americana
AUSTRALIA	Australia	Australie	Australia
CANTON IS	Canton and Enderbury Islands	Iles Canton et Enderbury	Islas Cantón y Enderbury
CHRISTMAS IS	Christmas Island (Australia)	Ile Christmas (Australie)	Isla Christmas (Australia)
COCOS IS	Cocos (Keeling) Islands	Iles Cocos (Keeling)	Islas Cocos (Keeling)
COOK ISLANDS	Cook Islands	Iles Cook	Islas Cook
FIJI	Fiji	Fidji	Fiji
FR POLYNESIA	Frech Polynesia	Polynésie française	Polinesia francesa
GUAM	Guam	Guam	Guam
JOHNSTON IS	Johnston Island	Ile Johnston	Isla Johnston
KIRIBATI	Kiribati	Kiribati	Kiribati
MIDWAY IS	Midway Island	Iles Midway	Islas Midway
NAURU	Nauru	Nauru	Nauru
NEWCALEDONIA	New Caledonia	Nouvelle-Calédonie	Nueva Caledonia
NEW ZEALAND	New Zealand	Nouvelle-Zélande	Nueva Zelandia
NIUE	Niue	Nioué	Niue
NORFOLK IS	Norfolk Island	Ile Norfolk	Isla Norfolk
PACIFIC IS	Pacific Islands	Iles du Pacifique	Islas del Pacifico
PAPUA N GUIN	Papua New Guinea	Papouaise Nouvelle-Guinée	Papua Nueva Guinea
PITCAIRN	Pitcairn	Pitcairn	Pitcairn
SAMOA	Samoa	Samoa	Samoa
SOLOMOM IS	Solomon Islands	Iles Salomon	Islas Salomón
TOKELAU	Tokelau	Tokélaou	Tokelau
TONGA	Tonga	Tonga	Tonga
TUVALU	Tuvalu	Tuvalu	Tuvalu
VANUATU	Vanuatu	Vanuatu	Vanuatu
WAKE ISLAND	Wake Island	Ile de Wake	Isla Wake
WALLIS ETC	Wallis and Futuna Island	Iles Wallis et Futuna	Islas Wallis y Futuna
USSR	Union of Soviet Socialist Republics	Union des Républiques socialistes soviétiques	Unión de Repúblicas Socialistas Soviéticas
DEV.PED M E	Developed market economies	Pays développés à économies de marché	Economias de mercado desarrolladas
N AMERICA	North America	Amérique du Nord	América del Norte
W EUROPE	Western Europe	Europe occidentale	Europa occidental
OCEANIA	Oceania	Océanie	Oceania
OTH DEV.PED	Other developed market economies	Autres pays développés à économies de marché	Otras economias de merc desarrolladas

APPENDIX TABLE 2

COUNTRY CODES

(source: FAO's registration form on country code, 1985)

Afghanistan	AFG	French Polynesia	FPL
Albania	ALB	Gabon	GAB
Algeria	ALG	Gambia	GAM
Andorra	AND	Germany, Democratic Republic	GDR
Angola	ANG	Germany. Federal Republic	GFR
Antigua	ANT	Ghana	GHA
Argentinia	ARG	Greece	GRE
Australia	AUL	Grenada	GRN
Austria	AUS	Guatemala	GUA
Bahamas	BHA	Guinea	GUI
Bahrain	BAH	Guinea-Bissau	GBS
Bangladesh	BGD	Guyana	GUY
Barbados	BAR	Haiti	HAI
Belgium	BEL	Honduras	Hon
Belize	BZE	Hong Kong	HOK
Benin	BEN	Hungary	HUN
Bhutan	BHU	Iceland	ICE
Bolivia	BOL	India	IND
Botswana	BOT	Indonesia	INS
Brazil	BRA	Iran	IRA
British Virgin Islands	BVI	Iraq	IRQ
Brunei	BRU	Ireland	IRE
Bulgaria	BUL	Israel	ISR
Burkina Faso	BKF	Italy	ITA
Burma	BUR	Ivory Coast	IVC
Burundi	BDI	Jamaica	JAM
Byelorussian SSR	BYE	Japan	JPN
Cameroon	CMR	Jordan	JOR
Canada	CAN	Kampuchea Democratic	KAM
Cape Verde	CVI	Kenya	KEN
Cayman Islands	CAY	Kiribati	KIR
Central African Rep.	CAF	Korea, Dem. People's Rep. of	DRK
Chad	CHD	Korea, Republic of	ROK
Chile	CHI	Lao	LAO
China	CPR	Lebanon	LEB
Colombia	COL	Lesotho	LES
Comoros	COI	Liberia	LIR
Congo, People's Rep. of	PRC	Libya	LIB
Cook Islands	CKI	Liechtenstein	LIE
Costa Rica	COS	Luxembourg	LUX
Cuba	CUB	Macao	MAC
Cyprus	CYP	Madagascar	MAG
Czechoslovakia	CZE	Malaysia	MAL
Denmark	DEN	Malawi	MLW
Djibouti	DJI	Maldives	MDV
Dominica	DMI	Mali	MLI
Dominican Republic	DOM	Malta	MAT
Ecuador	ECU	Mauritania	MAU

(source: FAO's registration form on country code, 1985)

Egypt	EGY	Mauritius	MAR
El Salvador	ELS	Mexico	MEX
Equatorial Guinea	EQG	Monaco	MNC
Ethiopia	ETH	Mongolia	MON
Fiji	FIJ	Montserrat	MOT
Finland	FIN	Morocco	MOR
France	FRA	Mozambique	MOZ
Namibia	NAM	Ukrainian SSR	UKR
Nepal	NEP	Union of Soviet Socialist Rep.	USR
Nauru	NAU	United Arab Emirates	UAE
Netherlands	Net	United Kingdom	UK
Netherlands Antilles	NAN	United States of America	USA
New Caledonia	NCA	Uruguay	URU
New Zealand	NZE	Vanuatu	VAN
Nicaragua	NIC	Venezuela	VEN
Niger	NER	Viet Nam	VIE
Nigeria	NIR	Wallis and Futuna Islands	WFI
Niue	NIU	Yemen, Arab Republic	YEM
Norway	NOR	Yemen, People's Dem. Rep.	PDY
Oman	OMA	Yugoslavia	YUG
Pakistan	PAK	Zaire	ZAI
Panama	PAN	Zambia	ZAM
Papua New Guinea	PNG	Zimbabwe	ZIM
Paraguay	PAR		
Peru	PER		
Philippines	PHI		
Poland	POL		
Portugal	POR		
Puerto Rico	PRI		
Qatar	QAT		
Romania	ROM		
Rwanda	RWA		
Samoa	SAM		
San Marino	SNM		
Sao Tomé and Principe	STP		
Saudi Arabia	SAU		
Seychelles	SEY		
Senegal	SEN		
Sierra Leone	SIL		
Singapore	SIN		
Somalia	SOM		
South Africa	SAF		
Spain	SPA		
Sri Lanka	SRL		
St. Helena	STH		
St. Kitts-Nevis-Nevila	STK		
ST. Lucia the Grenadines	STL		
Sudan	SUD		
Suriname	SUR		
Swaziland	SWA		
Sweden	SWE		
Switzerland	SWI		

(source: FAO's registration form on country code, 1985)

Syria	SYR
Tanzania	UTR
Thailand	THA
Togo	TOG
Tokelau Islands	TOK
Tonga	TON
Trinidad and Tobago	TRI
Tunisia	TUN
Turkey	TUR
Turks and Caicos Islands	TCI
Tuvalu	TUV
Uganda	UGA

APPENDIX TABLE 3A

KIND OF DATA CODES

01. precipitation totals.
02. number of raindays, (at least 1 mm precipitation per day is considered a rainday).
03. maximum 24 hours rainfall.
10. mean 24 hour temperature (usually the average of the maximum and minimum temperature).
11. mean maximum temperature during 24 hour period.
12. mean minimum temperature during 24 hour period.
20. total radiation intensity during 24 hour period.
21. total hours of bright sunshine during daylight period.
22. total hours of bright sunshine as percentage of total daylight period.
23. degree of cloudiness during daylight period.
30. mean 24 hour relative humidity or mean actual vapour pressure.
31. highest relative humidity during 24 hours.
32. lowest relative humidity during 24 hours period.
33. highest actual vapour pressure during 24 hours period.
34. lowest actual vapour pressure during 24 hours period.
40. mean 24 hour wind velocity.
41. wind velocity during day time.
42. wind velocity during night time.
50. potential evapotranspiration estimate. (Penmann)
51. potential evapotranspiration estimate. (Hargreaves)
52. potential evapotranspiration estimate. (Thornthwaite)
60. Evaporation (Class A Pan)
61. Evaporation (Colorado Pan)
62. Evaporation (Piche)

APPENDIX TABLE 3B

TIME INTERVAL CODE

1: annual only
2: monthly
3: decade (10-day)
4: weekly
5: pentade (5-day)
6: daily

APPENDIX TABLE 3C

TIME PERIOD CODE

00: for annual or monthly values

	for daily data	pentade data	decade data
1:	day 1	day 1- 5	day 1-10
2:	day 2	day 6-10	day 11-20
3:	day 3	day 11-15	day 21-end of the month
4:	day 4	day 16-20	-
5:	day 5	day 21-25	-
6:	day 6	day 26-end of the month	-
7-31:	day 7-31	-	-

APPENDIX TABLE 3D

TIME PERIOD CODE for WEEKLY DATA

Code	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1- 7	29- 4	26- 4	2- 8	30- 6	4-10	2- 8	30- 5	3- 9	1- 7	5-11	3- 9
2	8-14	5-11	5-11	9-15	7-13	11-17	9-15	6-12	10-16	8-14	12-18	10-16
3	15-21	12-18	12-18	16-22	14-20	18-24	16-22	13-19	17-23	9-21	19-25	17-23
4	22-28	19-25	19-25	23-29	21-27	25- 1	23-29	20-26	23-20	22-28	26- 2	24-31
5			26- 1		28- 3			27- 2		29- 4		

APPENDIX TABLE 4

UNIT OF MEASURE CODE

01	millimeters	(total values over time interval reported)
02	inches * 10	" " " " " "
03	number of rainy days	" " " " " "
04	degrees centigrade * 10	(daily values over time interval reported)
05	degrees Fahrenheit * 10	" " " " " "
06	megajoules per m² * 10	" " " " " "
07	milliwatt hours per cm²	" " " " " "
08	calories per cm² (or langleys)	" " " " " "
09	millimeters evaporable water * 10	" " " " "
10	hours of bright sunshine * 10	" " " " " 11pecentage " " " "
	"	
12	oktas * 10	" " " " "
13	millibars * 10	" " " " "
20	m/sec at ground level * 10	" " " "
21	m/sec at 1 meter above ground level * 10	" " " "
22	m/sec at 2 meter above ground level * 10	" " " "
23	m/sec at 3 meter above ground level * 10	" " " "
24-35	m/sec at 4....15 meter above ground level * 10	" " " "
40	m/sec at unknown meter measuring height	" " " "

If other units of measure are reported than in above list coding numbers from 50 to 100 can be used with description of unit of measure reported.

SOTER CLIMATE STATION FILE

COUNTRY (A)	COUNTRY CODE (B)	STATION NAME (C)	STATION CODE (D)	LATITUDE (E)	LONGITUDE (F)	ALTITUDE (G)

SOTER CLIMATE ATTRIBUTE FILE

Country code	Station code	Kind of data	Time interval	Time period	Unit of measure	Total years of record	Observation period		Year of actual observation	Source	JAN	FEBR	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
							First year	Last year															
(B)	(D)	(H)	(I)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R1)	(R2)	(R3)	(R4)	(R5)	(R6)	(R7)	(R8)	(R9)	(R10)	(R11)	(R12)	(R13)

Remarks:

APPENDIX B1

LISTING PER COUNTRY OF CLIMATE STATIONS IN PILOT AREA LATIN AMERICA

STATLIS. REP 12/1/88

CCD	SCD	STATENAME	LATIT	LONGIT	ALTI
ARG	16	Alberdi	-3149	-6030	110
ARG	28	Alvear	-2904	-5633	70
ARG	14	Angelgallard	-3137	-6040	17
ARG	29	Apostoles	-2755	-5549	110
ARG	38	Basabilvaso	-3222	-5853	
ARG	24	Bellavista	-2733	-5854	65
ARG	32	Charaday	-2738	-5954	
ARG	30	Cnia C. Pelligrini	-2832	-5710	
ARG	37	Concepcion	-2823	-5754	
ARG	19	Concepcionde Uruguay	-3228	-5813	21
ARG	12	Concordia	-3122	-5802	36
ARG	22	Corrientes	-2727	-5848	60
ARG	31	Curuzu Cuatia	-2948	-5803	74
ARG	18	Delicias	-3155	-6024	103
ARG	13	Esperanza	-3126	-6055	38
ARG	8	Esquina	-3001	-5931	52
ARG	33	Federal	-3057	-5847	
ARG	26	General Paz	-2744	-5737	71
ARG	2	Goya	-2909	-5916	36
ARG	40	Gualeguachu	-3300	-5837	26
ARG	34	Hasenkamp	-3130	-5950	
ARG	39	Intiyaco	-2840	-6006	
ARG	20	Loreto	-2722	-5530	163
ARG	3	Mercedes	-2914	-5805	87
ARG	9	Montecaseros	-3015	-5739	53
ARG	41	Nare	-3058	-6028	
ARG	42	Noyoga	-3223	-5949	
ARG	15	Parana	-3147	-6029	74
ARG	6	Paso de Los Liberes	-2943	-5706	65
ARG	7	Paso de Los Aeroporto	-2941	-5709	70
ARG	10	Paz	-3044	-5938	38
ARG	21	Posadas	-2725	-5555	133
ARG	43	Pres. R.S. Pena	-2652	-6027	92
ARG	4	Reconquista	-2911	-5942	47
ARG	23	Resistencia	-2728	-5858	51
ARG	27	Rosario	-3254	-6043	21
ARG	11	Salto Grande	-3111	-5754	37
ARG	35	Sanjose de Feliciano	-3024	-5845	67
ARG	1	Santo Tome	-2832	-5607	79
ARG	5	Vera	-2928	-6013	57
ARG	44	Victoria	-3237	-6011	29
ARG	25	Villa Angela	-2734	-6043	74
ARG	36	Villa Guilhermina	-2813	-5928	
ARG	17	Villaguay	-3151	-5905	52

STATLIS. REP 12/1/88

CCD	SCD	STATENAME	LATIT	LONGIT	ALTI
BRA	5	Alegrete	-2946	-5547	103
BRA	7	Bage	-3120	-5406	215
BRA	3	Cruzalta	-2838	-5337	472
BRA	13	Don Pedrito	-3059	-5440	
BRA	1	Irai	-2712	-5318	226
BRA	11	Itaqui	-2907	-5633	
BRA	12	San Gabriel	-3020	-5419	
BRA	4	Santamaria	-2941	-5348	137
BRA	10	Santiago	-2911	-5453	
BRA	8	Santo Angelo	-2818	-5416	
BRA	9	Sao Boria	-2840	-5600	
BRA	2	Saoluizgonza	-2824	-5458	250
BRA	6	Uruguaiana	-2945	-5705	73
PAR	1	Capitanmiran	-2716	-5548	105
PAR	2	Encarnacion	-2719	-5549	79
PAR	3	Yacyreta	-2723	-5626	85
URU	16	Achar	-3227	-5612	75
URU	9	Argengua	-3128	-5650	180
URU	1	Artigas	-3024	-5628	121
URU	10	Belen	-3048	-5747	
URU	11	Bernabe Rivera	-3019	-5649	160
URU	5	Cerro Largo	-3222	-5415	93
URU	12	El Molino	-3145	-5606	185
URU	17	La Paloma	-3244	-5535	110
URU	7	Paso de Los Toros	-3248	-5631	85
URU	4	Paysandu	-3221	-5805	51
URU	13	Quebracho	-3156	-5754	85
URU	18	Queguay Chico	-3205	-5652	170
URU	19	Rio Brancho	-3237	-5324	75
URU	2	Rivera	-3054	-5532	259
URU	3	Salto	-3123	-5758	45
URU	6	Santa Isabel	-3245	-5631	78
URU	14	Sarandi Cuaro	-3055	-5629	230
URU	8	Tacuarembo	-3147	-5631	78
URU	15	Vichadero	-3150	-5444	140

APPENDIX B2

LISTING PER COUNTRY OF CLIMATE STATIONS FOR WHICH DATA ARE "TO BE COLLECTED".

STATIONS.REP 12/1/88

CCD	SCD	STATNAME	LATIT	LONGIT	ALTI
ARG	28	Alvear	-2904	-5633	70
ARG	29	Apostoles	-2755	-5549	110
ARG	30	Cnia C. Pelligrini	-2832	-5710	
ARG	31	Curuzu Cuatia	-2948	-5803	4
ARG	32	Charaday	-2738	-5954	
ARG	33	Federal	-3057	-5847	
ARG	34	Hasenkamp	-3130	-5950	
ARG	35	Sanjose de Feliciani	-3024	-5845	67
ARG	36	Villa Guilhermina	-2813	-5928	
ARG	37	Concepcion	-2823	-5754	
ARG	38	Basabilvaso	-3222	-5853	
ARG	39	Intiyaco	-2840	-6006	
ARG	40	Gualeguachu	-3300	-5837	26
ARG	41	Nare	-3058	-6028	
ARG	42	Noyoga	-3223	-5949	
ARG	43	Pres. R.S. Pena	-2652	-6027	92
ARG	44	Victoria	-3237	-6011	29
BRA	8	Santo Angelo	-2818	-5416	
BRA	9	Sao Boria	-2840	-5600	
BRA	10	Santiago	-2911	-5453	
BRA	11	Itaqui	-2907	-5633	
BRA	12	San Gabriel	-3020	-5419	
BRA	13	Don Pedrito	-3059	-5440	
URU	9	Arengua	-3128	-5650	180
URU	10	Belen	-3048	-574	
URU	11	Bernabe Rivera	-3019	-5649	160
URU	12	El Molino	-3145	-5606	185
URU	13	Quebracho	-3156	-5754	85
URU	14	Sarandi Cuaro	-3055	-5629	230
URU	15	Vichadero	-3150	-5444	140
URU	16	Achar	-3227	-5612	75
URU	17	La Paloma	-3244	-5535	110
URU	18	Queguay Chico	-3205	-5652	170
URU	19	Rio Brancho	-3237	-5324	75

CLIMATIC DATA OF THE FIRST SOTER PILOT AREA

Country: Argentina Station: Vera

Latitude: -2928 Longitude: -6013 Altitude: 57

Datakind	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annu
precipitat	mm	98.0	105.0	146.0	94.0	58.0	31.0	31.0	30.0	65.0	80.0	105.0	132.0	975.0
PET-Penman	mm	164.0	137.0	115.0	67.0	41.0	27.0	34.0	63.0	83.0	102.0	149.0	181.0	1163.0
meanmintem	°C	19.3	18.8	17.3	12.0	10.5	9.0	7.7	8.7	10.7	13.7	15.9	18.0	13.5
meanmaxtem	°C	33.6	32.5	30.2	25.4	23.1	19.8	20.9	22.9	24.7	26.4	30.1	31.6	26.8
meantemp	°C	26.5	25.7	23.8	18.7	16.8	14.4	14.3	15.8	17.7	20.1	23.0	24.8	20.2
24h-radiat	cal/cm²	502.0	468.0	417.0	323.0	239.0	166.0	219.0	292.0	360.0	393.0	525.0	522.0	369.0
meanhumid	mbar	21.9	21.5	21.2	16.8	14.8	13.7	12.3	12.3	13.9	16.9	17.6	18.7	16.8
windspeed	m/s(2m)	2.2	2.0	2.0	2.0	1.8	2.4	2.2	2.8	3.4	3.0	2.6	2.6	2.4

Country: Brazil Station: Sao Luis Gonzaga

Latitude: -2824 Longitude: -5458 Altitude: 250

Datakind	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annu
precipitat	mm	135.0	122.0	127.0	177.0	149.0	154.0	111.0	114.0	138.0	197.0	110.0	132.0	1666.0
PET-Penman	mm	164.0	120.0	115.0	67.0	41.0	30.0	38.0	58.0	75.0	104.0	133.0	172.0	1117.0
meanmintem	°C	19.3	19.0	17.6	14.0	12.0	10.5	9.6	10.6	12.1	13.8	15.7	17.8	14.3
meanmaxtem	°C	32.8	32.0	30.2	25.9	22.9	20.4	20.9	22.8	24.0	26.2	29.5	32.0	26.6
meantemp	°C	26.1	25.5	23.9	20.0	17.5	15.5	15.3	16.7	18.1	20.0	22.6	24.9	20.5
24h-radiat	cal/cm²	534.0	484.0	420.0	328.0	260.0	197.0	234.0	291.0	344.0	424.0	530.0	555.0	383.0
meanhumid	mbar	22.4	22.5	21.2	17.4	15.4	14.1	12.8	13.6	15.1	16.5	18.3	20.2	17.5
windspeed	m/s(2m)	2.1	1.2	2.1	1.6	1.1	1.9	2.0	1.9	1.9	1.7	1.3	2.1	1.7

Country: Uruguay Station Cerro Largo

Latitude: -3222 Longitude: -5415 Altitude: 93

Datakind	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annu
precipitat	mm	91.0	100.0	110.0	105.0	96.0	128.0	98.0	104.0	121.0	98.0	72.0	54.0	1177.0
PET-Penman	mm	182.0	136.0	109.0	67.0	36.0	21.0	28.0	44.0	67.0	101.0	141.0	180.0	1112.0
meanmintem	°C	16.8	16.5	15.1	11.6	8.7	7.4	6.4	7.1	9.1	11.1	12.5	14.8	11.4
meanmaxtem	°C	31.1	30.1	27.5	24.1	20.6	17.6	17.2	18.6	20.0	22.9	26.2	29.8	23.8
meantemp	°C	24.0	23.3	21.3	17.9	14.7	12.5	11.8	12.9	14.6	17.0	19.4	22.3	17.6
24h-radiat	cal/cm²	515.0	474.0	393.0	300.0	222.0	174.0	199.0	247.0	312.0	406.0	509.0	537.0	357.0
meanhumid	mbar	19.5	19.9	18.8	15.6	13.9	12.7	11.5	12.1	13.1	14.9	15.7	17.1	15.4
windspeed	m/s(2m)	3.1	2.9	2.7	2.5	2.5	2.5	2.7	2.9	3.1	3.1	3.1	2.9	2.8

3.2 Assessment of Current Geographic Information Systems

Marion F. Baumgardner

In the SOTER Project Proposal one of the tasks to be performed early in the Project is the assessment of current geographic information systems. On 25 August 1988 a meeting was held at ISRIC, Wageningen, the Netherlands to begin the process of assessment of available GIS systems. Minutes of that meeting have been distributed. During that meeting the following were named to serve as an ad hoc committee for the assessment task: Bruce MacDonald, Marion Baumgardner, Jurgen Lamp, Peter Burrough, Carlos Valenzuela and Vincent van Engelen. It was agreed that Bruce MacDonald would prepare a comprehensive list of required capabilities and needs for a GIS for SOTER. Bruce MacDonald distributed a draft of his comprehensive list in late October 1988 and is awaiting replies and suggestions from the committee.

Although no decision has been made on the system to be used, this presentation is an interim report of the basic specifications for a SOTER GIS facility.

A. Basic Capability Requirements of the System

The system must be able to perform the following functions:

1. Digitize the soil theme and base information (in point and stream mode) to cartographic accuracy.
2. Build topology.
3. Link the line information to a database (ORACLE).
4. Transfer the data between the Project, ISRIC (SOTER Secretariat), and an archive facility (UNEP/GRID).
5. Transform data for up to 4 ONC mapsheets to a world projection and merge and edgematch.
6. Output the map data on a dot matrix printer or inkjet plotter and on a cartographic quality plotter.

Note: The capability to import raster data, to convert between raster and vector formats, and to do contouring may also be required.

B. Basic Hardware Facility

The following hardware components are considered essential for each Project Site (each country):

1.	Basic computer 286 clone, 12 Mhz, 40 Mb hard drive 80287 math coprocessor, mono monitor and card	US$ 3,000
2.	Low resolution graphics VGA colour VIP card, NEC multisyne II colour monitor	US$ 1,200
3.	Non-cartographic quality output; e.g. NEC dot matrix printer	US$ 1,300
4.	Digitizer, 60x90 cm (accuracy > 0.025 cm)	US$ 3,000
Approximate cost of hardware		US$ 8,500

C. **Enhanced Hardware Facility**

The following hardware facility should be available at ISRIC (Central facility of SOTER) where improved computer capability, better graphics and cartographic quality output are desired:

1.	Computer 386 clone, 20 Mhz, 70Mb hard drive, 80387 math coprocessor, mono monitor and card	US$ 6,300
2.	High resolution graphics 1280 x 1024 graphics card, high resolution colour monitor	US$ 6,000
3.	Cartographic quality pen plotter maximum size plot: 55 x 85 cm	US$ 5,500
4.	Digitizer (same as above)	US$ 3,000
Approximate cost of enhanced hardware facility		US$ 20,800

D. **Suggested System Function Requirements**

1. Editing/processing
   a. data capture
   b. map editing and correction; edge matching
   c. map projection transformation
   d. raster or vector format
2. Data manipulation
   a. capability to relate polygon and attribute files
   b. overlay capability
   c. windowing
   d. query capability
   e. proximity analysis
   f. filtering
   g. measurements: capability to perform distance and area calculations
   h. topographic analytic, slope, aspect, elevation, relief rescaling, rotation
   i. 3-D display capability

E. **Software Acquisition**

Software is not independent from hardware, and the selection of both is important. The Committee suggests the following approach in the development of a SOTER facility:

1. A hardware configuration to be selected.
2. A minimum set of system function requirements to be defined.
3. Request-for-Proposal to be sent to vendors.
4. Responses from vendors to be assessed and selection of a GIS for SOTER be made.

3.3 Contribution of the processing and interpretation of remote-sensing data in the development of a world soils and terrain digital database

Dante Bedendo

This research project is designed for a period of 14 months (starting on September 1988) in the context of an M.Sc. level academic programme to be undertaken at the International Institute of Aerospace Survey and Earth Sciences (ITC) in Enschede, The Netherlands.

The research activities involve the use and analysis of digital remotely-sensed data for the development of the World Soils and Terrain (SOTER) Digital Database.

Objectives of the study

The main objectives of the study are:

a. to develop a GIS-based methodology to elaborate a Soil Degradation Map according to the GLASOD objectives
b. to use remote sensing products to generate data for the soils and terrain database in areas where these data are incomplete or non-existing.

These objectives will be accomplished using the following procedures:

1. Digital image processing techniques (using ITC's ILWIS system) based on enhancement and multispectral classifications algorithms for the interpretation of the available satellite data sets.
2. Visual interpretation of SPOT and Landsat TM-derived images and their combination with information from conventional aerial-photographs and caratographic basic data (soils, geological, topographical, climatic maps available) to produce an inventory of data for establishing a spatial database.
3. Fieldwork (field collection of all reference data available for the study area within the Argentina part of the SOTER/GLASOD Pilot Area).
4. Cartographic manipulations using a geographical information system (GIS) approach in order to explore and analyse all relationships between multiple sources of data in an interactive way.
5. A soil information system (to be developed using the ORACLE relational database management system).

The implementation of these objectives will integrate state-of-the-art hardware/software and image-processing and interpretation techniques supported by a minimal amount of (ground) field data in the context of a geographical information system (GIS).

Selection of methods to achieve the objectives:

Data from Landsat Thematic Mapper (TM) in magnetic tapes will be analysed using image-processing techniques and classification algorithms for their transformation into meaningful categories able to be further developed for assessing soil degradation status and risk, and subsequently formatted to be incorporated to the SOTER database. The automatic interpretation will cluster the spatial elements into similar units related to the (ground) reference data. Complex algorithms are required to detect the different land-cover units. They will be based on criteria similar to the ones used in aerial-photo interpretation to differentiate geomorphic units as related to expected differences in soil characteristics.

The classified output will be segmented into a grid compatible with existing geo-referenced information (soil survey maps, etc) available for the area, in order to integrate and display geographic data and imagery using a high-capability, interactive geographical information system (GIS).

The digital TM data will be converted into analogue (image) format for their subsequent visual interpretation and comparison with other scenes of the same area obtained with other sensors (SPOT).

Selection of (hardware and software) equipment:

The digital analysis and the geographical information system interplays are to be performed at ITC on the ILWIS IBM/AT-compatible, GIS image-processing micro-computer system.

ILWIS is a knowledge-based system providing state-of-the-art, problem-solving capabilities by integrating conventional GIS procedures (data gathering, data input, data storage, data manipulation and analysis, and data output) with image-processing facilities and a relational database. Such a structure of subroutines and programs (herein called "methods") can be combined and used flexibly.

Data gathering procedures incorporate ITC's expertise in developing survey techniques and aerospace interpretation methods. Image processing plays an important role in data gathering, especially in areas without much basic natural resources information. The ILWIS remote-sensing package consists of modules for image display, histograms, transfer function and look-up table manipulations, image enhancement and feature detection, classification and geometric corrections.

The structure incorporates a soil information system providing the data necessary to answer questions about soil resources and potentialities of a given area, through a flexible combination of a GIS-manipulations "sub-systems" with a relational database management system (ORACLE). This ORACLE program is installed for storage and retrieval of attribute files and has capabilities to solve many of the conflicting problems which arise in large integrated databases subject to continuous changes. Its software provides an interface having a suitable language (SQL) to query and update information. It also offers simultaneous access for many users (with immediate response for their information requests) in a relational data model.

Graphics data are entered with easy-to-use menu-driven procedures for digitizing maps (well-structured forms are used to input attribute data). Digitizing is done in a freehand format. Geometric data are stored in both vector and raster structures. Map manipulation and cartographic modelling are in the raster domain. Several procedures for point, aerial and neighbourhood transformations are available within the map-analysis package. Fast overlying constitutes an important characteristics of the system. The use of internal tabular data reduces data storage requirements and allows rapid reclassification procedures. Image-processing techniques are an essential component of the system's data analysis and data transformation capabilities.

Maps can be displayed in both vector and raster structures, colour output (in up to 255 colours) can be displayed on the screen, and hard copies can be obtained using the Tektronix colour printer and the IBM ink-jet plotter or compatible. Tabular data, statistics and reports are provided by the ORACLE relational database management system.

Procedures to be used and results (products) to be expected

1. Digital image processing

   This stage will involve the manipulation of digital data for their subsequent interpretation using the following computer-assisted operations:

   a. Image enhancement: to display image data more effectively and deliver colour compositions for subsequent visual interpretation and field survey as well as to increase the visual distinction between features in the scenes to assist in the classification step. It is expected to derive hard-copy images increasing the amount of information to be visually interpreted from the data. Several enhancement possibilities involving multiple spectral bands (spectral ratioing, colour transformations, principal and canonical components or vegetation components) may be used and they will be refined during the development of analysis techniques.

   b. Image classification: to automatically categorize all pixel values in an image into classes ("themes"). The spectral pattern present within each pixel data will be used as a numerical basis for the categorization. Statistically-based decision rules will be applied for determining the identity of each pixel in the image. The spectral pattern-recognition procedures will include both "supervised" and "unsupervised" approaches to spectrally-based image classification.

c. Data merging: to integrate the analysed remotely-sensed data with other geocoded or geographically-referenced data set of the area in the context of a geographic information system (GIS) using the GIS capabilities of converting any physical data rendered in vector/polygon format into raster forms that could be easily and accurately compared with the pixel (raster) data. The data generated by overlaying several layers of base/ground truth information with the classified data are expected to be used both during the classification procedure (to improve the classification accuracy) and in subsequent queries and manipulations of the GIS database.

2. Visual interpretation

Image elements will be visually interpreted using photographic and optical facilities. The interpretation procedures will be based upon the same principles of the geomorphic/physiographic approach (as developed at ITC) that are applied to aerial photo interpretation, and combined with local-reference knowledge on the characteristics of the area (landscapes, landforms, lithology, drainage pattern and conditions, vegetation, land cover, land-us, etc.). The initial delineation of boundaries will be supplemented by large-scale photographic interpretation and field survey/field collection of basic information.

Both TM- and SPOT-derived (hard-copy) imagery will be used to allow a comparison of both products in terms of spatial-resolution and multi-temporal differences.

3. Collection of reference data

This step will involve the (field) collection of observations about the test area(s) which will be derived from the available information (soil survey maps/aerial photographs, etc.) and/or based on the field check on the identity, extent and condition of soil degradation phenomena in the area.

4. Interaction of methods:

All the above-mentioned operations will be interrelated in practice during the analysis in such a way that no strict boundary can be defined "a priori" between them.

Evaluation of final products

Classified TM data in the context of a soil degradation assessment will be used through GIS operations to resample them into a compatible base for comparison (overlaying) of these data with raster-based existing information. The results obtained from the above-mentioned analytical stages will be evaluated as a possible base to set up an appropriate methodological approach for using remotely-sensed data processing and interpretation techniques to build a geographical database and a predictive model useful for soil degradation (status/risk) assessment and mapping in areas where this information is incomplete or non-existent.

Research planning

The development and testing of the above-mentioned methodological procedures to extract information from the study area form the bases for four main phases of the work scheduled as follows:

- January-March and June 1989: development of methodologies (including image-processing, visual interpretation and GIS operations activities)

- April-May 1989:
  fieldwork (field check/collection of data)

- July-August 1989:
  implementation of a database

- September-October 1989:
  text-processing of all the material elaborated/compiled (thesis writing).

3.4 Soil Degradation Status, Rate and Risk (Revised)

D. Richard Coote

Since the SOTER-GLASOD Workshop in Montevideo, Uruguay, in March 1988, the entire Volume II of the Procedures Manual has been rewritten. It now contains two chapters (Chapters 14 and 15) related to the assessment of the status and rate of soil degradation in the field during preparation of the SOTER database. These are followed by chapters on the assessment of the rate and risk of degradation by water erosion, wind erosion, salinization, chemical deterioration by leaching, and sodication. There is then a chapter on the use of climatic data in these assessments.

This revised version of Volume II is still being reviewed. Some comments and suggestions have been received, and others are anticipated as a result of the Working Group discussions at the Porto Alegre Workshop. Further revisions are planned in 1989.

Chapter 14: Status of Soil Degradation

This chapter is an interpretation of the "Guidelines for General Assessment of Human-Induced Soil Degradation" (GLASOD Working Paper No. 88/4) to meet the needs of those preparing the SOTER soil maps at the 1:1 million scale, and their associated databases.

The assessment provides for the recording of the type of degradation present if 1% or more of the area of a soil map polygon, or of a terrain component of the polygon, is affected. For example, Wt represents the presence of water erosion manifested by topsoil loss (sheet erosion), and Wd indicates land deformation by water erosion (gullies). Symbols are presented for each type of degradation anticipated on a global scale.

The degree of severity of each degradation type is assessed in one of four classes: slight, moderate, severe, and extreme. A "none" class can be assumed in situations where no symbol for a degradation type is recorded.
Descriptions are provided in Chapter 14 from which the pedologist can assess the degree of severity of each degradation type where it occurs in each terrain component.

The extent of the soil map polygon, or terrain component of the polygon, affected by each type of degradation is recorded in five classes: infrequent (1-5%); common (6-10%); frequent (11-25%); very frequent (26-50%); and dominant (>50%). If less than 1% of the area is affected, the degradation is ignored.

The pedologist preparing the SOTER maps in the field is requested to make an assessment of the rate of advancement of any observed soil degradation over the recent past. This is defined as the last 10 years. It should be done in five classes: none, slow, medium, rapid, and extremely rapid. It will most likely be necessary to consult with local experts, landowners, and others familiar with the area, to reach a reasonable assessment of the rate of progression of each type of degradation.

Where soil degradation is evident that cannot be related to recent human activity, it can be recorded as historical. For example, land that was severely eroded during previous civilizations, but which is now stable as a result of changes in land management, can be recorded as historical erosion class "a", indicating erosion dating from the period of "Early civilization (>250 years ago)". Other historical degradation can be recorded as "b" - European expansion (50-250 years ago), or "c" - post World War II to 10 years ago.

Finally, the field assessment should attempt to determine the most probable cause of the soil degradation problem. This may be recorded as "f" - deforestation, "g" - overgrazing, "i" - intensive cropping, or "o" - other. It is anticipated that most of the human-induced soil degradation will be attributable to one of the first three causes.

The principal problems that arose in the application of Chapter 14 in the Pilot Study Area appeared to be related to the degree of degradation (e.g. water erosion). Firstly, there was the question of applying a global scale to an area in which the problem, in this case erosion, was perceived locally as being severe, but where the degree was only slight or moderate in the context of soil erosion through out the world. Secondly, there was difficulty in deciding on the class of severity to record on the coding forms when there was often erosion of different degrees of severity affecting different portions of the polygon or terrain component. The first of these problems can be addressed by improving the descriptions of the different degrees of erosion severity; the second problem remains to be resolved. Similar problems were encountered with the assessment of the severity of compaction.

Another problem that was apparent in the Pilot Project Area was difficulty in deciding on the use of the historical degradation classes. Since the problems encountered were often considered to have been present for more than 10 years, the historical class "c" (World War II to 10 years ago) was often recorded. This had not been intended in the preparation of the procedures manual, and further revisions to this section will be required.

Chapter 15: **Assessment of the Present Rate of Soil Degradation**

The purpose of this chapter is to describe the requirement for an assessment of the present rate of increase in the severity of each soil degradation type present in each polygon or terrain component. The classes will be the same as those used for the recent past rate of degradation.

The importance of this assessment must be stressed, because it is probably the only opportunity for field checking the rate estimates made from models based on soil and climate data. This means that it will also serve to check the methods used to predict the risk of soil degradation given certain pre-determined cropping systems.

Chapter 16: **Assessment of the Rate and Risk of Water Erosion from SOTER Data**

This chapter is a revision of the earlier version that was agreed to, in principal, at the Montevideo workshop in March, 1988. It describes the application of a modified Universal Soil Loss Equation (USLE) using the SOTER database to estimate each of the required factors. The USLE is well known, and has been applied over many years in many climates and land forms, including parts of the Pilot Study Area. Its quantitative accuracy has not been widely accepted outside the United States, but it should still be a reasonable method for comparing erosion susceptibilities of soils and landforms. It is proposed here as an acceptable means of separating land into five classes of erosion risk.

Chapter 17: **Assessment of the Rate and Risk of Wind Erosion from SOTER Data**

This chapter describes the application of a modified U.S. Wind Erosion Equation (WEE), using the SOTER database to estimate each of the required factors. This equation has been applied to only a very limited extent outside of the United States, and its suitability for assessing even broad classes of wind erosion risk at a global scale is not yet known. It is proposed here mainly because of the lack of an alternative method. As agreed to at the Montevideo workshop, this method should be checked against available data and its usefulness to GLASOD determined before other methods are developed.

Chapter 18: **Assessment of the Rate and Risk of Salinization**

A method is proposed in this chapter that has not been used before, but which can be readily applied to the SOTER database. The proposed method uses the multiplication of a series of factor values, representing critical SOTER terrain component and soil layer attributes, to arrive at a product that can be numerically classed from "none" to "extreme".

Attributes that can completely control salinization are assigned a factor value of zero if they are in a SOTER class that precludes salinization from occurring. In this way, no matter what the other factor values, the rate and risk would be zero, or "none". Critical attributes in classes that would likely decrease (but not eliminate) the rate and risk of salinization are assigned factor values between zero and 1.0; those in classes that would likely have no effect on the rate and risk are given factor values of 1.0; and those in classes that would likely contribute directly to salinization are given factor values greater than 1.0. If the net product of the multiplication of the factor values is 1.0 or less, it is concluded that there is no risk of salinization, and that the present rate is zero. This is because the factors that tend to reduce salinization are of greater influence than those that tend to increase it. If the product of the factor values is greater than 1.0, then it is concluded that salinization will proceed, and the rate class will be estimated from the magnitude of the factor value product.

The product values for rate and risk can be displayed in the form of a multi-variate matrix, and class limits can be selected that reflect the range of possible values on a global scale. Table 18.1 provides an example of such a matrix, in which salinization rate in irrigated land is assessed using: 1. A climatic variable - moisture availability index 11. SOTER terrain components - depth to groundwater, electrical conductivity of groundwater, and position on slope; and 111. SOTER soil layer attributes - electrical conductivity and saturated hydraulic conductivity. The values have been interpreted into classes from "none" to "rapid". The highest possible class, "extremely rapid" does not appear because the criteria chosen for this assessment require that poor quality irrigation water must be known to be used before the "extremely rapid" class can be assigned, even if all the other indicators point to a high rate of salinization.

This proposed method of interpreting salinization rate and risk has been tested on only a very limited data set in Canada. A great deal of testing, calibration and interpretation remains to be done before the method can be widely used. However, in the absence of an alternative method that is compatible with the SOTER database, it is proposed that this method be evaluated with the Pilot Study Area data as soon as possible.

Chapter 19: **Assessment of the Rate and Risk of chemical Deterioration due to Nutrient leaching using the SOTER Database**

This chapter has been developed as a result of consultations initiated at the workshop in Montevideo in March, 1988, and attempts to address a very complex set of phenomena through interpretations of the SOTER database. The methodology proposed is similar to that proposed in Chapter 18 for salinization assessment. This approach has not yet been tested in any area, and it remains to be seen if it can be used to indicate classes of rate and risk of chemical leaching.

Chapter 20: **Assessment of the Rate and Risk of Sodication using the SOTER Database**

This chapter attempts to apply the same methodology proposed above for salinization and nutrient leaching to the problem of sodication. As before, this methodology has yet to be tested with field data, and its suitability for assessing classes of sodication rate and risk remains to be determined.

Chapter 21 **Climatic Data analysis for Degradation Assessment**

In this chapter the methodology is presented for processing and interpreting the climate files for use in the degradation assessment methods proposed in the previous chapters.

NOTE: There are some forms of soil degradation for which rate and risk assessments have not yet been proposed. It was not anticipated that types of degradation would be encounted in the first Pilot Study Area that were not already covered in the chapters above. However, it is now apparent that compaction is a major concern in this area, and the methodology for its rate and risk assessment will have to be dealt with as soon as possible.

3.5 Use of the SOTER Database

Denis Sims

1. Logical justification for the very considerable expenditure of scarce financial and technical resources required to establish the database.

We should never lose sight of the fact that almost the only logical justification for the exercise is the use of the database for the benefit of the countries concerned and the inhabitants of the areas covered by the surveys, to increase production, raise living standards, and protect resources. It is therefore necessary to consider whether, how, and at what levels it could be used for these purposes.

Basically, the information on soil and climate which is being collected is intended to be used to classify the land units which are thereby identified, in relation to their suitability for various uses, or in other words, to identify uses and practices which result in maximum sustained production.

In order to ensure that all necessary information is available, but that time and scarce professional and financial resources are not spent on collection of data which is not needed or purchase of needlessly complicated, unsuitable, or expensive software and hardware, it is advisable to consider in some detail how, and at what levels the database can be used, and what other inputs or institutional structures are required before it can be of use.

This short paper explores the structuring and logic of decision-making in terms of the use of land resources.

2. The basis of decision-making; a two-stage process

All decisions involve two stages:

1. what are the possible alternatives?
2. which of the alternatives is the best from the point of view of the needs or objectives of the decision-maker?

From these two simple, seemingly elementary, but correct statements it is possible to derive the logic and structure of a computerized systems approach.

2.1 Stage one: Possible alternative land uses

In order to find out what crops and land uses are possible on a given land or mapping unit we need to compare the attributes of the land unit with the environmental requierements of the widest possible range of uses. In systems terms this might be represented as in Figure 1.

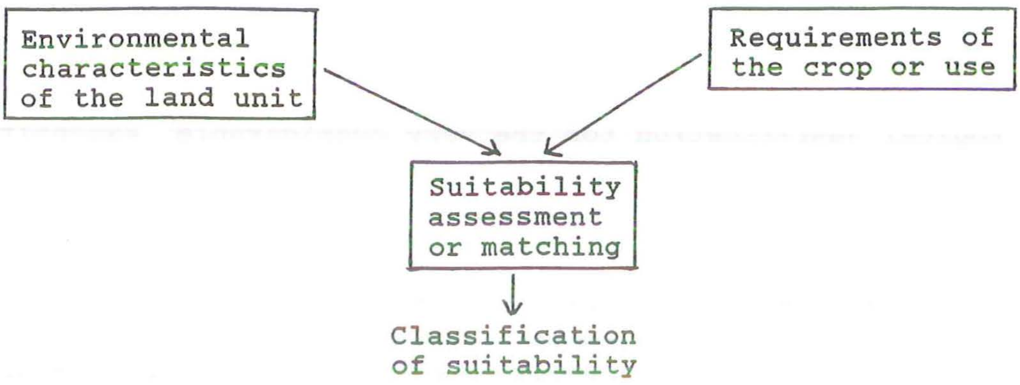


Figure 1: The Basic Process

But to be of practical use to planners, extension workers and farmers the results must be presented in quantitative terms, must be reasonably precise, and must facilitate comparisons between alternative land uses. Thus the system has to be further developed, as in Figure 2 below.

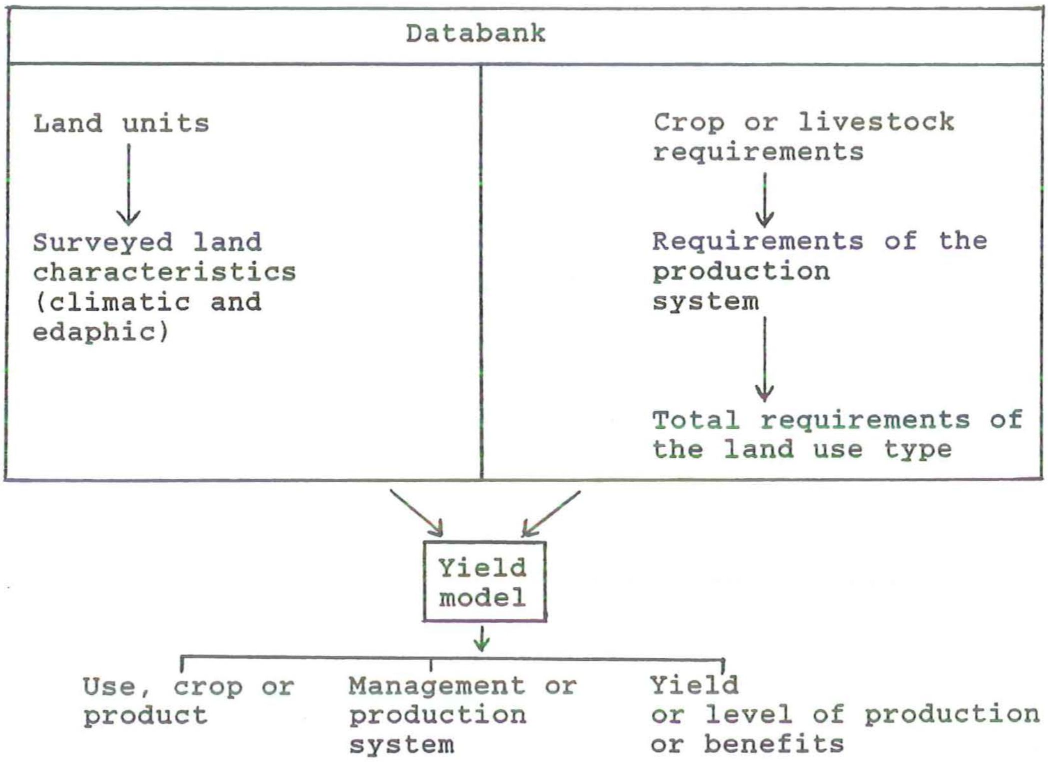


Figure 2: Basic model to produce list of alternatives in quantitative terms.

Land characteristics are climatic and edaphic parameters such as rainfall, temperature, soil texture, land slope, soil depth, which are required as inputs to the yield model and which are measurable in the field. Different crops and livestock types tolerate different maxima and minima in terms of environmental variables,and their yield levels or growth rate within this range varies with changes in these variables. Thus crop and livestock requirements are expressed in terms of temperature, moisture, light, day length, humidity, etc. Apart from the needs of the crops being produced, the production system itself may have certain requirements in terms of soil and climate. Examples are where land is too steep for mechanization or where too frequent intense hailstorms make the use of glasshouses impractical.

The yield model shown in Figure 2 is any method of estimating yield or output from a defined land unit with known characteristics. Its complexity will depend on the amount of data and expertise available.

The output from the yield model is a list of possible uses or products, an identified production system, and a level of average yield or output.

2.2 Stage two: selecting the "best" land use for each land unit

"Best", and "optimum" are relative terms, and depend on the objectives of the exercise and the needs of the customer or client. At farmer level the most important objectives might be the satisfaction of basic food requirements, then maximum cash income, then reduced labour inputs. At national level they might be food self-sufficiency, higher rural incomes, and environmental protection.

Notice that:

1. there is usually more than one objective
2. objectives may be to a greater or lesser extent incompatible
3. objectives can be ranked in order of immediate priority
4. objectives must be identified before "best" or "optimum" can be defined in terms of land use
5. objectives and their relative importance can alter over time. This reduces the value of printed suitability maps and enhances the value of a computerized system which can rapidly access, combine, and reclassify the basic data as required.

Adding the second stage to the basic model we get the diagram shown in Figure 3.

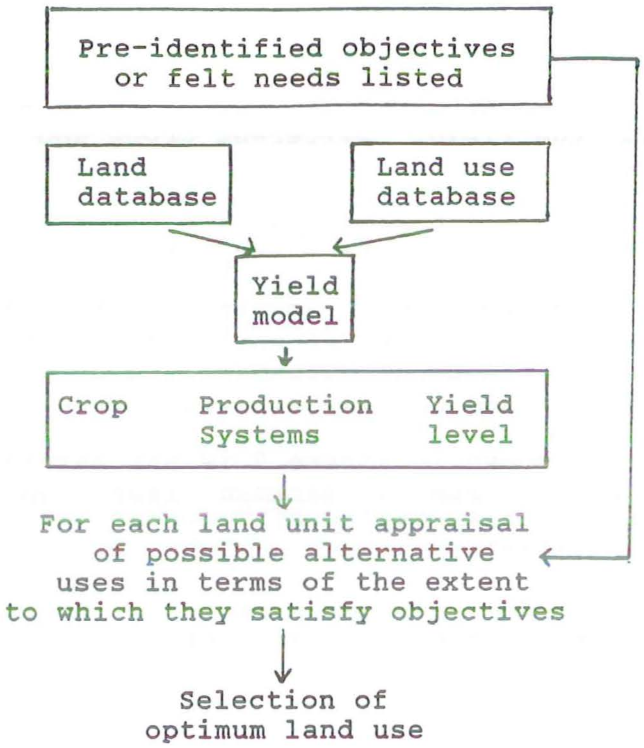


Figure 3: Basic land use planning model

Assessment of alternative land uses may involve economic appraisal, market surveys, calculation of labour requirements, environmental impact assessment, and other calculations, and probably the use of trade-off or optimization techniques.

The objectives of this paper is not to discuss the form or construction of databases, yield models, or optimization techniques (other than to observe that there is no justification for the use of a complicated or expensive method when a cheaper and simpler one will satisfy the objectives), but only to set out a very basic systems approach which will serve as a framework for increasingly precise and quantifiable land suitability classification and land use planning.

3. The level or scale of the exercise

Figure 3 shows an adequate but very generalized framework for identifying possible alternative land uses and deciding which is best for a given land unit. The same general approach, and the same structure, apply at national, district, village, or farm level. but the purpose, methodology, map scale, and level of detail will be very different. To apply the model at different levels and to connect up in a practical and quantitative way with agronomists, soil conservationists, farm management experts, economists, and many other disciplines, and analyse effects and benefits quantitatively, it is necessary to establish a more developed structure and terminology for land uses, and the following is tentatively proposed.

↑

Associations of major land uses

↓

Major land Uses
(forestry, pastoralism, field crop production, horticulture, etc.)

↓

Land Use Type
(single or compound. May in many cases be synonymous with Farming System)

↓

Less detail, Small scale

Cropping Pattern
(May be synonymous with Rotation)

↓

Most detail, Large scale

Crop, Product, or Activity
(outputs in economic terms are the imputed value of the products)

↓

Production Systems/Crop production systems

↓

Agricultural practices/Cultural Technique

↓

Operation or task
(eg. hoeing, ploughing)

↓

Inputs
(labour, seed, etc.)

↓

Figure 4: Suggested structure and terminology for description and analysis of land uses.

Note that it is possible to carry out an analysis at any selected level in the heirarchy, and that not all the levels shown above need necessarily be identifiable in any given land use system.

Using such a terminology land uses can be identified, described, and analysed in terms of their products the components of their production systems, and their economic and social aspects. It is possible for example to identify components which have certain impacts on the land, on costs, on yield, or on labour requirements (as for example the aspect of a production system which causes erosion) and model the possible effects (in physical, social, and economic terms), of changes in the land use or production system.

In order to set up the land use data bank shown in Figure 2 it is necessary to identify, describe, and name land uses, cropping patterns, production systems, and cultural techniques in the same way that it is necessary to identify and name land polygons, terrain units, and soils in order to set up the soils database.

In doing this, and in mapping land uses it is necessary to distinguish between land use and land cover. In general land cover is what you observe, and is classified and described in physical terms. Land cover is the effect of land use. Land use often, but not always, implies exploitation of land resources and is identified and described in terms of products, activities, and socio-economic setting. Very often land cover and land use terms are mixed together in map legends (eg. SOTER manual 10-31, para 18).

4.0 REPORTS WORKING GROUPS

4.1 Report Working Group on Correlation
Reporter: Juan C. Salazar

SOTER Database and Polygon map

1. Polygon numbers in different countries.
   On national level each country identifies its polygons with a number beginning by one (1). On international level according to the SOTER Manual each polygon will have a unique number. Polygons that cross borderlines will have numbers in the files of each country, but for SOTER will have only one number.

2. Cartographic base of the polygon map.
   The ONC sheets will be used with special reference to the most important river roads and towns. For national us political divisions will be used on a separate transparant sheet f.i. counties, municipalities.

3. Correlation Brazil Argentina.
   According to the existing information the polygons in the border area between Brazil and Argentina are completely different in land form and parent material and therefore the attributes are different except in a small area of the southern part of the borderline within the pilot area where polygons are alike and where a correlation fieldtrip will be necessary.

4. Output.
   During this meeting all the material prepared by the three national groups will be delivered.

Degradation

1. Degradation map.
   The three delegations presented degradation maps prepared according to different criteria. Some were very detailed, others were very generalized and consequently different opinions and proposals were brought forward for the presentation of the final degradation map of the pilot area. Because of the great number of proposals the international correlator, W. Peters, will review the material and the national delegations will send him their degradation maps as complete as possible to be analysed and processed. The product will be the final map that will be sent to the three delegation for their approval.

2. Document to be presented to UNEP
   The preparation of a document was considered necessary in which the investment by each country in this project is specified in order to justify the request to get the hardware, the software and the necessary training for using the system.

3. Follow up after the First Pilot Area.
After the experience and the results of the first step of this project a possible follow up was discussed within South America. One of the alternatives within this continent is the watershed of the Plata River. A different one would be part of the Amazon River area, where two or more countries would be involved.

4. Final delivery.
The final maps and reports of the three national groups will be delivered before 28 February 1989.

5. Final Fieldtrip.
In order to check the results and the workability of the system a final field trip is suggested after finishing this phase of the project.

4.2 Report Working Group on Data Management and Soil Degradation
Reporter: Eelko Bergsma

Data Management

1. Amendments needed.
   Input on land use will be regrouped. Main categories and subdivisions will be improved by UNESCO - FAO classification systems that exists already. Sims will send material to Oldeman at ISRIC.

2. a. Regular meetings of the three countries seem very useful, exchange of experiences and extension of application.
   b. Training during project activities is very useful for computer operators and development of further applications.
   c. Can UN Science and Technology Fund play a role?

Land Degradation

1. Erosion definitions

   - SSM descriptions may be consulted in addition. Qualitative and quantitative descriptions should be given.
   - 5 classes should be used
   -

	4/5 -	12/15 -	± 30 -	50 -	200
very slight	slight	moderate	severe	very severe	extreme

   - definitions are given by apparent erosion in the field. The estimation of damage to soil productivity is another matter, done if needed from the data base data.
   - But classes need to be made now, anticipating and facilitating the damage assessment in that later stage.

2. Erosion risk classes: made by evaluation of 3 factors.

   Rainfall : index will be the rain erodibility index of USLE. The Bols index may give a good estimation of R for South America (Couts).

   Terrain : distinguish overland flow types from interaction of rain and soil, rain and plants. Use five relief classes: L-NL; U; R; H; steep and very steep.

   Soil :
   - use soil texture classes
   - refer to Romkens (Bangkok 1/88)
   - refer to UNEP clay content classes
   - not sealing soils of LS and SL textures and swelling clays (class 5)
   - add a class for relative impermeable layers (such as ploughpan) within 30 cm from soil surface.

   Crop effect : include a list of plant cover factors for many common plant covers.

Management : include a list of practice effects factors, such as for the effect of tied-ridging, strip cropping, etc.

3. Gully erosion class definition.
Gully erosion, as one form of rain erosion, is described first by extent and secondly by intensity. The most extensively occurring intensity for a terrain unit is put on the map. Other intensities may also occur, but to a lesser extent. They are only put in the database, in the description of the terrain unit - 70% moderate gully erosion will be put on the map, the remaining 30% having severe gully erosion is recorded in the database only.

NB: Once the data are stored, a map showing the most severe erosion can be made for experimental comparison

How is the intensity measured?
By depth, width and length.
Three depth classes could have boundaries of 1 m and 5 m.
W and L are to be combined into real gully surface area, even though this will result in very low percentages such as 3%.

NB: even lower, such as 0,003%!

NB: This is completely unpractical for small scale maps as SOTER-GLASOD.

NB: The best suggestion is to take the gully catchments surface area per terrain unit.

Structural degradation

a. Crusting and sealing
b. Compaction
This includes a textural redistribution by rice paddy system, a "clay deposition pan", hindering tillage.

Risk of compaction

To be looked into more. Factors to be considered are:
- clay content
- organic matter
- drainage condition.

5.0 FINAL SESSION REPORTS

5.1 Accomplishments, Conclusions and Recommendations

1. Accomplishments.

1. The correlation teams have established an excellent regional cooperation and the activities as stated in the terms of reference have been executed on schedule.

2. All data on SOTER polygon files, terrain component files and soil layer files have been collected and polygon maps have been prepared. Climate files and soil degradation status files are being prepared and completed on or before the end of February 1989.

3. A second version of the Procedures Manual on Degradation Status and Risk assessment has been prepared and presented.

4. A database structure for the SOTER Attributes and the separate climate attributes has been created.

5. A first draft of a Geographic Information System approach for SOTER was presented.

2. Conclusions

1. A group of soil scientists with strong administrative support from each of the three participating countries has made a significant contribution to the implementation and testing of GLASOD/SOTER Procedures Manual for Small Scale Map and Database Compilation.

2. Although important progress has been made, continuous research and development is needed to further improve methodologies for soil degradation assessment at scale of 1:1,000,000.

3. Although the workshop was not originally included in the project document, it is concluded that for a correlation methodology assessment a workshop is essential at the end of the data acquisition phase of the project.

3. Recommendations

1. It is recommended and considered indispensable that support be sollicited to acquire and install a basic hardware/software system in each of the three participating countries as soon as possible.

2. As soon as a decision has been taken on hardware/software, training materials have to be prepared and an appropriate training programme be implemented in the three participating countries.

3. Taking advantage of the acquired skills and valuable experience of the teams in the participating countries it is recommended that further plans be developed for implementation and expansion of the SOTER database and its utilization. These plans should be formulated by the three countries involved.

5.2 Closing Comments

Marion F. Baumgardner

I wish to congratulate you for the excellent progress which you have made in this first Pilot Area in the Development of a World Soils and Terrain Digital Database. In only eight months you have successfully tested and improved the SOTER Procedures Manual. Your cooperative work across national boundaries and soil classification systems may well serve as a model approach as we extend our SOTER efforts to other regions of the world.

You are to be commented for your interest in seeking means to continue the development of the SOTER database in your countries beyond the Pilot Area. Already discussions have begun for the initiation of another Pilot Area in South America. It would be exciting if during the next five years we can solicit and obtain sufficient financial support to expand the Project and complete the SOTER Database for all of South America by the mid-1990s.

The prospect of an expansion of SOTER Project activities to other regions of the world provides other challenges to the SOTER Management. There is a critical need to begin the development of training programs, including educational publications, short courses, and audiovisual materials, for using the SOTER Procedures Manual, operating and using the SOTER GIS facility, and using the SOTER Database for management decisions. A concerted effort should be made to obtain funds for and to contract with an appropriate institution to develop such training programs for the SOTER Project.

The progress on the GLASOD/SOTER Project which has been presented here suggests that we are on schedule and that the contract with UNEP can be completed by the termination date on 31 December 1989. We will have several very interesting presentations of results from this Project to present at the International Soils Congress in Kyoto, Japan in August 1990.

6.0 ANNEXES

6.1 PROGRAMME

PROGRAMME

of the

Second Regional Workshop

on

SOTER and GLASOD

Pilot Area in South America

(Argentina, Brazil, Uruguay)

12-15 December 1988

at

Faculdade de Agronomia

UFRGS

Porto Alegre

Brazil

International Soil Reference and Information Centre (ISRIC)
Wageningen, The Netherlands

United Nations Environmental Programme (UNEP)
Nairobi, Kenya

Workshop GLASOD-SOTER
First Pilot Area

12-15 December 1988

Porto Alegre, Brazil

Place of meeting: Faculdade de Agronomia
UFRGS
Av. Bento Gonçalves, 7712
Tel. (0512)362011

PROGRAMME

Monday, December 12

09.00-09.15	Welcome	Abilio Baeta Neves Marion Baumgardner
09.15-10.00	Man Induced Soil Degradation in the Pilot Area	Wilhelmus Peters
10.00-10.30	Coffee	
10.30-11.00	Progress Report GLASOD-SOTER	Roel Oldeman
11.00-11.45	Progress Report Pilot Area	Wilhelmus Peters
11.45-12.00	Group Photo	
12.00-13.30	Lunch	
13.30-15.00	Progress Report Argentina	Delegation Argentina
15.00-15.30	Coffee	
15.30-17.00	Progress Report Uruguay	Delegation Uruguay

Tuesday, December 13

08.30-10.00	Progress Report Brazil	Delegation Brazil
10.00-10.30	Coffee	
10.30-11.00	Climate Data File	Roel Oldeman
11.00-11.30	SOTER Database Progress	Vincent van Engelen
11.30-12.00	Contribution of the processing and interpretation of remote sensing data in the development of a world soils and terrain digital databases	Dante Bedendo presented by Eelko Bergsma
12.00-12.30	Assessment of current Geographic Information Systems	Marion Baumgardner
12.30-13.30	Lunch	
13.30-15.00	Soil Degradation, Status, Rate and Risk Assessment	Richard Coote
15.00-15.30	Coffee	
15.30-16.45	Use of SOTER Database	Denis Sims

Wednesday, December 14		
08.30-12.00	Working Groups A. Correlation B. Data Management and Soil Degradation	
12.00-13.30	Lunch	
13.30-14.15	Report Working Group A	
14.15-15.00	Report Working Group B	
15.00-15.30	Coffee	
15.30-17.00	Demonstration of SOTER Database	Vincent van Engelen
Thursday, December 15		
09.00-10.00	Conclusions and Recommendations	
10.00-10.15	Closing Remarks	
10.15-11.00	Coffee	
11.00	Departure Field Trip	
Friday, December 16		
16.00	Return to Porto Alegre Departure Participants	

6.2 LIST OF PARTICIPANTS

LISTA DE PARTICIPANTES

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6.3 Report Field Trip, 15/16 December 1988
Roel Oldeman

Under the competent guidance of Prof. Egon Klamt a two-day excursion was organized at the conclusion of the workshop. Participants on this tour were Marion Baumgardner, Eelko Bergsma, Dick Coote, Vincent van Engelen and Roel Oldeman. The trip through the Rio Grande do Sul State (figure 1) gave the participants a good impression of some of the important landscapes, soils and soil degradation problems in the Brazilian part of the pilot area.

The group entered the pilot area at Ijui: a generally rolling topography with mainly red sandy loam soils and as major cash crop soya, often planted on slopes greater than 8% usually with narrow-based graded contour banks whose designed capacity appeared to be too small to contain the run-off so that moderate to severe erosion was evident in areas of concentration. It became later clear that soil compaction, leading to reduced infiltration rate results in overland flow and gullying. By digging in land which had been under soya for several years and in adjacent land remaining under forest it was demonstrated that compaction of these soils might have been considerably increased by present cropping practices. It was questioned whether the compaction problem was the result of tillage and wheel traffic, or simply a reflection of the loss of the A-horizon by erosion. It would be useful to study these two situations in more detail and quantify in particular the soil physical properties of the two sites.
There appears to be a misunderstanding on the use of the term "rolling" used for the description of main land forms. "Rolling" is a relief description, indicating a variation of slope steepness with dominant slopes between 8% and 16%. There is no relation to the depth of bedrock!

The group also observed areas with spectacular gully erosion in the western part of the pilot area (between Alegrete and Sao Francisco de Asis). Large tracts of very poor sandy soils forming an undulating to rolling topography are mainly used for grazing. Once the poor quality grass cover is broken as a result of overgrazing or burning (which was common in early years) gullies are formed. They appeared to be active at the cutting head, while downstreams the walls of the gullies were stable and partly vegetated. Some local residents indicated that these gullies may have been here for the last 50 to 100 years. In other words: a situation with severe historic erosion and slight to moderate current erosion.

The group traversed several polygons, identified by the mapping teams. Polygons are differentiated on the basis of parent rock, texture class, slope class, local surface form. It was not possible on this short tour to obtain an idea of the practical applicability and the utility of the method. However it can be concluded that there will have to be some better guidelines for assessing the degree of soil degradation problems in the field.

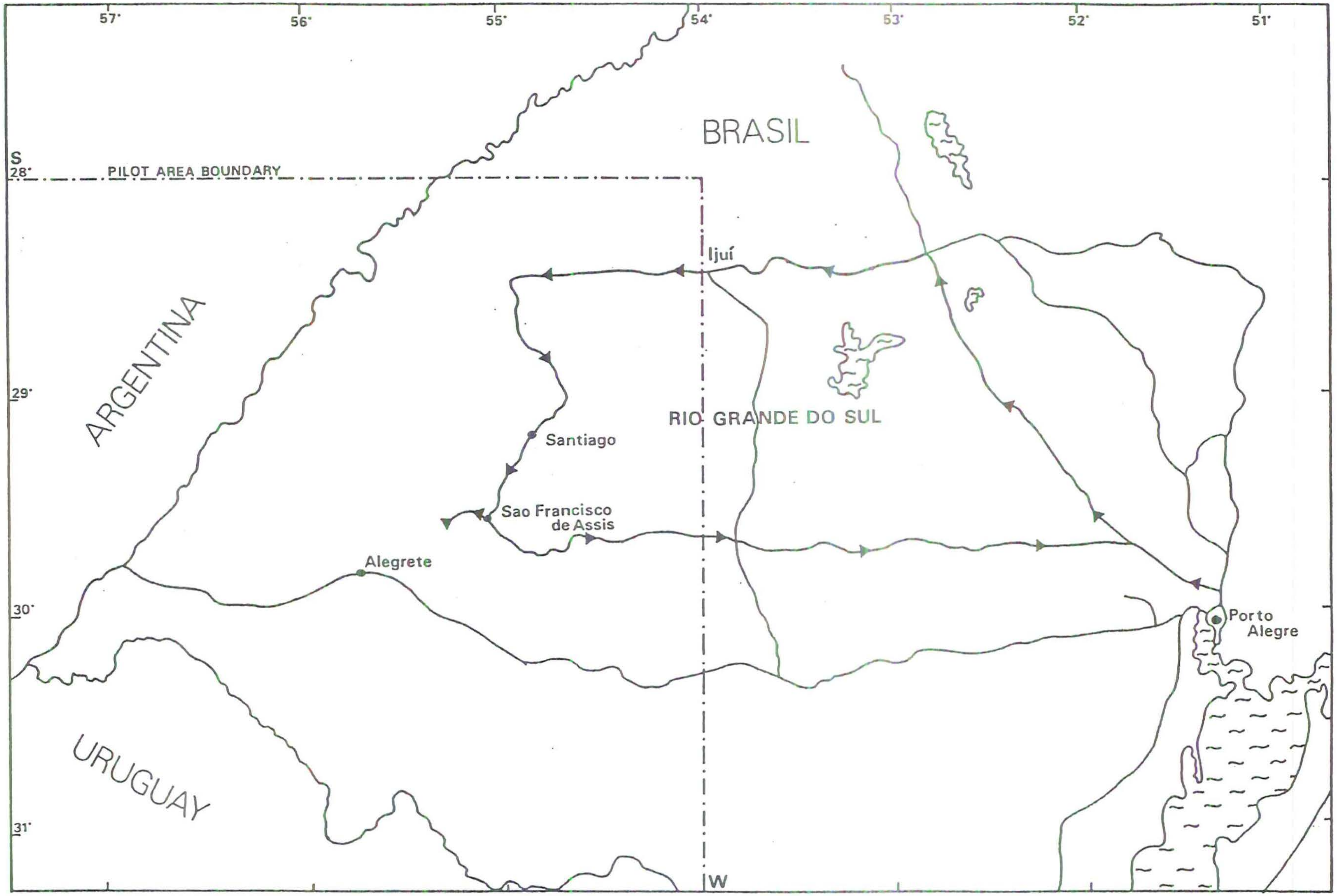

Fig. 1. Route field excursion (——◄——) 15-16 December 1988 (GLASOD/SOTER 2nd Reg. Workshop, Porte Alegre.