Working Paper and Preprint

94/04

Global and National

Soils and Terrain Digital Databases

(SOTER)

Attribute Database User Manual

P. Tempel
April, 1994

ISRIC

INTERNATIONAL SOIL REFERENCE AND INFORMATION CENTRE

Contents

Preface

Background of SOTER

There is a strong need for soils and terrain data in many activities related to natural resources. The data should be in a computerized format to permit use in automated interpretation. Development of computerized natural resource inventories and land evaluation systems for use in developing countries has been carried out since the early nineteen-seventies, e.g. FAO's Agro-Ecological Zones programme.

SOTER (Global **SO**ils and **TER**rain digital database) is an initiative of the International Society of Soil Science (ISSS). The idea to create a digital database was conceived in 1986. In 1987 the International Soil Reference and Information Centre (ISRIC) received financial support from UNEP to develop a methodology and to carry out a first pilot study in an area covering parts of Argentina, Brazil and Uruguay in cooperation with the national soil survey institutes (phase 1). A second test was executed by the US Soil Conservation Service and the Canadian Land Resource Research centre (now the Centre for Land and Biological Resources Research) in an area along the US/Canadian border. Follow-up activities (phase 2) included training of the national staff in the use of a Geographical Information System (GIS) with SOTER data and refining of the SOTER methodology together with FAO, while in 1993 UNEP gave financial assistance to start SOTER activities in Kenya and to enlarge the activities in argentina and Uruguay. Also a SOTER database compilation was initiated in Hungary.

In the context of SOTER sub-projects have been executed viz. in the South American pilot study, while new activities are under execution since 1993, like the construction of a SOTER database in Kenya. At the same time the methodology was revised several times resulting in the fifth version of the SOTER Procedures manual, as a joint publication of UNEP, FAO and ISRIC (1993)[1].

Parallel to the regional activities, applications of the database were further developed. A major effort was made in the creation of an automated interpretation of the SOTER database for the assessment of water erosion risk using two well known erosion models. A similar exercise in cooperation with the International Institute for Land Reclamation and Improvement (ILRI) aims at the development of a salinization risk assessment using the SOTER database.

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[1] van Engelen, W.P. and Wen Ting-Tiang (eds), 1993, "Global and National Soils and Terrain Digital Databases (SOTER) - Procedures Manual", UNEP/ISSS/ISRIC/FAO, Wageningen.

Summarizing, Soter's main objectives are

1. An orderly arrangement of natural rsource information through the creation of a computerized database containing available information on soils and terrain, linked to a geographic information system (GIS) which ties each item to its geographical location.
2. Database and information service of land resource data for global and regional resource planning.

SOTER's long term objective is

> the establishment of a compatible, amendable and accessible Global Soils and Terrain Digital Database (SOTER) at a scale of 1:1M, in cooperation with UN agencies and other international and national organizations.

This manual describes the installation, configuration, and proper application of the user interface for the SOTER non-spatial attribute database. The SOTER user interface incorporates procedures for storing and editing soils and terrain data. SOTER is essentially a dBASE IV application, written in the dBASE language. dBASE IV is a well known and widely used relational database management system.
Although SOTER is fully interactive and self-explanatory (all necessary instructions appear on screen), this manual provides additional information to enable a more effective use of the SOTER procedures. It is therefore recommended to read this manual carefully.
For more information please contact the director of ISRIC, P.O.Box 353, 6700 AJ Wageningen, The Netherlands.

Wageningen, June 1994
Piet Tempel

1 Installation

1.1 Installation notes.

The SOTER data management software comes to you on a 3.5" High Density (HD) diskette This diskette contains two batch files, either to install your SOTER copy from the A-drive (use batch file "installa.bat"), or from the B-drive (use batch file "installb.bat"). Both installation programs will copy the SOTER software to your **C**-disk. Edit the appropriate installation batch file for a different destination[1].

1.2 Install directory

The install program will always create a directory SOTER94 under the root directory, and four subdirectories under SOTER94; DATA, DELETED, PROJECTS and REPORTS:

C:\SOTER94	This directory contains all system files, program files, memory files, and code tables;
C:\SOTER94\DATA	This directory contains all your data files. For a listing of the structure of these files see "Actualization of the database structure for non-spatial SOTER attribute data in dBASE IV" ,24 January 1994.
C:\SOTER94\DELETED	This directory will contain all data that you delete from tables in the DATA directory. The structure of the DELETED tables is identical to those of the DATA tables, except for two additional fields: - DDATE: containing the deletion data; - DTIME: containing the deletion time.
C:\SOTER94\REPORTS	At present this directory is still empty. In future versions of the SOTER data management system, directory REPORTS will contain all output disk files, that are generated by SOTER.

[1] The value of one or more system variables in two memory files, SOTERDIR.MEM and DEFAULT.PRJ, have to be changed accordingly: at the dBASE IV dot-prompt enter 'RESTORE FROM SOTERDIR'. Subsequently, change the D_*DIR variable(s) to the appropriate path(s) and SAVE the memory variables again TO SOTERDIR. Repeat these steps for memory file DEFAULT.PRJ (but now include the file extension, .PRJ). Otherwise SOTER will not be able to find any of your data files.
NB. Do not forget to terminate every data path with a backslash ('\')!

C:\SOTER94\PROJECTS — A project is a designated combination of a data directory, a backup directory and a reports directory. The names (i.e. paths) of these directories are stored in a project file, the project files are kept in the PROJECTS directory. After installation, this directory will contain one project file; DEFAULT.PRJ.

1.3 dBASE configuration

1.3.1 Memory requirements

The SOTER94 application (the latest version of the SOTER data management system) requires additional memory. After installation of dBase IV (version 1.5 or higher) run the "dbsetup utility". In dbsetup select the "Memory" pulldown menu and change the value for "Rtblksize" from 50 to 100. Subsequently save the "config.db" configuration file. Not doing so might cause an "Exceeded maximum number of runtime symbols" error message.

1.3.2 Language driver compatibility

If you are using dBase IV version 2.0 or higher, use dbsetup to turn **Ldcheck** (verification of language driver compatibility) **off**. You can find Ldcheck in the "General" pull-down menu.
dBASE IV uses different language drivers to support different DOS code pages (character sets) and language requirements. If you try to open a dBASE file created with a different language driver, dBASE displays a message and prompts you for an action. SET LDCHECK OFF suppresses this language driver_ID checking functionality.

1.3.3 Hardware and software requirements

Running SOTER requires the installation of dBASE IV version 1.5 or higher[2] on your computer.
dBASE IV version 1.5 runs on the IBM PC, PC XT and Personal Computer AT; PS/2 models 30, 50, 60 and 80; Compaq Deskpro 286 and 386; or other 100% compatible computers. It runs with PC-DOS or MS-DOS version 2.1 through 3.3x, PC-DOS and MS-DOS version 4.01, MS-DOS version 5.0 and Compaq DOS version 3.3x. A hard disk with at least 4MB free is required to install dBASE IV version 1.5. You will need 640K of installed RAM with at least 450K available at runtime.
To use dBASE IV version 2.0 you will need an IBM or IBM-compatible, protected mode 286, 386, or 486 computer; 2 MB RAM; at least 4.5MB hard disk space to install the dBASE IV system files, and an additional 2MB hard disk space during installation; PC-DOS or MS-DOS 3.3x, 4.01, 5.0 or 6.0.
The SOTER system files require approximately 1MB of hard disk space. Hardcopy output of SOTER reports will require the availability of a (matrix or laser) printer.

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[2] Versions higher than 1.5 require (protected mode) extended memory. Thus, you will need a micro computer with at least a 80286 processor.

2 SOTER database structure

2.1 Introduction

When mapping spatial phenomena, two basic types of data can be distinguished:

1) **Geometric data**, i.e. the location and extent of an object represented by a point, line or surface, and topology (shapes, neighbours and hierarchy of delineations), and
2) **Attribute data**, i.e. characteristics of the object.

Both types of data are present in the SOTER database. Soils and terrain information consists of a geometric component indicating the location and topology of SOTER units, and of an attribute part describing the non-spatial SOTER unit characteristics. The geometry information is stored in that part of the database that is handled by a Geographic Information System (GIS), while the attribute data is stored in a separate set of data files, manipulated by a Relational Database Management System (RDBMS). This type of computerized record-keeping system offers one of the most effective and flexible tools for the storage and management of non-spatial SOTER attribute data (Pulles, 1988).

In a relational database each data file, or table, contains only one record type representing instances of a specific object, e.g. a SOTER unit. In each data file the records have a unique identifier field or field combination called the **primary key**, e.g. the SOTER unit_ID. Each data file may also contain one or more **foreign keys**. A foreign key is a field or field combination in a data file whose values are required to match those of the primary key of some other data file. Foreign-to-primary-key matches represent **references** from one data file to another; they are the "glue" that holds the database together. Another way of saying this is that the foreign-to-primary-key matches represent certain **relationships** between records.
Another characteristic of a relational database is the minimalization of data redundancy; when two or more occurrences of a database object are identical, their attribute data need to be entered only once, e.g. two terrain components with identical characteristics.
Figure 1 is a schematic representation of the structure of the attribute database. The quadrangles represent the tables in the SOTER database, the lines in between them depict the relationships between the tables.

A unique label attached to related information in both the geometric and attribute database links these two types of information for each SOTER unit (see Procedures Manual, page 13).

As was mentioned in the introduction, this manual will limit itself to the non-spatial attribute part of the database, in particular to the user interface to access and manipulate these data.

2.2 The SOTER non-spatial attribute database

The attribute database consists of sets of related data files to be handled by an RDBMS. The attributes of the terrain and terrain component are either directly available or can be derived from other parameters during the compilation of the database. Only for horizon data, two types of attributes can be distinguished, depending on their importance and availability:

1) Mandatory attributes
2) Optional attributes

Many of the horizon parameters of the soil component consist of measured characteristics of which the availability varies considerably. However, there is a minimum set of soil attributes that are generally needed if any realistic interpretation of the soil component of a SOTER unit is to be expected: their presence is considered mandatory. Other soil horizon attributes are of lesser importance and there presence in the database is considered optional. Whether a horizon attribute is mandatory or optional is indicated in the chapter of the Procedures Manual describing the attributes. **It is imperative that, in order to maintain the integrity of the SOTER attribute database, a complete list of mandatory attributes is entered for each soil component. Optional attributes are accepted by the database as and when available.**

Under the SOTER system of labelling, every SOTER unit is assigned a unique 4-digit identification code. In the terrain component and soil component tables this identification code is supplemented with (1-digit) subcodes for the terrain component and soil component.

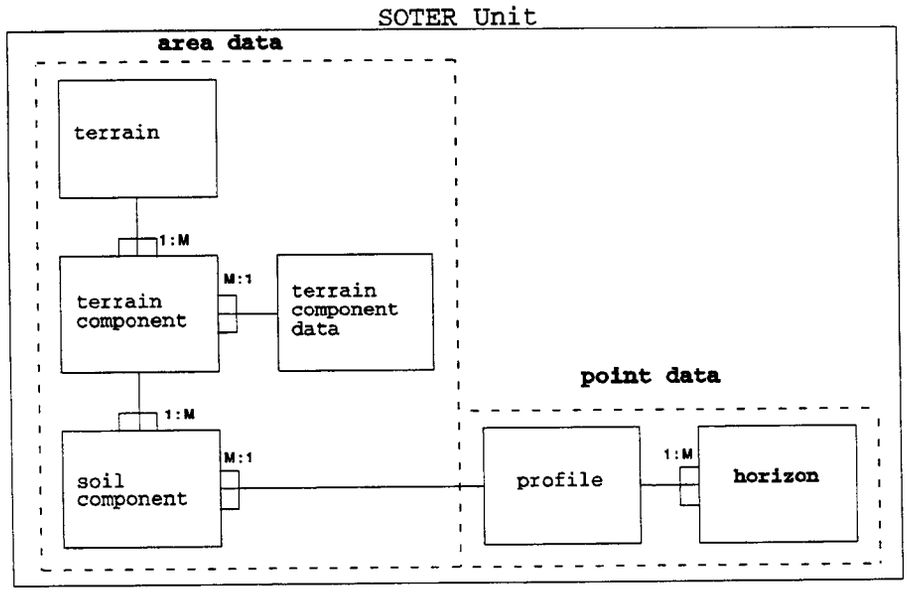


Figure 1 SOTER attribute database structure with area and point data (1:M = one to many, M:1 = many to one relations).

Where identical terrain components and soil components occur in more than one SOTER unit, a split has been made in tables holding data on the proportion resp. position of the terrain component and soil component, and in tables holding data on the characteristics of the terrain component (**terrain component data**) and of the soil component (**profile** and **horizon** data). See figure 1.

Thus, the terrain component information is divided over two tables:

1) The **terrain component table** which indicates the SOTER unit to which the terrain component belongs and the proportion it occupies within that unit

2) The **terrain component data table** which holds all specific attribute data for a terrain component

The terrain component table contains an entry for each individual terrain component within a SOTER unit, while the second table only contains entries for terrain components with a unique set of attribute values, i.e. a set of attribute values not present already in the terrain component data table.

In the same way, soil component information may be stored in more than one table:

1) The **soil component table** retains the proportion and position of each soil component within a terrain component.

2) The **profile table** retains all attribute data for the soil profile as a whole.

3) The horizon table retains data for each individual soil horizon. In order to provide for some indication of the degree of variability in horizon attribute values, three sets of attribute values can be distinguished:
    a) single values taken from the **representative profile** (either measured, or estimated)
    b) **maximum (measured) values** taken from all available profiles within the soil component
    c) **minimum (measured) values** taken from all available profiles within the soil component

As with terrain component data, only soil profiles not yet included in the database may be entered. Thus, for profile and horizon data describing soils that occur in more than one soil components, only one entry will be needed.

The horizon tables must contain all mandatory measured data. In case data is not available for some of the quantifiable attributes, SOTER will allow expert estimates to be used for attributes of the representative profile.

To indicate attribute variability within a soil component, various statistical parameters are available. Data from the Representative profile are considered modal values. However, in view of the small number of profiles generally available for the compilation of a soil component, the calculation of standard deviations and means would not be very realistic. Therefore, only maximum and minimum values of the profiles of the same soil component are included as an indication of the range of variation within a component.

All mandatory and optional attributes for the soil component, as well as all other non-spatial attributes of the SOTER units, are listed in table 1. The listing for the soil component attributes is compatible with the data set that is stored in the FAO-ISRIC Soil Database but for some additional items. Annex A shows an example of a simple SOTER database.

Table 1. Non-spatial attributes of a SOTER unit

TERRAIN		
1 SOTER unit_ID	6 slope gradient	11 dissection
2 year of data collection	7 relief intensity	12 general lithology
3 map_ID	8 major landform	13 permanent water surface
4 minimum elevation	9 regional slope	
5 maximum elevation	10 hypsometry	

TERRAIN COMPONENT	TERRAIN COMPONENT DATA	
14 SOTER unit_ID	18 terrain component data_ID	26 texture group non-consolidated parent material
15 terrain component number	19 dominant slope	27 depth to bedrock
16 proportion of SOTER unit	20 length of slope	28 surface drainage
17 terrain component data_ID	21 form of slope	29 depth to groundwater
	22 local surface form	30 frequency of flooding
	23 average height	31 duration of flooding
	24 coverage	32 start of flooding
	25 surface lithology	

SOIL COMPONENT	PROFILE	HORIZON (* = mandatory)
33 SOTER unit_ID	48 profile_ID	63 profile_ID*
34 terrain component number	49 profile database_ID	64 horizon number*
35 soil component number	50 latitude	65 diagnostic horizon*
36 proportion of SOTER unit	51 longitude	66 diagnostic property*
37 profile_ID	52 elevation	67 horizon designation
38 number of reference profiles	53 sampling date	68 lower depth*
39 position in terrain component	54 lab_ID	69 distinctness of transition
40 surface rockiness	55 drainage	70 moist colour*
41 surface stoniness	56 infiltration rate	71 dry colour
42 types of erosion/deposition	57 surface organic matter	72 grade of structure
43 area affected	58 classification FAO	73 size of structure elements
44 degree of erosion	59 classification version	74 type of structure*
45 sensitivity to capping	60 national classification	75 abundance of coarse fragments*
46 rootable depth	61 Soil Taxonomy	76 size of coarse fragments
47 relation with other soil components	62 phase	77 very coarse sand
		78 coarse sand
		79 medium sand
		80 fine sand
		81 very fine sand

82 total sand*
83 silt*
84 clay*
85 particle size class
86 bulk density*
87 moisture content at various tensions
88 hydraulic conductivity
89 infiltration rate
90 pH H_2O*
91 pH KCl
92 electrical conductivity
93 exchangeable Ca^{++}
94 exchangeable Mg^{++}
95 exchangeable Na^{+}
96 exchangeable K^{+}
97 exchangeable Al^{+++}
98 exchangeable acidity
99 CEC soil*
100 total carbonate equivalent
101 gypsum
102 total carbon*
103 total nitrogen
104 P_2O_5
105 phosphate retention
106 Fe dithionite
107 Al dithionite
108 Fe pyrophosphate
109 Al pyrophosphate
110 clay mineralogy

2.3 The Land cover database

Land cover characteristics - land use and vegetation - are stored in two separate database files:

1) Table **Land use** links land use types to SOTER units in the Terrain table, possibly for various dates;

2) Table **Vegetation** links vegetation types to SOTER units in the Terrain table, possibly for various dates.

In contrast to the more stationary land characteristics in the non-spatial SOTER attribute database, land cover can be considered a changeable land feature requiring frequent updating with, and addition of, more recent data. Since obsolete land cover data is not deleted from the database, in time a historical record of land use and vegetation will develop.
Land cover data is recorded at the SOTER unit level. The SOTER unit_ID is the link between the soil/terrain data in the non-spatial SOTER attribute database and the land cover database.

2.4 The Climate database

Climate data are normally assembled at climate stations. Hence climate data are basically point observations. For that reason, climate data cannot be linked directly to surface features such as SOTER units. In most pedon databases a soil profile is associated with climate data of the (climatically) nearest climate station.

Climate data are spread over two database files, according to their nature:

1) Table **Climate station**, containing climate station particulars;

2) Table **Climate data**, containing the actual climate data (average and/or total monthly and annual values for a number of climate characteristics) from the climate stations.

A third table contains references to climate data sources:

3) Table **data source** links a climate data source to (long-term) climate observations in the Climate data table.

2.5 The Laboratory database

The tables in this part of the SOTER database convey information concerning the laboratories responsible for soil sample analysis, and the applied analysis techniques and methods:

1) Table **Laboratory** contains the identification codes and associated names of the laboratories responsible for the analysis of the soil samples taken from a specific profile.

2) Table **Laboratory method** refers to the analytical techniques and methods used by a laboratory for the assesment of a specific profile horizon attribute value.

3) Table **Analytical method** lists method codes and descriptions of all possible analysis techniques and methods used for the assesment of all possible profile horizon attribute values.

2.6 The Reference database

These tables convey information concerning the source maps used in the SOTER unit compilation process, and the regional/national institutions administering national profile databases and/or collections. This information is jointly called "reference" information.

1) Table **Source map** contains information on the type of source map, its scale, location and year of issue.

Since the geographical map boundaries are also included, a Geographical Information System (GIS) may be used to indicate the exact position or coverage of the source map within the SOTER map.

2) Table **Profile database** contains information concerning the owner, organisation, or institute responsible for the national profile database or collection comprising the reference and representative profiles that have been used as a source for SOTER profile data.

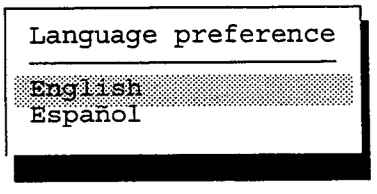
3 Using the SOTER94 Data Management System

3.1 Running SOTER94

After the (one-time) doubling of "Rtblksize", run dBASE IV. While at the dBASE dot prompt, enter "SET DIRECTORY TO C:\SOTER94[3]". Subsequently, run the SOTER data management system by entering "DO SOTER94" at the dBASE dot prompt.

You can also directly run the SOTER data management system from the operating system prompt: go to the SOTER system directory, e.g. C:\SOTER94, and enter "dbase soter94".

SOTER's first action is to save your current dBASE environment (colour settings, SET options etc.) to a memory file[4]. When you leave SOTER and return to the dBASE dot prompt, SOTER will restore your previous dBASE environment.
Next, SOTER comes up with a **Language preference** menu. All prompts, messages and captions will be displayed henceforth in the language you select from this menu. At this moment (version 1.0) two language options are available:

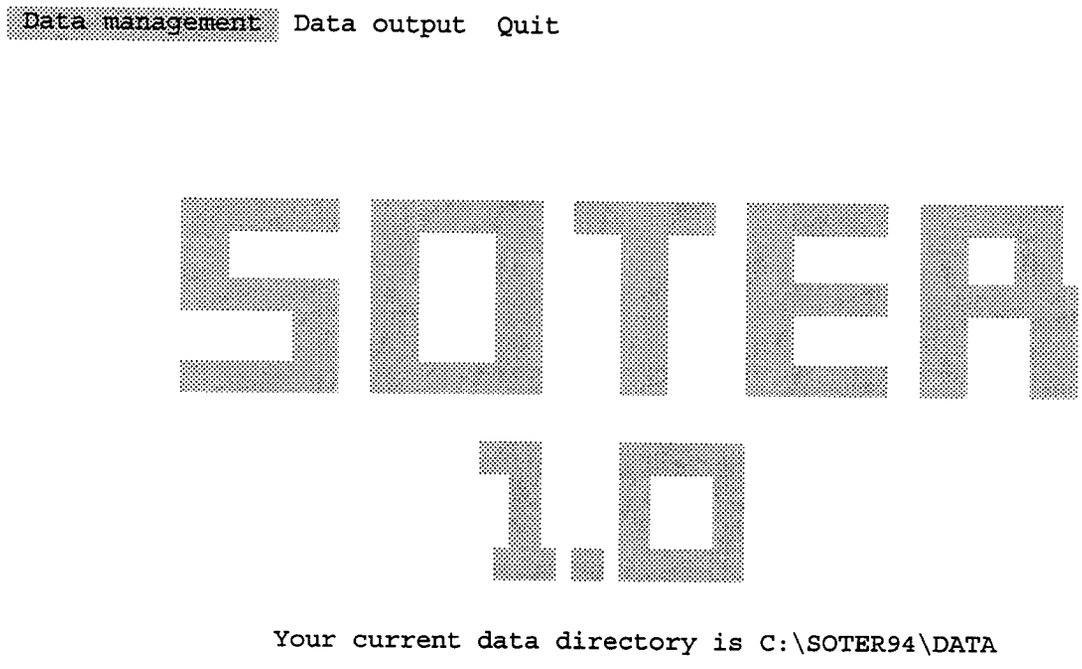


On key <**Esc**> the (default) language will be English. NB. there are a number of prompts generated by the dBASE system that are not affected by the language selected!

[3] Assuming that the system files have been installed in the default installation directory "C:\SOTER94". Otherwise enter the appropriate system directory

[4] The template for the name of this memory file is ENhhmmss.MEM, where hhmmss is a time stamp, indicating the time the file was created. For example, the name of an ENvironment file that was created around 3.15 am could be EN151532.MEM.

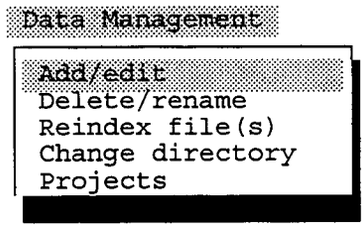
Next, the SOTER main screen will appear



At the top of the screen is a horizontal **bar menu**, similar to many spreadsheet menus, with three items: Data management, Data output, and Quit. This is the SOTER main menu through which you can access all of SOTER's facilities. You select an item from the menu bar by moving the highlight to the item and pressing <**Enter**>, or by clicking it with your mouse. On selecting one of the first two bar menu items, a pull-down menu opens. Again, an item can be selected by moving the highlight to the item and pressing <**Enter**>, or by clicking it with your mouse.
Hereafter, the main menu items and their auxiliary submenu options will be discussed in detail.

3.2 Data Management

Data management encompasses a set of tools enabling you to manipulate your data. On selection of **Data management** the following pulldown menu appears
(see next page):



Data management menu options are selected in the usual way.

3.2.1 Add/edit data

3.2.1.1 General considerations

All data are to be entered in coded form according to the latest edition of the "Global and National Soils and Terrain Digital Databases (SOTER) Procedures Manual" (ISRIC Wageningen, 1993).
Although information once entered can be edited afterwards, it will be more expedient to enter only completed SOTER data entry forms in stead of preliminary data. This will avoid intricate data editing and promote database integrity.

In SOTER, all ***coded*** non-spatial attributes are of datatype ***character***.

Missing numerical data are to be entered as -1 (minus one, for an integer data field), or as -.1 (minus point one, for a fractional data field). **BEWARE:** by default 0 (zero) will be entered in the database if no value is specified for a numerical attribute.

Entries for a number of attributes must be preceded by a valid ISO country code (e.g. climate station_ID, pedon database_ID). For the attributes in question, this requirement will be signalled on the message line of their input screen. See annex B for a list of all ISO country codes.
Horizons are sequentially numbered from top to bottom, starting with 1 (one).

Date and year entries are checked against the current year and a **base year**, i.e the date or year you want to enter must fall in the range [current year[5] - base year]. By default this base year is 1930. However, you can change the base year by editing SOTER program file "soter94.prg" (any ASCII editor will do). Go to the line that says "**base_year = 1930**" and change "1930" to a year of your liking.

Each entry of an individual case, or 'record', in one of the SOTER database tables starts with a **primary key data entry window**. Figure 2 shows the primary key data entry window for the terrain component table (next page):

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[5] Dates are checked only against the current year. Thus, it is possible to enter a date or month subsequent to the current date or month in the current year.

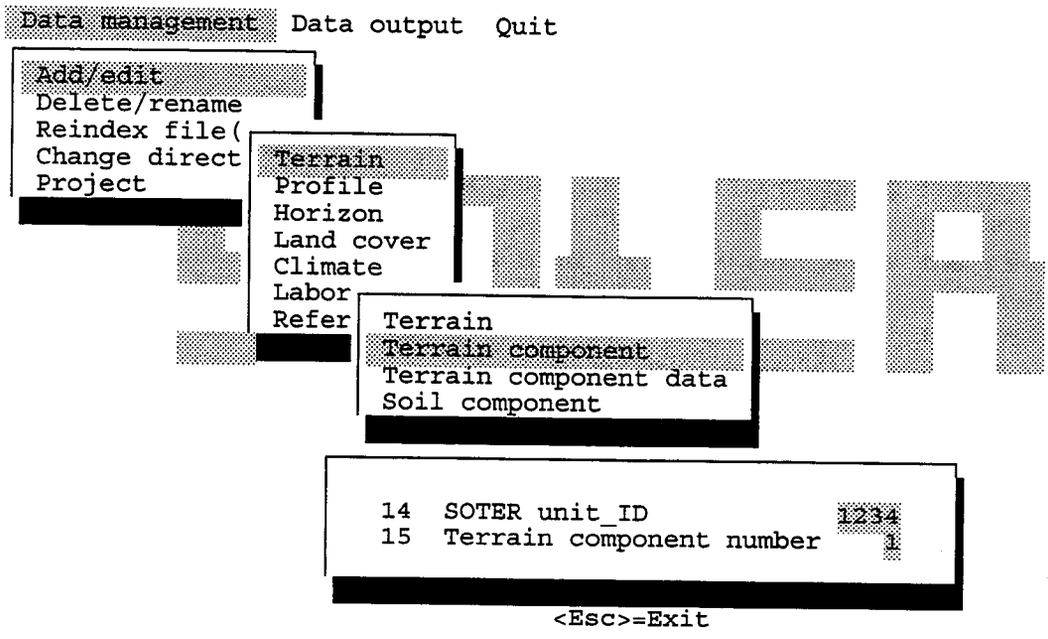
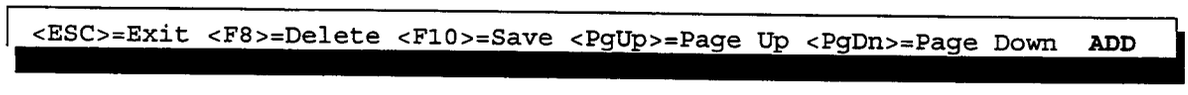


Figure 2. The primary key data entry window for the terrain component table

On the basis of the values entered, SOTER ascertains the existence of this particular case in the appropriate database table. If the case does not exist, you will be asked wether you want to **add** it to the database. Otherwise you will be asked wether you want to **edit** the case, or record. In both cases, a negative answer will return you to the File menu, a positive answer will present you with a data entry screen.

The primary key values will be repeated on the first line(s) of every data entry screen. In the top right corner of the screen, the "page" number of the current data entry screen is shown, together with the total number of data entry screens for that table.

A **status bar** at the bottom of each data entry screen displays special key actions as well as the status of the case you are working on: **EDIT** denotes an existing case, **ADD** denotes a new case not yet entered in the database table.



While entering data, function keys <F8> and <F10> can be used at any time to delete, respectively save the case in hand. Only saved cases can be deleted. When attempting to delete a case with status **ADD**, SOTER will respond with a warning. When a record with status **EDIT** is saved, SOTER asks wether to overwrite the old information or not. It is not possible to delete or change the information in one of the primary key fields. This can be accomplished only through option Delete/rename in the Data management pull-down menu.

Deleted cases will be provided with a date and time stamp, and stored in the current backup directory (see section "Change directory" for a description of the SOTER directory structure).

For most data input fields a help message and an error message - in case of erroneous input - will be displayed on the message line underneath the status bar. For all coded attributes a help screen with valid codes and their meaning can be displayed on the screen by pressing function key <F5> when the cursor is in the input field. Subsequently you can select the appropriate code from this list. SOTER will notify the user whenever this feature is available for an attribute. Figure. 3 shows an example of such a code list for attribute *Major landform.*

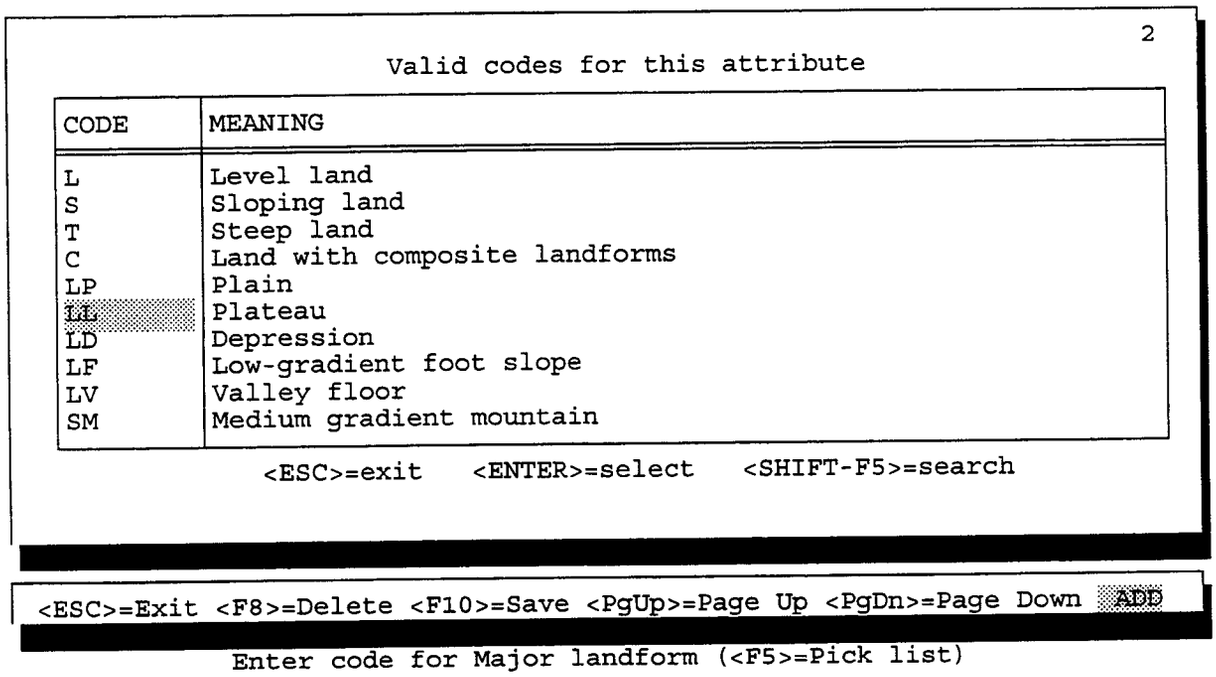
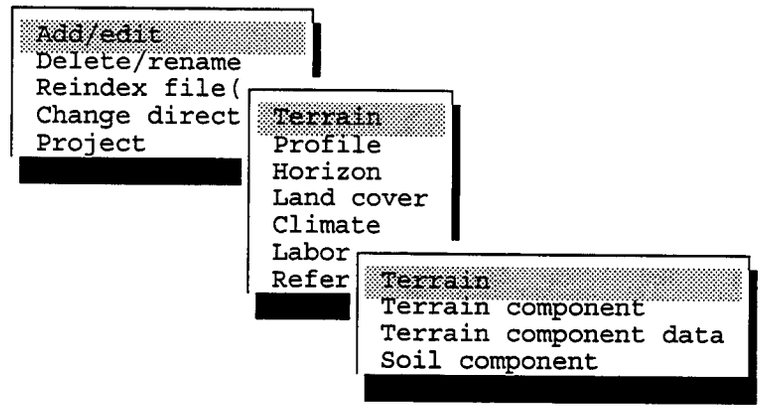
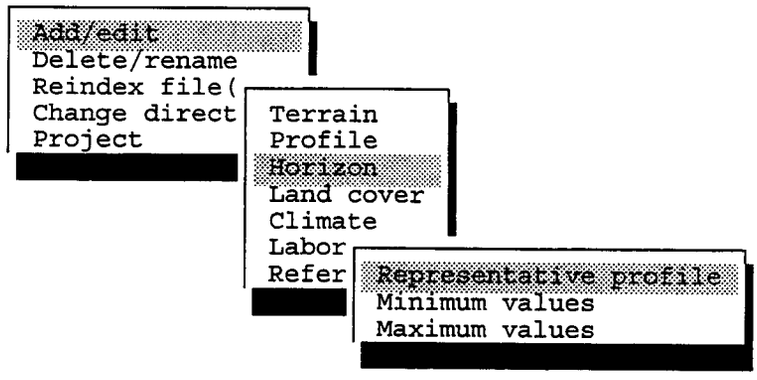


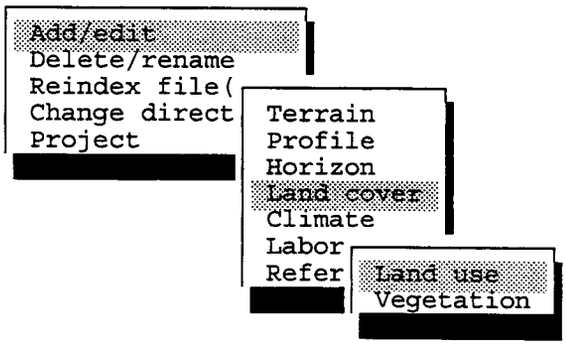
Figure 3. Help screen with valid codes listed for attribute *Major landform.*

3.2.1.2 Add or edit data

On selection of Add/edit in the Data management pull-down menu, a menu with the SOTER database divisions pops up. Selection of a division gives access to the base tables in that division. However, menu option Profile will start the add/edit procedure for database file "profile" straightaway, since it is the only base table in that division. Figures 4a and 4b display the base tables in the other database divisions.







Figures 4a. The base tables per database division.

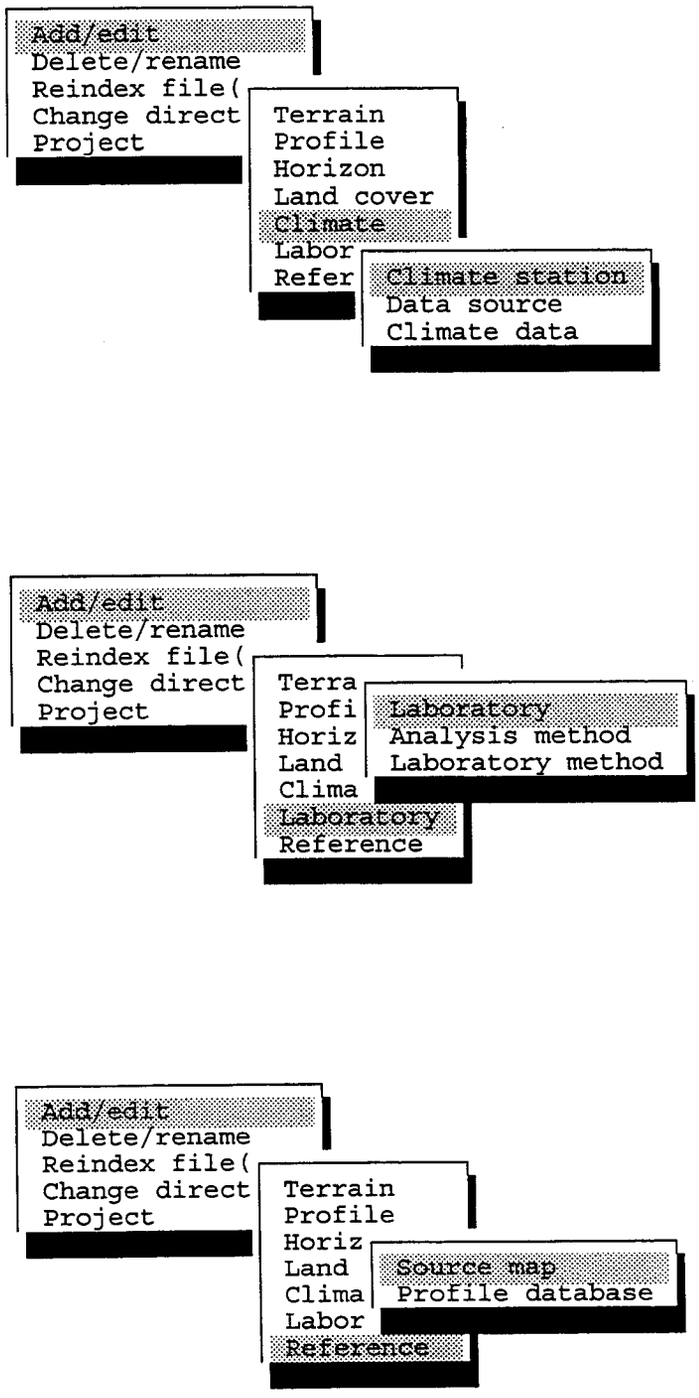


Figure 4b. The base tables per database division.

Select a database file in one of the database divisions for which you want to add or edit a case.

Next, you will be prompted for the primary key. A **primary key** is a unique identifier for each record, or case, in a database file - that is, an attribute, or combination of attributes with the property that, at any given time, no two records of the database file contain the same value for that attribute or combination of attributes. NB. Each attribute is represented by a column, or field in the database file. The primary key attributes for all SOTER database files are listed in table 2.

Database tabel	Primary key fields
Terrain	SOTER unit_ID (1)
Terrain component	SOTER unit_ID (14) Terrain component number (15)
Terrain component data	Terrain component data_ID (18)
Soil component	SOTER unit_ID (33) Terrain component number (34) Soil component number (35)
Profile	Profile_ID (48)
Horizon	Profile_ID (63) Horizon number (64)
Horizon (minimum values)	Profile_ID (63) Horizon number (64)
Horizon (maximum values)	Profile_ID (63) Horizon number (64)
Land use	SOTER unit_ID (1) Date of observation (2) Land use code (3)
Vegetation	SOTER unit_ID (1) Date of observation (2) Vegetation code (3)
Climate station	Climate station_ID (1)
Climate data source	Data source_ID (25)
Climate data	Climate station_ID (6) Kind of climate data (7)
Laboratory	Laboratory_ID (1)
Analytical method	Method of analysis_ID (7)
Laboratory method	Laboratory_ID(3) Date (4) Attribute(5)
Source map	map_ID (1)
Profile database	Soil profile database_ID (1)

Table 2: Primary key attributes for all SOTER database files.
(The numbers refer to the attribute numbers in the Procedures manual)

For example, the **terrain** database file will never contain two or more records with identical values for field "SOTER unit_ID", i.e. every record in this database file will have a unique value for field "SOTER unit_ID".
Likewise, the combination of values for fields "SOTER unit_ID", "Terrain component number", and "Soil component number" in the **Soil component** database file will be unique for every record in that database file.

After entering the required primary key values - in the Primary key data entry window - SOTER will search the selected database file for a record uniquely identified by that primary key. If found, you will be asked wether you want to edit (or delete) this record. Otherwise you will be asked to add the record to the database file with the primary key as entered. On confirmation the appropriate input cq. edit screen(s) will appear:

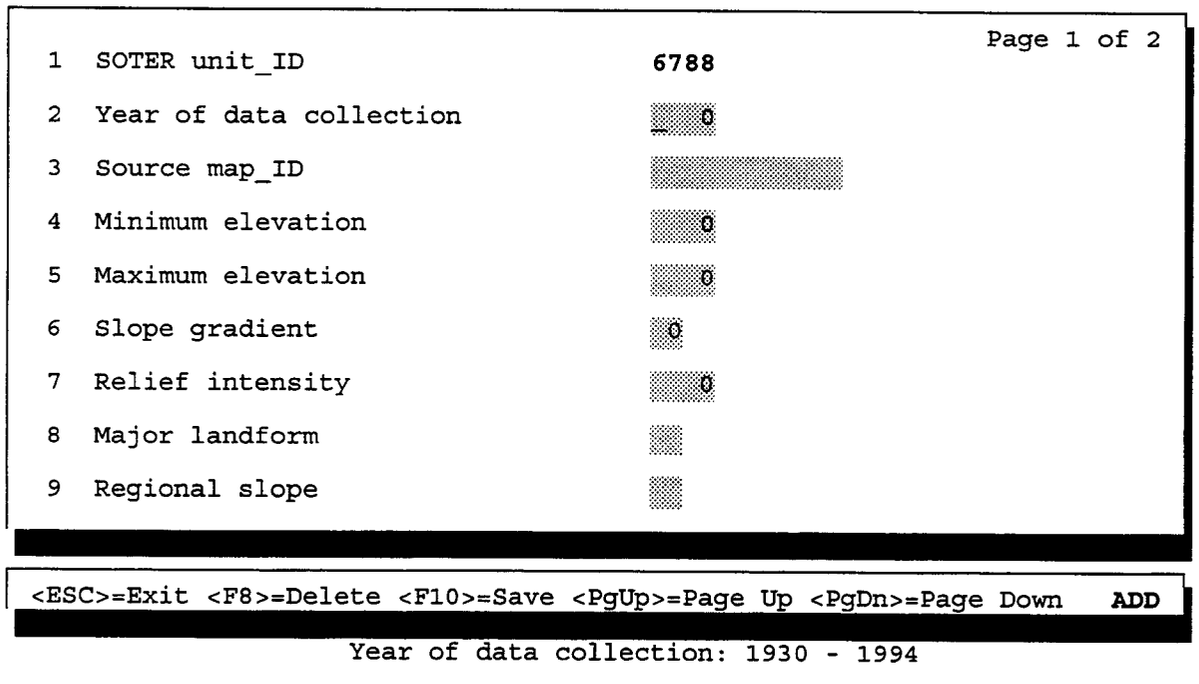


Figure 5. The first of two data entry screens ("Page 1 of 2") for Terrain data

In case of an existing record, i.e. a case with status **EDIT**, the entry screen will be filled out with the attribute values stored in that record. New cases yield an empty entry screen. You can move around in an entry screen with <tab>, <shift>-<tab>, and the cursor-keys, or with your mouse: simply klick the field you want to move to. Move to another entry scren, or "page", with <PgUp> and <PgDn>.

The entry of values for the following attributes calls for extra attention:

Terrain component data_ID
Terrain component data_ID's require leading zeros for SOTER unit_ID's less than 1000. Thus, a terrain component data_ID referring to the data for terrain component number 2 in SOTER unit 67 should be enetered as "0067/2". In other words, the SOTER unit_ID part of a Terrain component data_ID should always consist of four digits.

Date
The format for dates containing a month number is MM/YYYY. Month numbers below 10 require a leading zero. Thus, May 1978 should be entered as "05/1979". In other words, a month number should always consist of two digits.

Start of flooding
Month numbers below 10 require a leading zero, and must be separated by slashes. Thus starting months March and August should be entered as "03/08". At most three starting months can be entered, e.g. January, May and October, to be eneterd as "01/05/10".

3.2.2 How to delete or change keyfields

SOTER is a relational database system. When designing a relational system, separate data tables (i.e. database files) are created, primarily to avoid data redundancy and, to some extent, data inconsistency. However, for data from separate database files to appear in a single screen listing or printed report, the database files have to be related so as if they comprised a single set (or file). A **relation**, or **reference,** is a link between two (or more) database files on a key[6] contained in both sets. To be more precise, the relating key is an attribute, or combination of attributes, in a database file whose values are required to match those of the primary key of a second database file. Of course, both keys should be of the same type. For example, attribute *Source map_ID* relates a SOTER unit in table Terrain to a source map in table Source Map (figure 3). Attribute *Source map_ID* is a foreign key in table Terrain, but the primary key in table Source Map. This also implies that a specific source map can be associated with many SOTER units, but a SOTER unit can refer to only one source map. This is an example of a socalled **one-to-many** relationship.

[6] In relational database theory known as a "foreign" key. Refer back to page ?? for more information on the "foreign key" concept.

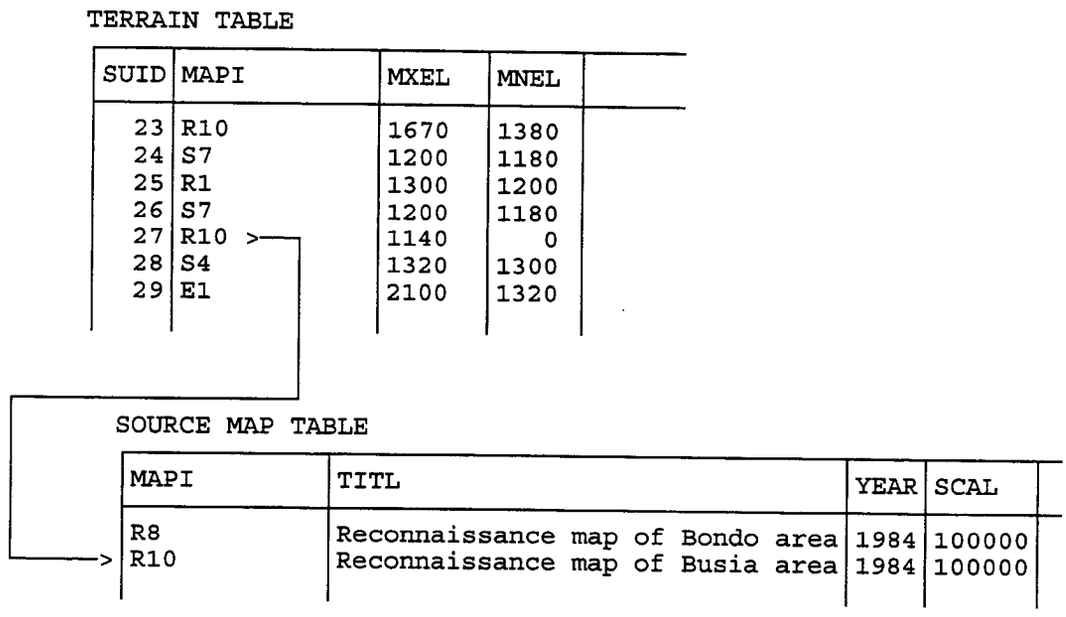


Figure 6. Attribute *Source map_ID* relates a SOTER unit in table Terrain to a source map in table Source Map.

A source map that is never referred to by a SOTER unit may be considered **redundant** and for that reason deleted from the Source map table.
However, when deleting a source map like the one with map_ID "R10", at least one SOTER unit will refer to a source map that does not exist anymore. Thus, database **integrity** will be violated. In this case all references to the deleted source map in other tables must also be removed from the database to maintain data integrity.
Of course the preceding also goes for changes made to primary keys and/or foreign keys; a foreign key in one table must always refer to a primary key in another table. Changes made to key values may endanger this condition.

The importance of the references just described takes shape in a separate menu option in the Data Management pull-down menu for the modification of primary key values, or the altogether removal of a case from the database.

On selection of Delete/rename in the Data management submenu, a menu with two options pops up: delete/rename a case (i.e. a record) in a Single file, or delete/rename also the references (i.e. the "foreign keys") to that case in All files. Either selection yields a pop-up menu with the SOTER database divisions. Selection of a division gives access to the base tables in that division. Again, with the exception of option Profile, since it is the only base table in that division. On selection of a base file, SOTER prompts you for the primary key of a case you want to modify or delete. Only then will you be asked what action should be started (figure 4). You can return to the file menu at any time by pressing **<Esc>**.

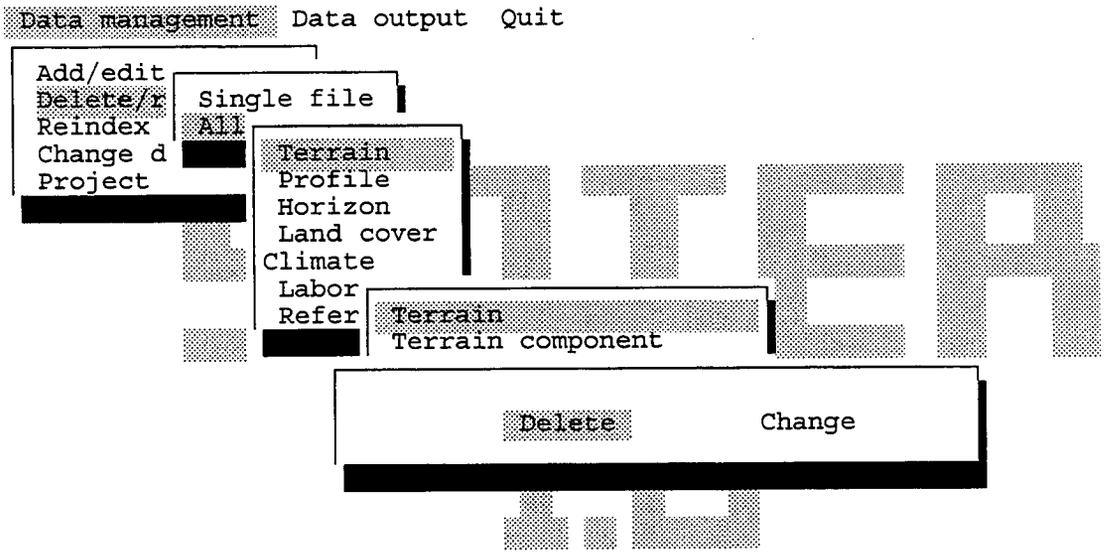


Figure 7. Delete (or change the primary key of) a SOTER unit. Also delete (or change) all references to this SOTER unit in the database.

A case that has been deleted from a base table is relocated in the table of the same name in your current backup directory, together with a date and time stamp. If All files was selected, those cases in other base tables with a primary key value comprising the primary key value of the deleted case will also be deleted and relocated in the current backup directory. Thus, deleting e.g. a SOTER unit with identification code 501 will entail the removal of all cases in other database files with a primary key containing that particular SOTER unit_ID, i.e. all soil and terrain components, and land use and vegetation records with a SOTER unit_ID of 501. All other references to this SOTER unit will be blanked, since there is no point in referring to a database object that does not exist. In case you had selected Change, all references in both primary and foreign key would be replaced by the new value.

Though the All files option takes the selected action longer to execute, it should be preferred over the Single file option, since it will not violate database integrity as can be the case with this last option.

3.2.3 Reindexing

You enter data into a database file in **natural order** - the order in which the data are received by the database file. However, you usually want to work with the data in alphabetical, numeric or date order. An **index**[7] controls the order in which data appears. Moreover, it will help SOTER to conduct more efficient data searches, and relate database files. An index is a special kind of stored file. To be specific, it is a file in which each entry (i.e. data record) consists of a key expression of one or more attributes, plus a pointer to the corresponding record in the database file that has been indexed (see fig. 8).

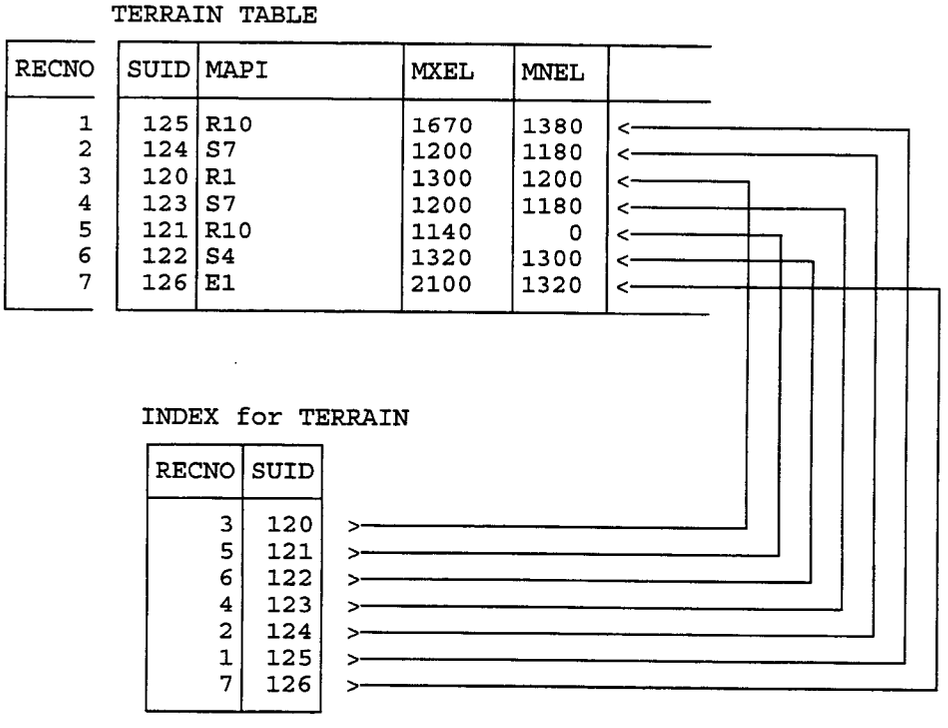


Figure 8. An index for table Terrain on key expression *SOTER unit_ID*. Recno acts as a pointer to the corresponding record in the database file.

All database files are indexed on one or more fields. Improper use of the database files or a system failure may corrupt your indexes. The results of data management and output operations are then most likely to be incorrect. Reindexing will restore your index files. You can reindex one particular database file, or reindex all database files.

[7] It is called an index by analogy with a conventional book index, which also consists of entries containing "pointers" (i.e. page numbers) to facilitate the retrieval of information from an "indexed" file (i.e. the body of the book).

On selection of Reindex file(s) in the Data management submenu, a menu with two options pops up: reindex a single database file, or reindex all database files. On selection of Single file the SOTER database divisions menu will pop up. Select a base table in one of the divisions. On selection of All files SOTER will reindex all pedon database files in succession.
While reindexing a database file the name of the database file is displayed on the screen (figure 9).

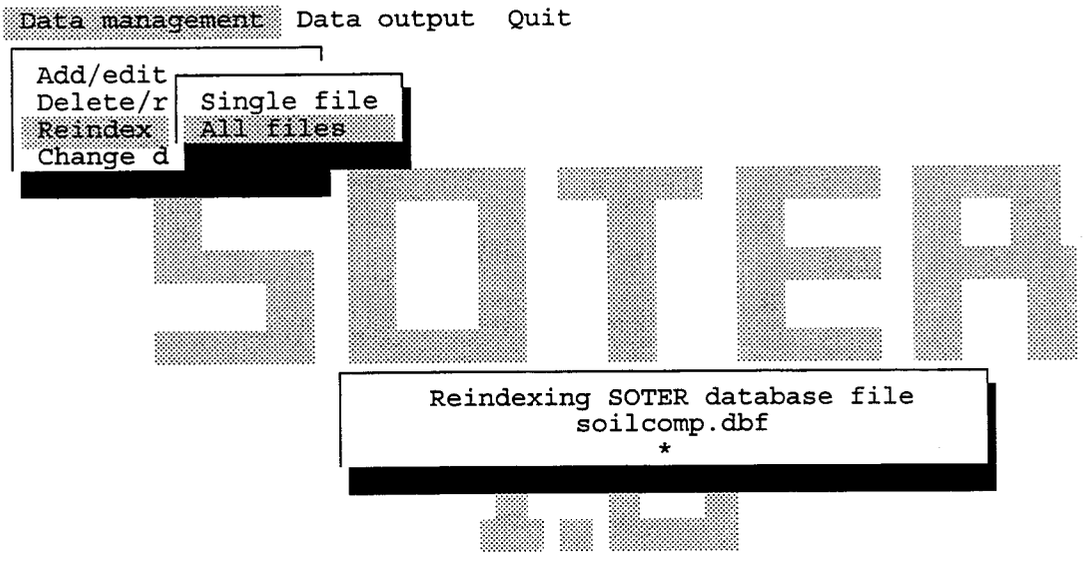


Figure 9. While reindexing a database file, SOTER displays its name on the screen

CAUTION: When adding records manually (i.e. directly in dBASE) to a database file, unicity of the primary key - the identifier for each record in the database file - can no longer be guaranteed. That is, the database file nay contain more than one record with the same key value(s). After reindexing, SOTER will recognise only the first occurrence of records with the same key in a database file.

3.2.4. Change directory

By default the installation program ("installa/b") will create, among others, the following directories under the root directory of your hard disk:

SOTER94: this directory will contain all program files, key files, language modules, and memory files of the SOTER94 data management system. It will be referred to as the **system directory**.

SOTER94\DATA: this directory will contain all your SOTER data files and their associated indexes. Subsequently it will be referred to as the **data directory**.

SOTER94\DELETED: this directory will contain all your discarded data, i.e. the data that has been deleted from your data files. Subsequently it will be referred to as the **backup directory**.

SOTER94\REPORTS: This directory will contain all output disk files, that are generated by SOTER (to be implemented).

While employing the SOTER94 data management system the current working directory will be the system directory. This will ensure the data management system will always find the required program files, key files, language modules, and memory files. For the same reason the aforementioned (system) files should be kept together in one and the same directory.

By default the SOTER data files are stored in subdirectory DATA of the SOTER94 system directory. However, separate sets of SOTER data files can be created and stored in other directories thus allowing the user to work on more than one SOTER project. Refer to the next paragraph to create or select a new project. Data Management menu option Change directory allows you to switch data directories. However, **the reports and backup directories will remain the same.**

By default the installation program will create a subdirectory DELETED under the SOTER94 system directory. This directory will capture ("back up") all data you delete from your data files in an Add/edit or Delete/rename operation. The data files in the DELETED directory are identical to those in the DATA directory but for two extra fields:

DDATE A date field containing the date the record was deleted from a data file of the same name.

DTIME A character field containing the time the record was deleted from a data file of the same name.

Data Management menu option Change directory allows you to switch backup directories. However, **the reports and data directories will remain the same.**

All options in the Data output menu generate text files that are stored in the current Reports directory. By default the installation program will create a subdirectory REPORTS under the SOTER94 system directory.
Data Management menu option Change directory allows you to switch reports directories. However, **the backup and data directories will remain the same.**

On selection of Change directory in the Data management submenu, a menu with the aforementioned three directories pops up. Select the directory you want to switch: Data, Reports, or Backup. On selection a second popup menu will appear, displaying (in that

order) the current working directory[8], the current disk drive, and all subdirectories of the current working directory figure 10). In this case <parent> means: the parent directory of the current working directory. To switch drives, highlight the current disk drive and press <**Enter**>. To move upward in the directory tree, highlight <parent> and press <**Enter**>. To move downward in the directory tree, highlight one of the subdirectories and press <**Enter**>. Once the desired directory has been reached, highlight its name in the subdirectory list and press function key <**F2**>. Press <**Esc**> to return to the Data Management submenu without changing the directory. The current **data directory** will be displayed on the screen.

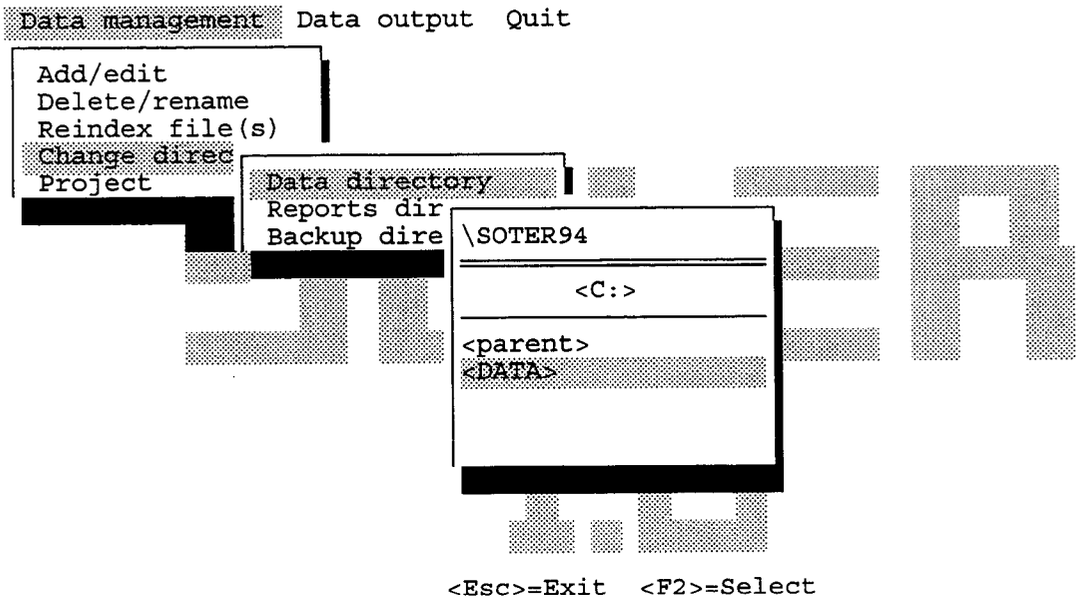


Figure 10. Change directory.

3.2.5 Projects

A **project** is nothing more than a designated combination of a data directory, a backup directory and a reports directory. The full paths of these directories, terminated by a backslash ('\'), are stored in a dBASE memory file with file name {project}.PRJ, together with the name of the project.
While changing to another Data directory will not change your Reports and Backup directories (i.e. they will remain the same), selecting another project will yield a new Data directory as well as a new Backup directory and a new Reports directory. In this way each data directory can be associated with a Backup directory and reports directory of its own, preventing deleted data or reports from different data sets (data directories) from getting tangled up in the same Backup and Reports directories.

[8] This is a single backslash ('\') in case the current working directory is the root directory.

All project files are kept in the PROJECTS directory, a subdirectory of the SOTER94 system directory. After installation, this directory will contain one project file, DEFAULT.PRJ, containing

Project name (d_project) "DEFAULT";
Data directory (d_datadir) "C:\SOTER94\DATA\"
Backup directory (d_deldir) "C:\SOTER94\DELETED\"
Reports directory (d_outdir) "C:\SOTER94\OUTDIR"

Data management option Projects allows you to create, select, or delete a project. On selection of Projects in the Data management pull-down menu a menu with these three options will pop up.

On selection of Create a dialog box will appear, asking you to enter a new project name:

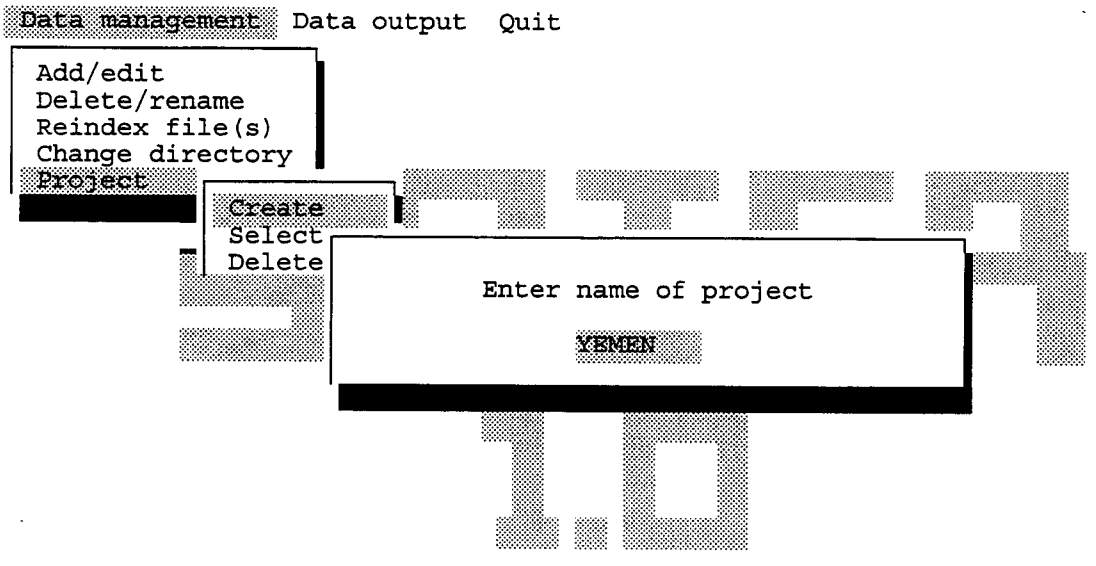


Figure 11.Dialog box to enter the name for a new project.

Do not enter the name of an existing project, nor the name of a subdirectory of the directory you intend to locate your project.
In the next step, you will be asked to select the directory you want to locate your project (figure 12);

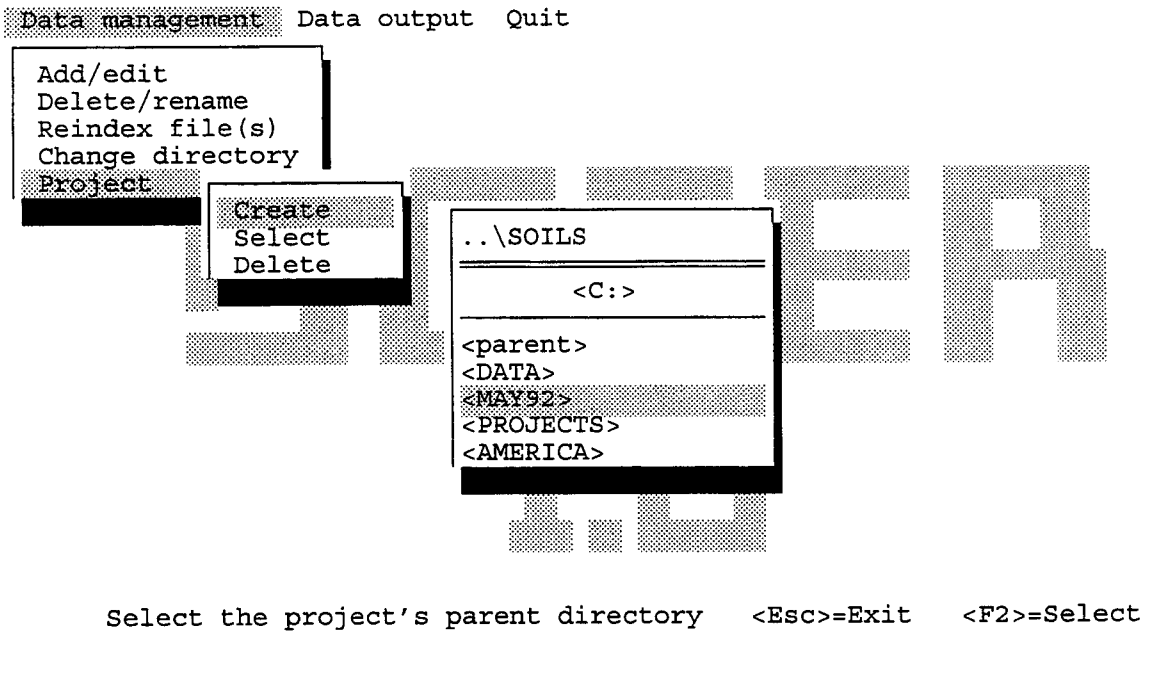


figure 12. Selection of parent directory for a project to be newly created.

Select the project's parent directory in the directory window with function key <**F2**>. Press <**Esc**> to abandon the creation of a project. Be sure the directory you select does not have a subdirctory with the name of your project, because SOTER will create this subdirectory. Under this {project} subdirectory SOTER will create another three subdirectories: DATA, DELETED, and REPORTS. Subsequently, appropriate empty data sets will be created in the DATA and DELETED subdirectories, and a project file will be created in the PROJECTS subdirectory. Your new project will be made the current project, i.e. the project you're working on.
For example, after a project with name YEMEN has been created in parent directory "C:\ASIA\ALLDATA", the situation will be as follows:

```
C:\ASIA\ALLDATA
        └── C:\ASIA\ALLDATA\YEMEN
                    ├── C:\ASIA\ALLDATA\YEMEN\DATA with
                    │                terrain.dbf
                    │                terrcomp.dbf
                    │                ...
                    ├── C:\ASIA\ALLDATA\YEMEN\DELETED with
                    │                terrain.dbf
                    │                terrcomp.dbf
                    │                ...
                    └── C:\ASIA\ALLDATA\YEMEN\REPORTS
```

Furthermore, the ..\SOTER94\PROJECTS directory will contain a project file named "YEMEN.PRJ", with the following data:

Project name (d_project) "YEMEN";
Data directory (d_datadir) "C:\ASIA\ALLDATA\YEMEN\DATA"
Backup directory (d_deldir) "C:\ASIA\ALLDATA\YEMEN\DELETED"
Reports directory (d_outdir) "C:\ASIA\ALLDATA\YEMEN\REPORTS"

Your current data directory will be "C:\ASIA\ALLDATA\YEMEN\DATA".

Both selection and removal of a project take place in basically the same way. On selection of Select or Delete the next screen will appear (figure 13)

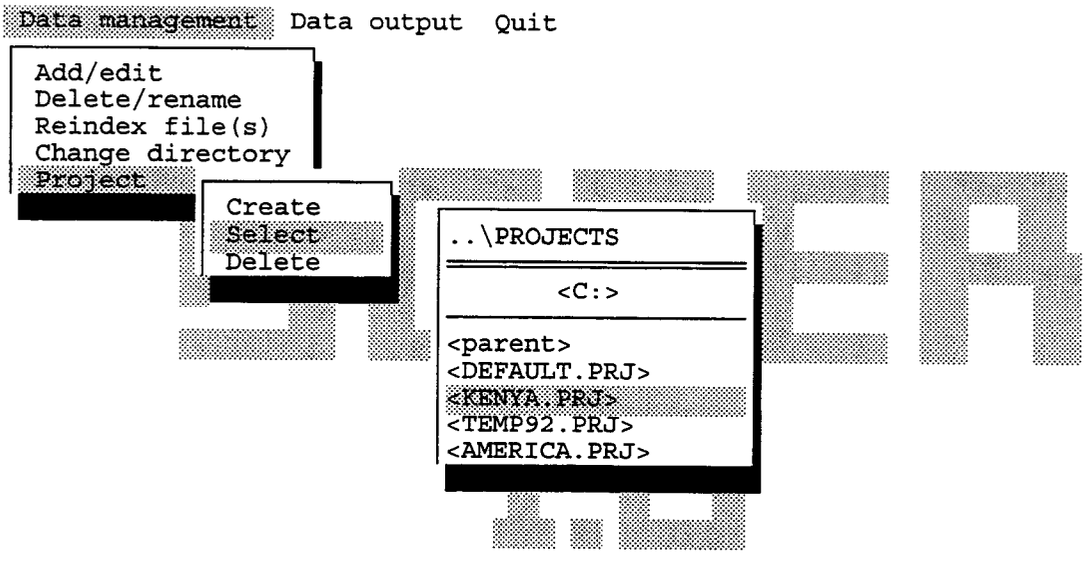


Figure 13. Select or remove an existing project from the PROJECTS directory.

Select the project (i.e. its corresponding ".PRJ" file) you want to make the current project, or that you want to remove, from the PROJECTS window by highlighting its ".PRJ" file, and pressing <**Enter**>.
In the case of project option Select your new (i.e. current) data directory will be displayed at the bottom of the screen. In the case of project option Delete, the selected project will be removed from your projects list. NB. **ONLY THE PROJECT FILE (.PRJ) WILL BE REMOVED, and none of your data or reports.**

3.3 Data output

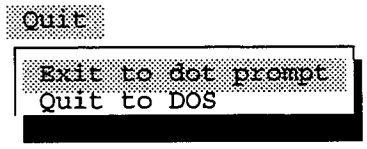
Data output not available yet.

3.4 Leaving SOTER

You can quit the SOTER data management system in two ways

- Through bar menu option Exit;
- By pressing <**Esc**>, while you are in the bar menu, and no pull down menus are open.

On selection of Exit in the bar menu at the top of the screen, the following pull-dow menu will appear (next page):



Selecting Exit to dot prompt will return you directly to the operating system, i.e. to the DOS ">" prompt. Thus, both the SOTER data management system and dBASE IV will terminate. Selecting Quit to DOS on the other hand, will return you to the dBASE dot (".") prompt. It is actually the dBASE IV RDBMS that runs your SOTER data management system; dBASE acts as a kind of "host" for SOTER. You can leave dBASE by entering "QUIT" at the dat prompt.

The second way to leave SOTER, pressing <**Esc**> while you are in the bar menu, will return you directly to the operating system.

Appendix A: example database

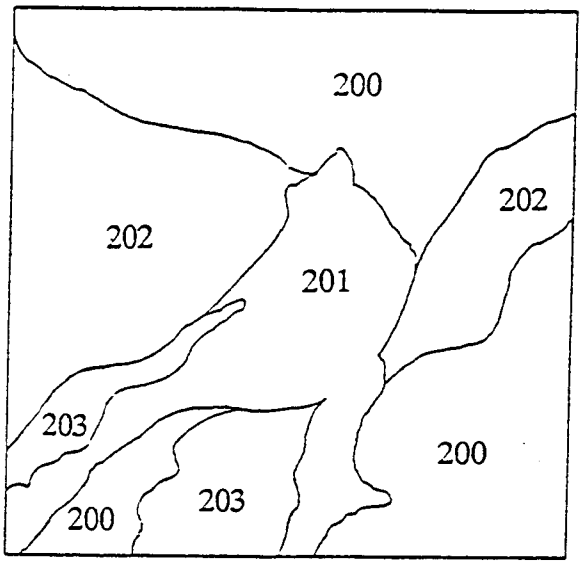


Figure 1 represents a very simple SOTER map with only four SOTER units (or, mapping units) having SOTER unit ID's 200, 201, 202 and 203.

The SOTER unit with ID 200 is the most complex of these four. It consists of four (non-mappable) terrain components. The attribute values for terrain component 4 are similar to those of terrain component 2 in SOTER unit 188. These attribute values have already been entered in table Terrain component data, thus it will be sufficient to refer to these data by means of the terrain component data code "188/2". The first two terrain components both contain two soil components. Terrain components 3 and 4 on the other hand, contain just one soil component. The SOTER unit in its entirety contains 6 distinct soils, two of which have been described previously in the database (the soils characterized by the representative profiles AC123 and AC713).

SOTER unit 201 consists of three (non-mappable) terrain components. Each terrain component contains just one soil component. Each soil has been described previously in the database. Thus it will be sufficient to refer to these by means of their representative profile ID's.

SOTER unit 202 contains just one (mappable) terrain component. The terrain component in turn, consists of three (non-mappable) distinct soil components. One soil (characterized by representative profile EC906) has been described previously in the database.

SOTER unit 203 consists of one terrain component, that is uniform in its soil characteristics, and thus, consists of merely one soil component that can be depicted on

ANNEX A (continued): example databaset

the map. Both the terrain component and the soil component have not been described previously in the database. Coverage with the soil, characterized by representative profile VI988, for SOTER unit 203 is 100%

TERRAIN

SUID
200
201
202
203

TERRAIN COMPONENT

SUID	TCID	TCDC	PROP
200	1	0200/1	40
200	2	0200/2	30
200	3	0200/3	15
200	4	0188/2	15
201	1	0201/1	60
201	2	0201/2	20
201	3	0201/3	20
202	1	0200/1	100
203	1	0203/1	100

TERRAIN COMPONENT DATA

TCDC
0188/2
0200/1
0200/2
0200/3
0201/1
0201/2
0201/3
0202/2
0203/1

SOIL COMPONENT

SUID	TCID	SCID	PROP	PRID
200	1	1	25	EC539
200	1	2	15	AC713
200	2	1	15	EC906
200	2	2	15	AC123
200	3	1	15	EC936
200	4	1	15	EC821
201	1	1	60	AC150
201	2	1	20	AC713
201	3	1	20	AC123
202	1	1	50	DL364
202	1	2	35	EC906
202	1	3	15	DL538
203	1	1	100	VI121

PRID
AC123
AC150
AC713
DL364
DL538
EC539
EC821
EC906
EC936
OB237
OB493
VI121

Appendix B: Country codes according to ISO-3166 of 1992.

AF Afghanistan
AL Albania
DZ Algeria
AS American Samoa
AD Andorra
AO Angola
AI Anguilla
AQ Antarctica
AG Antigua and Barbuda
AR Argentina
AM Armenia
AW Aruba
AU Australia
AT Austria
AZ Azerbaijan
BS Bahamas
BH Bahrain
BD Bangladesh
BB Barbados
BE Belgium
BZ Belize
BJ Benin
BT Bhutan
BO Bolivia
BW Botswana
BV Bouvet Island
BR Brazil
IO British Indian Ocean Territory
BN Brunei Darussalam
BG Bulgaria
BF Burkina Faso
BU Burma
BI Burundi
BY Belarus
CM Cameroon
CA Canada
CV Cape Verde
KY Cayman Islands
CF Central African Republic
TD Chad
CL Chile
CN China
CX Christmas Island
CC Cocos Islands
CO Colombia
CG Congo
CK Cook Islands
CR Costa Rica
HR Croatia
CU Cuba
Y Cyprus
CS Czechoslovakia
CI Côte d'Ivoire
DK Denmark
DJ Djibouti
DM Dominica
DO Dominican Republic
TP East Timor
EC Ecuador
EG Egypt
SV El Salvador
GQ Equatorial Guinea
EE Estonia
ET Ethiopia
FK Falkland Islands
FO Faroe (Islands)
FJ Fiji
FI Finland
FR France
GF French Guiana
PF French Polynesia
TF French Southern Territories
GA Gabon
GM Gambia
GE Georgia
DE Germany, Fed. Rep. of
GH Ghana
GI Gibraltar
GR Greece
GL Greenland
GD Grenada
GP Guadeloupe
GU Guam
GT Guatemala
GN Guinea
GW Guinea-Bissau
GY Guyana
HT Haiti
HM Heard and McDonald Islands
HN Honduras
HK Hong Kong
HU Hungary
IS Iceland
IN India
ID Indonesia
IR Iran, Islamic Republic
IQ Iraq
IE Ireland
IL Israel
IT Italy
JM Jamaica
JP Japan
JO Jordan
KH Kampuchea, Democratic
KZ Kazakhstan
KE Kenya
KI Kiribati
KR Korea, Republic of
KP Korea, Dem. Peopl. Rep.
KW Kuwait
KG Kyrgystan
LA Lao, People's Democratic Rep.
LB Lebanon
LS Lesotho
LR Liberia
LY Libyan Arab Jamahiri
LI Liechtenstein
LT Lithuania
LU Luxembourg
MO Macau
MG Madagascar
MW Malawi
MY Malaysia
MV Maldives
ML Mali
MT Malta
MH Marshall Islands
MQ Martinique
MR Mauritania
MU Mauritius
MX Mexico
FM Micronesia
MD Moldova, Republic of
MC Monaco
MN Mongolia
MS Montserrat
MA Morocco
MZ Mozambique
NA Namibia
NR Nauru
NP Nepal
NL Netherlands
AN Netherlands Antilles
NT Neutral Zone
NC New Caledonia
NZ New Zealand
NI Nicaragua
NE Niger
NG Nigeria
NU Niue
NF Norfolk Island
MP Northern Mariana Islands
NO Norway
OM Oman
PK Pakistan
PW Palau
PA Panama
PG Papua New Guinea
PY Paraguay
PE Peru
PH Philippines
PN Pitcairn
PL Poland
PT Portugal
PR Puerto Rico
QA Qatar
RE Reunion
RO Romania
RU Russian Federation
RW Rwanda
LC Saint Lucia
WS Samoa
SM San Marino
ST Sao Tome and Principe
SA Saudi Arabia
SN Senegal
SC Seychelles

SL Sierra Leone
SG Singapore
SB Solomon Islands
SO Somalia
ZA South Africa
ES Spain
LK Sri Lanka
SH St. Helena
KN St. Kitts and Nevis
PM St. Pierre and Miquelon
VC St. Vincent and the Grenadines
SD Sudan
SR Suriname
SJ Svalbard and Jan Mayen
SZ Swaziland
SE Sweden
CH Switzerland
SY Syrian Arab Republic
TW Taiwan, Province China
TJ Tajikistan
TZ Tanzania, United Republic of
TH Thailand
TG Togo
TK Tokelau
TO Tonga
TT Trinidad and Tobago
TN Tunisia
TR Turkey
TM Turkmenistan
TC Turks and Caicos Islands
TV Tuvalu
SU USSR
UG Uganda
UA Ukraine
AE United Arab Emirates
GB United Kingdom
US United States
UY Uruguay
UM US. Minor Outlying Islands
UZ Uzbekistan
VU Vanuatu
VA Vatican City State
VE Venezuela
VN Viet Nam
VG Virgin Islands (U.K.)
VI Virgin Islands (U.S.)
WF Wallis and Futuna Islands
EH Western Sahara
YE Yemen
YD Yemen, Democratic
YU Yugoslavia
ZR Zaire
ZM Zambia
ZW Zimbabwe