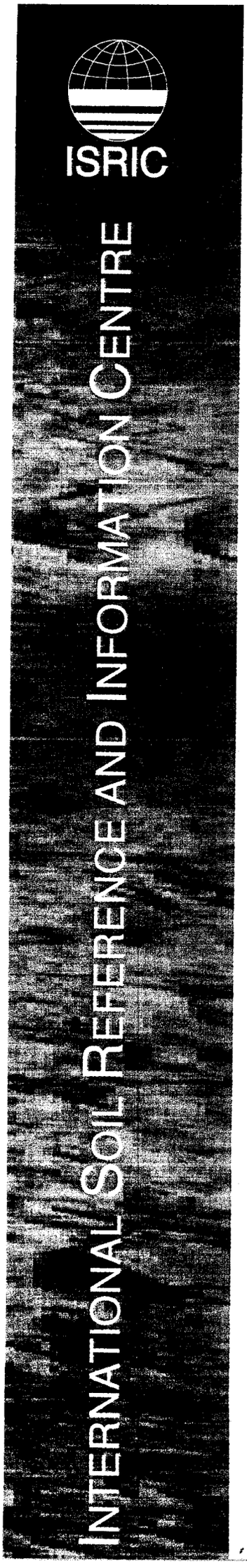

Global and National Soils and Terrain Digital Databases (SOTER) Scale 1:2,500,000

Attribute database user manual Adapted for SOVEUR

P. Tempel

UNEP

ISSS-AISS-IBG

FAO FIAT PANIS

Report 97/09

Global and National Soils and Terrain Digital Databases (SOTER) Scale 1:2,500,000

Attribute database user manual

P. Tempel

ISRIC International Soil Reference and Information Centre

UNEP United Nations Environment Programme

ISSS-AISS-IBG International Soil Science Society

United Nations Food and Agriculture Organization

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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 (world **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 manual jointly by UNEP, FAO and ISRIC (1993).

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 ILRI is aiming at the development of a salinization risk assessment using the SOTER database.

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 World Soils and Terrain Database (SOTER) at a scale of 1:1M, in cooperation with UN agencies and other international and national organizations.

About this manual

This manual describes the installation 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. The user interface is originally a dBASE application, which wqs later rewritten and compiled in CA-Clipper (5.3). Consequently, all database files are dBASE compatible, and can be imported in nearly every desktop database or spreadsheet program.
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.
This manual has been specifically adapted for the use of SOTER scale 1:2,500,000 within the framework of SOVEUR.

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 an installation program ("install.exe") that will install both the program files and the data files on your harddisk. Insert the distribution diskette into your floppy disk drive, and enter "`Install <harddisk>`" where "`<harddisk>`" is the designation for the harddisk on which SOTER should be installed. For example, to install SOTER on your "D" drive, enter "`Install d`". Next, the installation program will start copying files from the distribution diskette to the appropriate directories.

1.2 Install directory

The install program will create any directory you specified in the installation procedure, if it did not already exist. By default, the installation program will create the following directories (if they did not already exist):

C:\SOVEUR	this directory will contain the program file and all key files, memory files, and temporary files of the SOTER data management system.
C:\SOVEUR\DATA	this directory will contain all your SOTER data files and their associated indexes.
C:\SOVEUR\DELETED	this directory will contain all your discarded data, i.e. the data that has been deleted from your data files.
C:\SOVEUR\REPORTS	This directory will contain all output disk files, that are generated by SOTER.
C:\SOVEUR\PROJECTS	This directory will contain all project description files.

The installation program will issue a warning if you try to overwrite an existing copy of the SOTER data manager.

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 page 13 of the SOTER Procedures Manual, van Engelen and Wen 1993).

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 combination of a 2-character ISO country code[1] and a 4-digit sequence number. In the terrain component and soil component tables this combination, or **primary key**, is supplemented with (1-digit) subcodes for the terrain component and soil component.

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 soil component (**profile** and **horizon** data). See figure 1.

Soil component information is stored in the following three tables:

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 a soil profile that is considered representative for the soil component.

3) The horizon table retains data for each individual horizon of the representative profile. Data for this profile are considered modal values.

[1] According to ISO-3166 (1992).

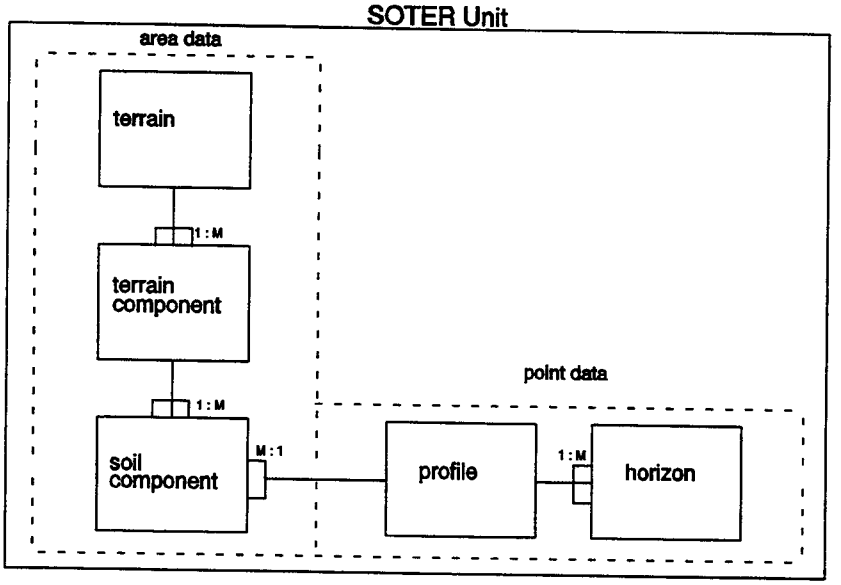


Figure 1

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

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 component, 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.

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	TERRAIN COMPONENT	
1 ISO country code	9 ISO country code	17 Surface drainage
2 SOTER unit_ID	10 SOTER unit_ID	18 Depth to groundwater
3 Year of data collection	11 Terrain component number	19 Frequency of flooding
4 Map_ID	12 Prop. of TC in SOTER unit	20 Duration of flooding
5 Major landform	13 Dominant slope	
6 Regional slope	14 Local surface form	
7 Hypsometry	15 Depth to bedrock	
8 General lithology	16 Parent material	

SOIL COMPONENT	HORIZON (* = optional)
21 ISO country code	43 Profile_ID
22 SOTER unit_ID	44 Horizon number
23 Terrain component number	45 Upper depth
24 Soil component number	46 Lower depth
25 Prop. of SC in SOTER unit	47 Diagnostic horizon
26 Profile_ID	48 Diagnostic property
27 Position in terrain component	49 Horizon designation
28 Surface rockiness	50 Moist colour
29 Surface stoniness	51 Dry colour
30 Rootable depth	52 Type of structure
	53 Abundance of coarse fragments
	54 Total sand
PROFILE	55 Silt
	56 Clay
31 Profile_ID	57 Particle size class (USDA)
32 Profile database_ID	58* pH H_2O
33 Latitude	59* pH KCl
34 Longitude	60* Electrical conductivity
35 Elevation	61* Exchangeable Ca^{2+}
36 Sampling date	62* Exchangeable Mg^{2+}
37 Lab_ID	63* Exchangeable Na^{+}
38 Drainage	64* Exchangeable K^{+}
39 Infiltration rate	65* Exchangeable Al^{3+}
40 FAO classification (1990)	66* Exchangeable acidity
41 FAO phase (1990)	67 CEC soil
42 National classification	68 Total org. carbon
	69* Total nitrogen
	70* Total carbonate equiv.
	71* Gypsum content
	72* Bulk density
	73* Soil water retention at pF1.7
	74* Soil water retention at pF2.0
	75* Soil water retention at pF2.5
	76* Soil water retention at pF3.7
	77* Soil water retention at pF4.2

Entry of all attributes listed for the Terrain Unit, Terrain Component, Soil Component, Profile and Horizon is mandatory, unless otherwise specified (*). All *primary keys* are in italics.

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 combination of ISO country code and 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 SOTER 2.5M DATA MANAGEMENT SYSTEM

3.1 Running SOTER

Start the SOTER Data Management System by entering `'SOTER'` at the DOS prompt. Briefly, the DOS/16M Tenberry Software copyright message will be displayed. Next, the SOTER main screen will appear (figure 2):

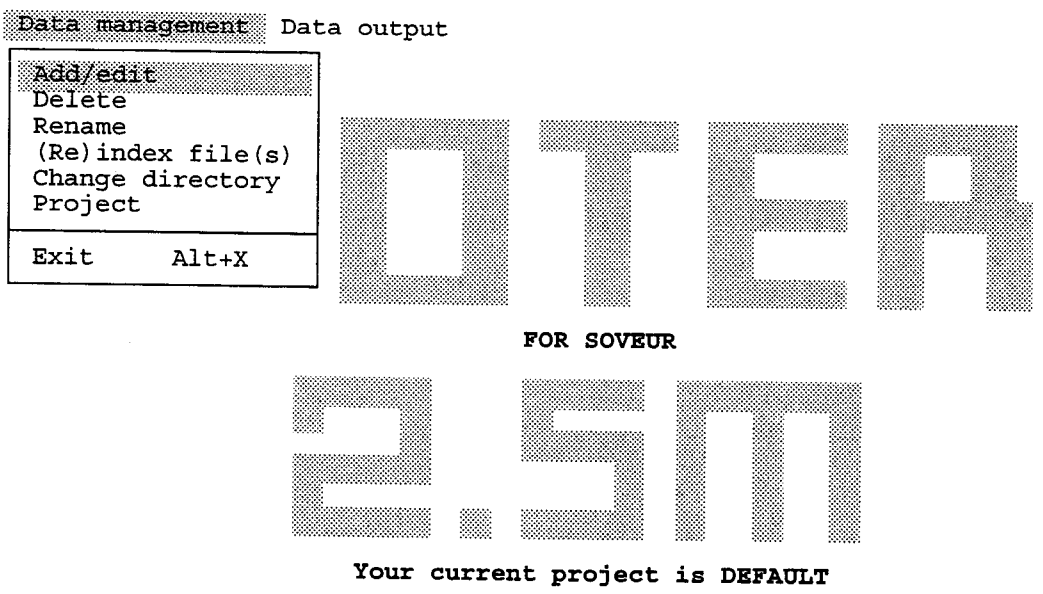


Figure 2

SOTER 2.5M main screen

At the top of the screen is a horizontal **bar menu**, similar to many spreadsheet menus, with two items: Data management and Data output. 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 the **Data management** bar menu item, 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 (figure 3):

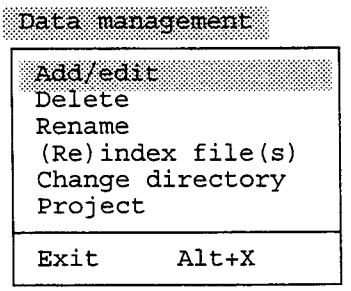


Figure 3

The **Data Management** pulldown menu

Data management menu options are selected in the usual way.

3.2.1 Add/edit data

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" (van Engelen and Wen, 1995).
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[2] - base year]. By default this base year is 1930.

Each entry of an individual case, or 'record', in one of the SOTER database tables starts with a **primary key data entry window**. Figure 4 shows the primary key data entry window for the terrain component table

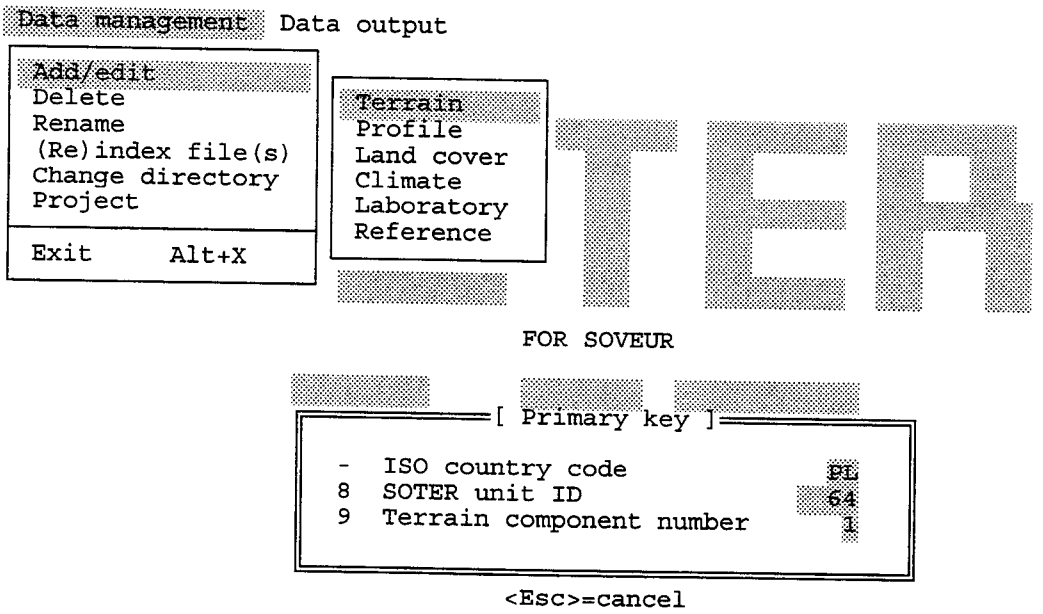


Figure 4

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.

[2] 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.

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.

```
<ESC>=Exit  <F8>=Delete  <F10>=Save  <PgUp>=Page Up  <PgDn>=Page Down  ADD
```

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 not respond. 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 project origin, and stored in the current backup directory (see section "Change directory" for a description of the SOTER directory structure).

```
                              [ Terrain ]
                                                          Page 1 of 1
 Valid codes   Description
               ╤
 C             │ Land with composite landforms
 CD            │ Major depression
 CL            │ Narrow plateau
 CV            │ Valley
 L             │ Level land
 LD            │ Depression
 LF            │ Low-gradient foot slope
 LL            │ Plateau
 LP            │ Plain
 LV            │ Valley floor
 S             │ Sloping land
 SE            │ Medium-gradient escarpment zone
 SH            │ Medium gradient hill
 SM            │ Medium gradient mountain
 SP            │ Dissected plain
<ESC>=Exit <F8>=Delete <F10>=Save <PgUp>=Page Up <PgDn>=Page Down  ADD
            Enter code for Major landform (<F5>=Pick list)
```

Figure 5

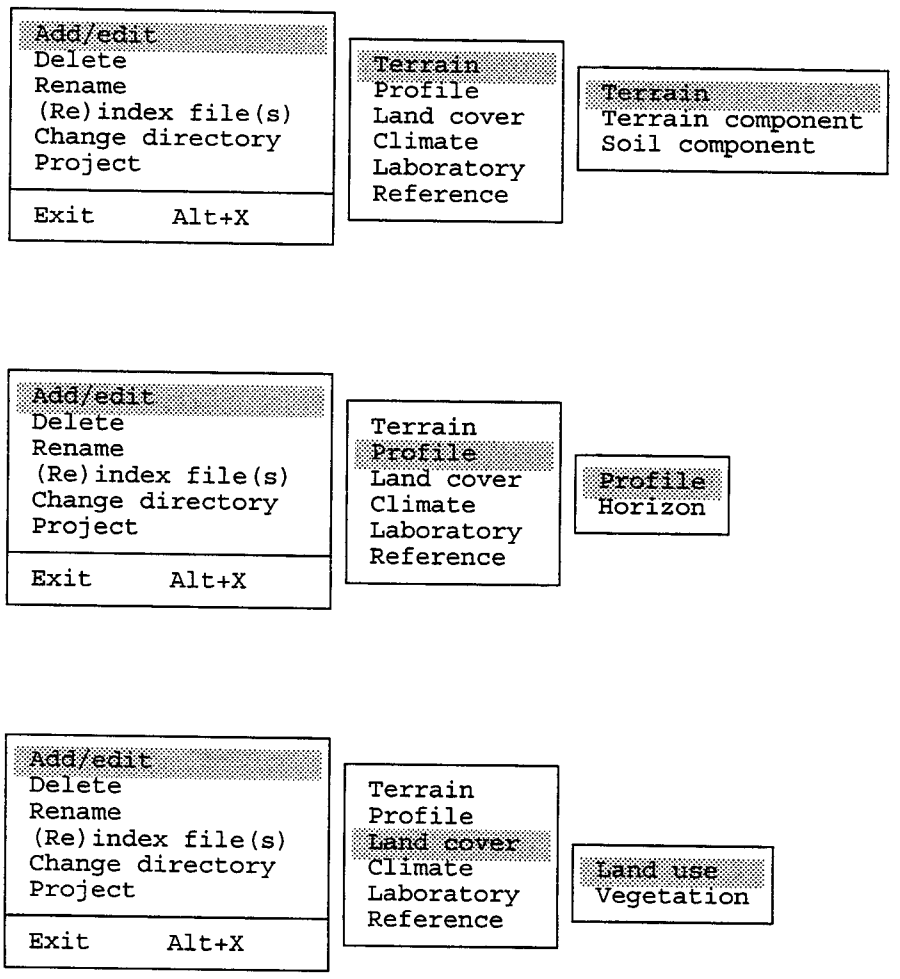
Help screen with valid codes listed for attribute *Major landform*.

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 5 shows an example of such a code list for attribute *Major landform*.

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. Figures 6a and 6b display the base tables in all database divisions.



Figures 4a.

The base tables per database division.

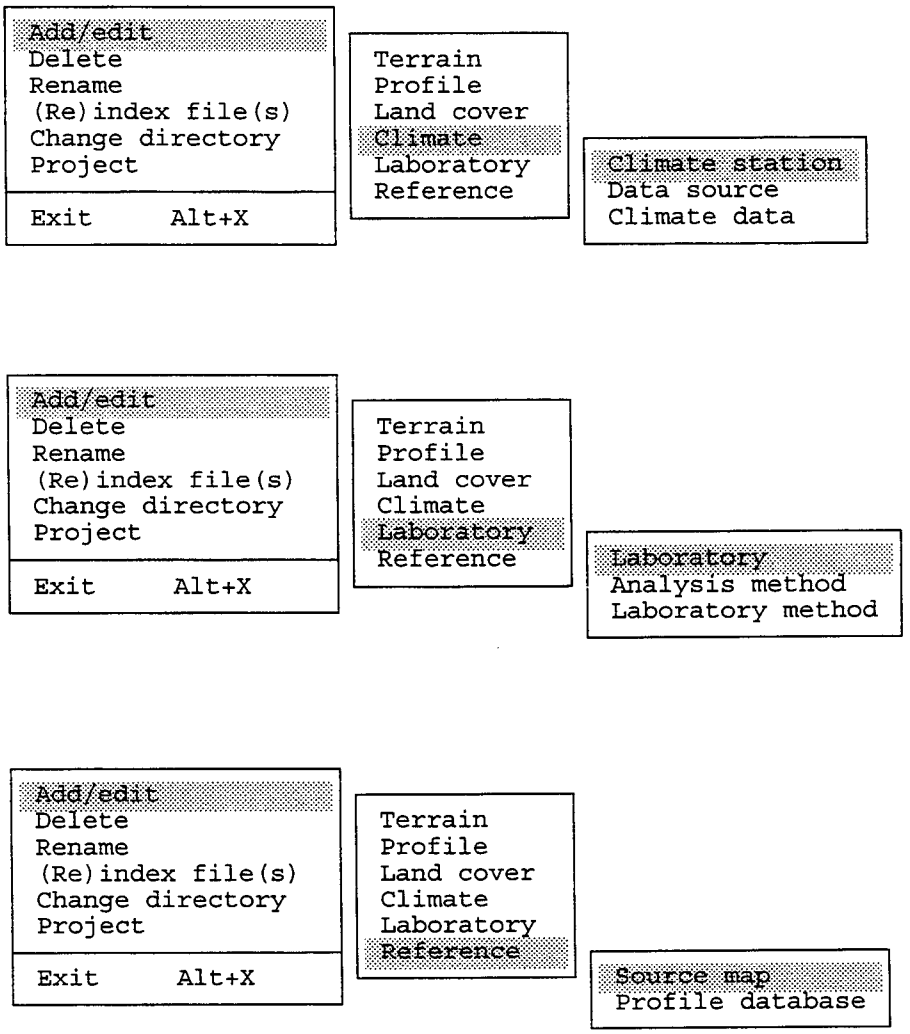


Figure 6b

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.

Table 2.

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

Database tabel	Primary key fields
Terrain	ISO country code SOTER unit_ID (1)
Terrain component	ISO country code SOTER unit_ID (14) Terrain component number (15)
Soil component	ISO country code SOTER unit_ID (33) Terrain component number (34) Soil component number (35)
Profile	Profile_ID (48)
Horizon	Profile_ID (63) Horizon number (64)
Land use	ISO country code SOTER unit_ID (1) Date of observation (2) Land use code (3)
Vegetation	ISO country code 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)

For example, the **terrain** database file will never contain two or more records with identical values for the combined fields "SOTER unit_ID" and "ISO country code", i.e. every record

in this database file will have a unique combination of values for the fields "SOTER unit_ID" and "ISO country code".
Likewise, the combination of values for fields "ISO country code", "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 7):

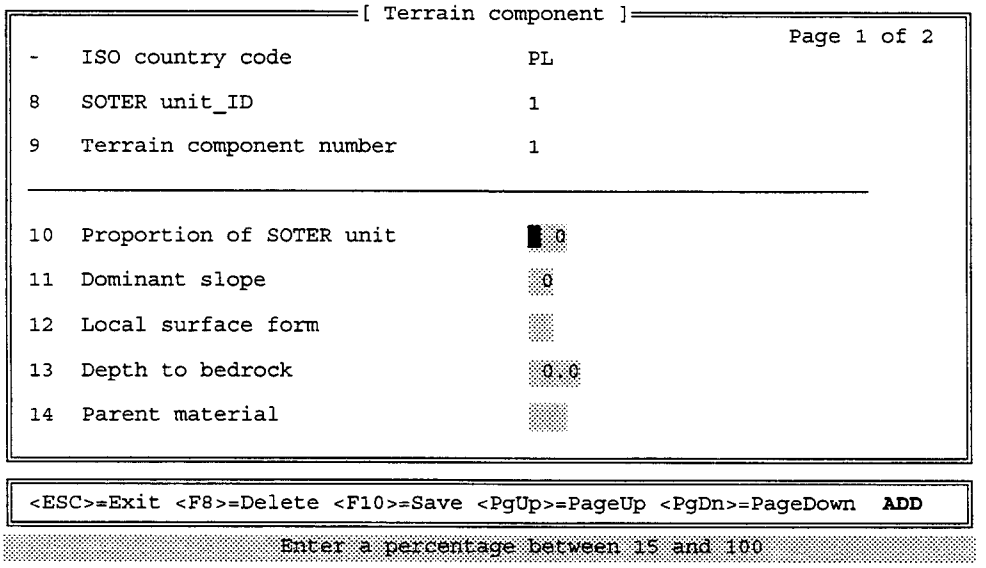


Figure 7

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 screen, or "page", with <PgUp> and <PgDn>.

The entry of values for **Date** fields calls for extra attention. 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.

3.2.2 How to delete or change key fields

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[3] 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 8). 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.

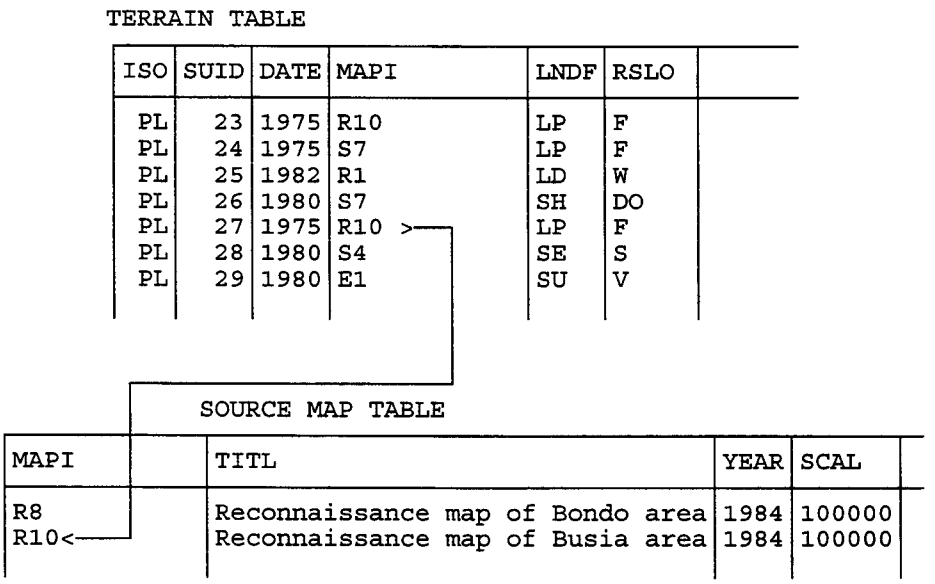


Figure 8

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

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

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 separate menu options 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 or Rename in the Data management menu, a submenu with two options pops up: delete resp. rename a case (i.e. a record) in a Single file, or delete resp. 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. On selection of a base file, SOTER prompts you for the primary key of a case you want to modify or delete.

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, and its project origin. 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 from Poland with identification code 501 will entail the removal of all Polish 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 an ISO country code of 'PL' and 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**[4] 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 (figure 9):

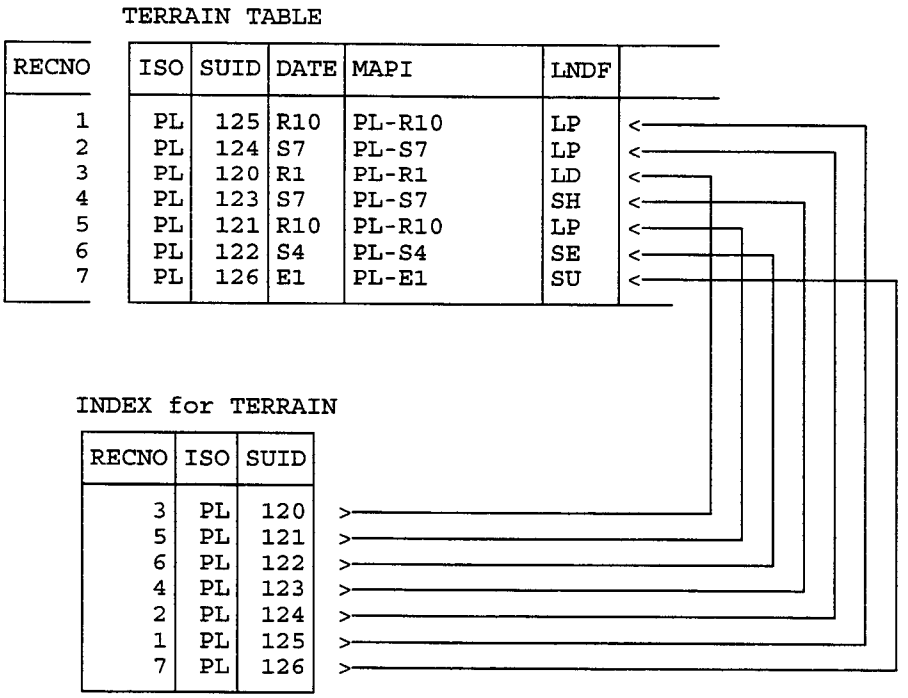


Figure 9

An index for table Terrain on key expression *ISO country code* and *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.

[4] 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 10):

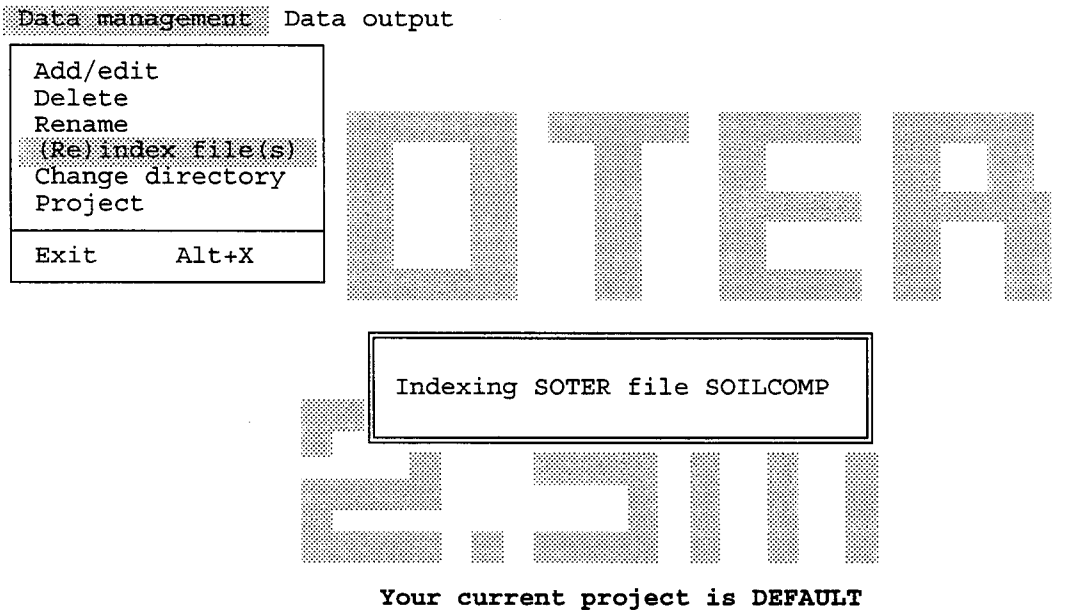


Figure 10

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

CAUTION: When adding records manually (e.g. 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 ("install <harddisk> ") will create, among others, the following directories under the root directory of your hard disk:

SOVEUR: this directory will contain the program file and all key files, memory files, and temporary files of the SOTER data management system. It will be referred to as the **system directory**.

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

SOVEUR\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**.

SOVEUR\REPORTS: This directory will contain all output disk files, that are generated by SOTER (until now only an integrity check report).

SOVEUR\PROJECTS: This directory will contain all project description files. Subsequently it will be referred to as the **projects directory**.

While employing the SOTER data management system the current working directory will be the system directory. This will ensure the data management system will always find the required key files, temporary files 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 SOVEUR 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 SOVEUR 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 three extra fields:

PROJECT	A character field containing the name of the project the record originated from, i.e. the active project that the record was deleted from.
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 will generate text files that are stored in the current Reports directory. By default the installation program will create a subdirectory REPORTS under the SOVEUR 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[5], the current disk drive, and all subdirectories of the current working directory figure 11). 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.

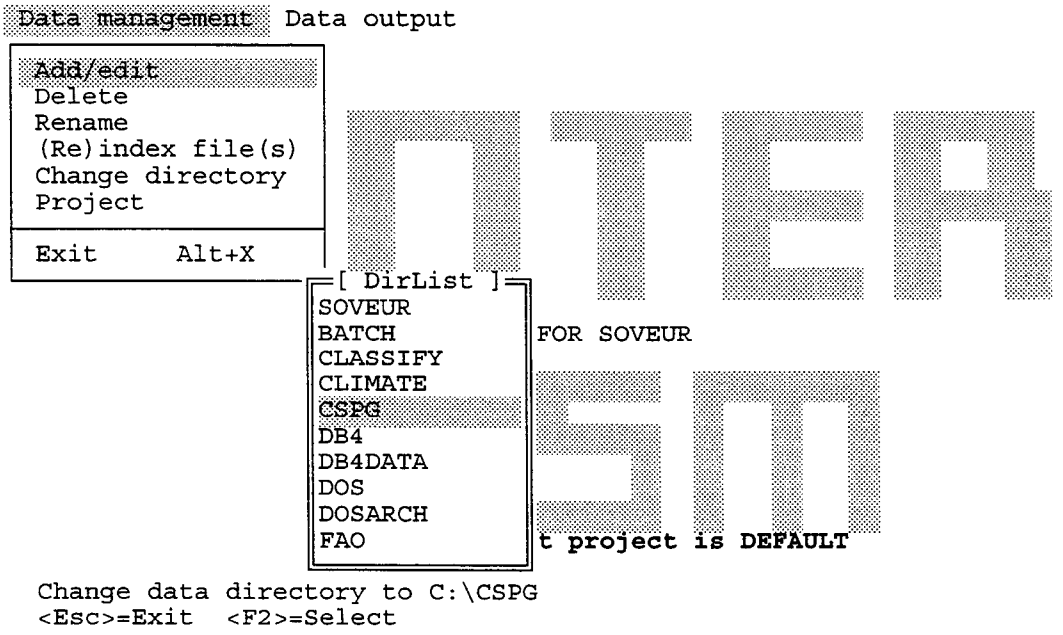


Figure 10.

Change directory.

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

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

Project name	: "csave_project = DEFAULT"
Data directory	: "csave_data = C:\<system_directory>\DATA\"
Backup directory	: "csave_deleted = C:\<system_directory>\DELETED\"
Reports directory	: "csave_reports = C:\<system_directory>\REPORTS\"

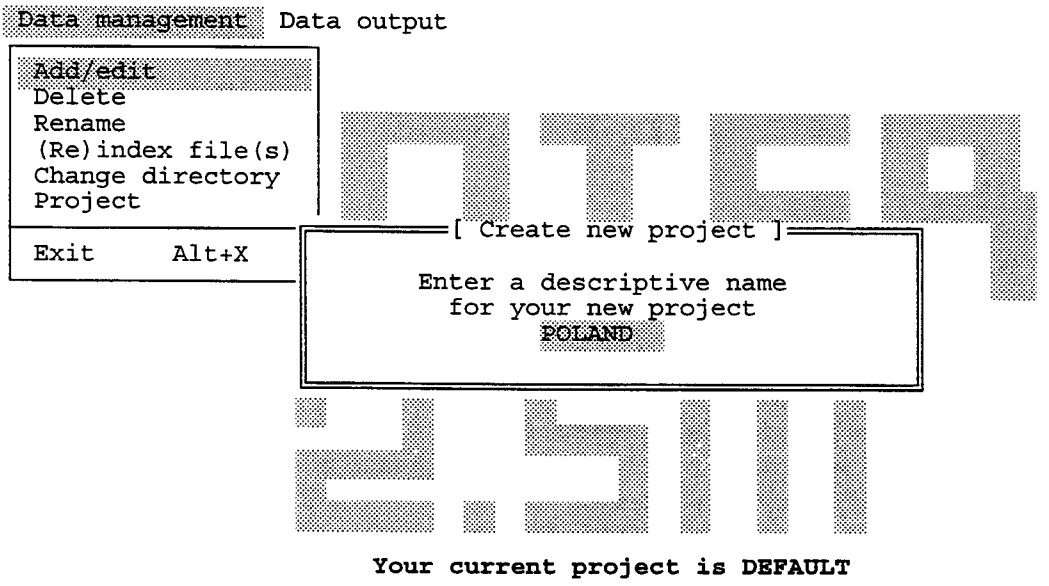


Figure 11

Dialog box to enter the name for a new project.

Data management option Projects allows you to create, select, or delete a project, or to view the project description file of your current project. On selection of Projects in the Data management pull-down menu a submenu with these four options will pop up.

On selection of Create a dialog box will appear, asking you to enter a new project name (figure 12). 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 13):

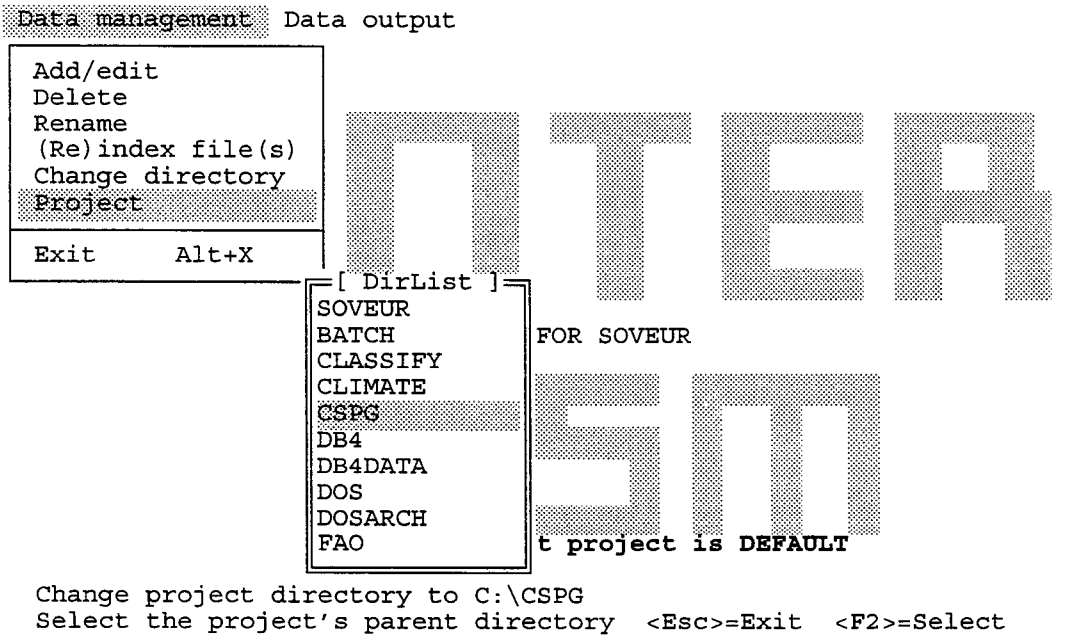


figure 13

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 subdirectory 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 **POLAND** has been created in parent directory "C:\CSPG", the situation will be as follows (figure 14):

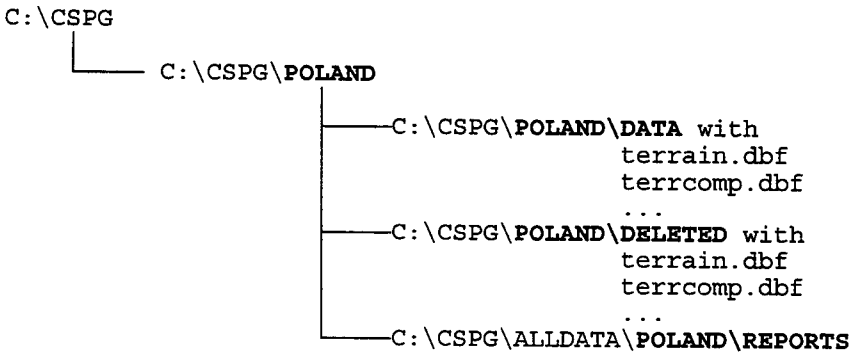


Figure 14

The directory tree for the newly created project **POLAND**

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

Project name	: "csave_project = POLAND"
Data directory	: "csave_data = C:\CSPG\POLAND\DATA"
Backup directory	: "csave_deleted = C:\CSPG\POLAND\DELETED"
Reports directory	: "csave_reports = C:\CSPG\POLAND\REPORTS"

Your current data directory will be "C:\CSPG\POLAND\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 15):

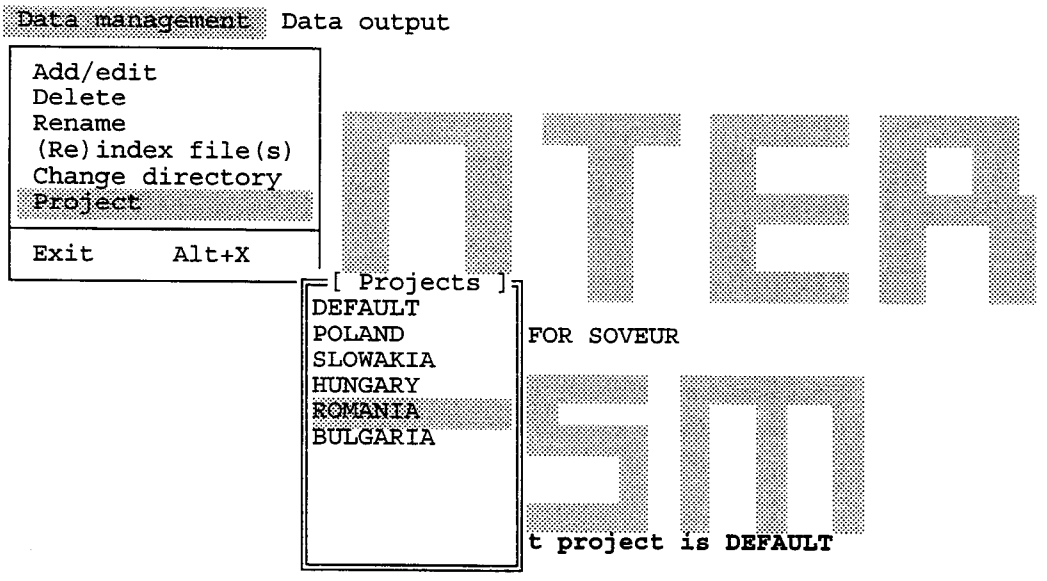


Figure 16

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 report files.**

Finally, project option Current displays the contents of the project description file of your current project (figure 16):

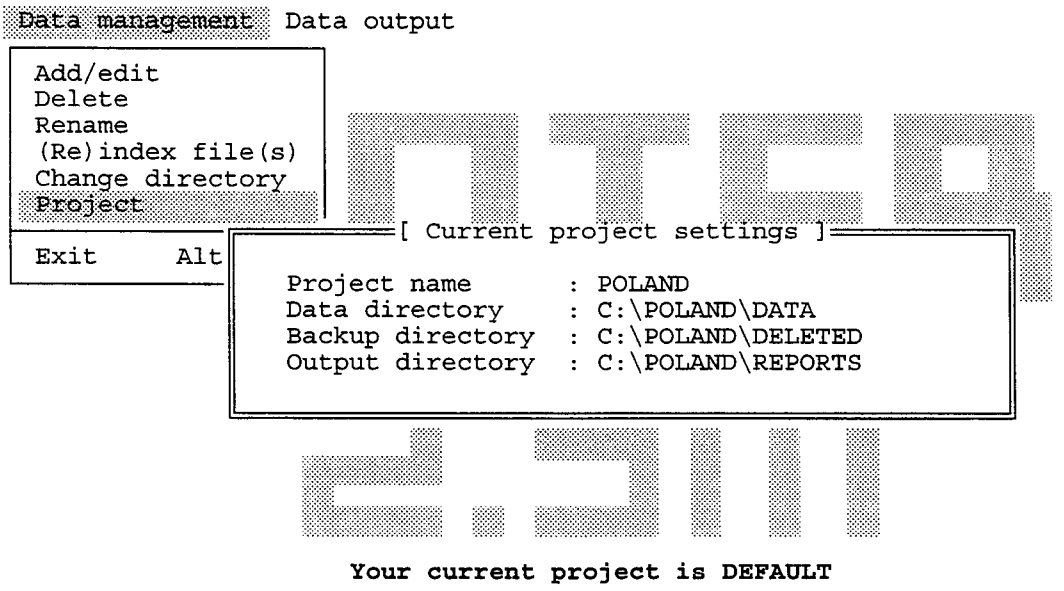


Figure 16

Message box showing the contents of the project description file
of the current (active) project

3.3 Data output

Data output encompasses a single tool: **Database integrity**. This tool generates an ASCII text file that lists the referential and data integrity of the current project (database).

Referential integrity

If a table includes a foreign key matching the primary key of another table, then every value of the foreign key in the first table must either (a) be equal to the value of the primary key

in some record of the second table or (b) be wholly null - i.e. each attribute value participating in that foreign key value must be null, or empty.
In other words, the foreign key values in a particular table must always refer to an existing intity in another table (check out paragraph 3.2.2).

Data integrity

Every field of a table should contain valid data, or be empty (null). An invalid or inadmissible entry in a field violates data integrity. The database integrity tool signals every violation of data integrity, and accordingly writes an error message to the text file.

Integrity check report

All integrity violations are written to an ASCII text file. The name of this file is 'INTEGRIT.CHK', and it is located in the REPORTS directory of your current project. Every database integrity run will overwrite the integrity check report. Rename each report for future use.

On selection of Database integrity in the Data output submenu, the SOTER data manager first reindexes the system database files[6], then every database table is successively processed. Progress is displayed by means of a gauge.

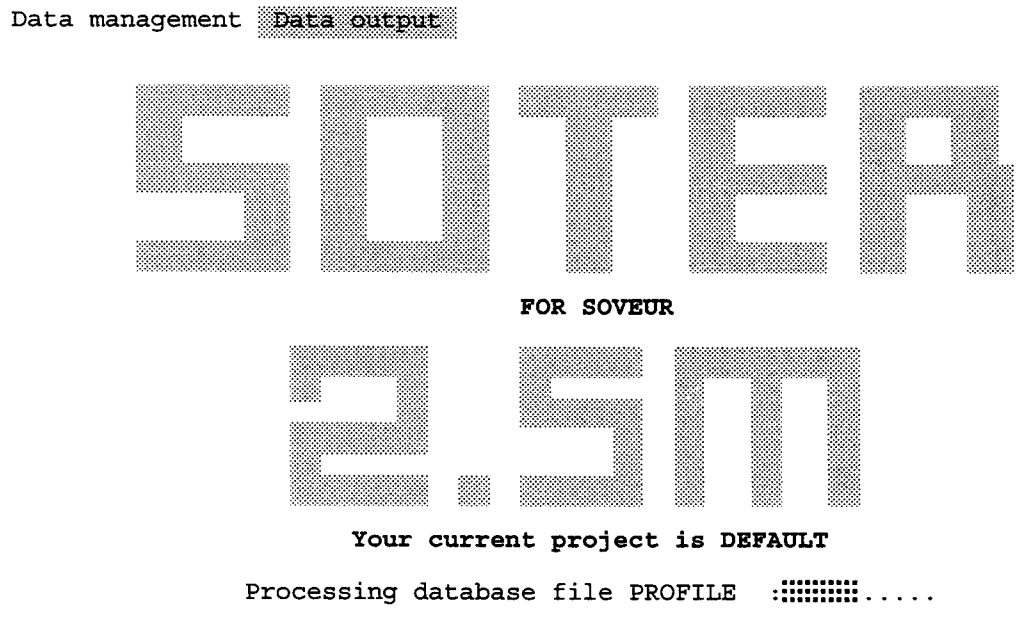


Figure 18

Checking data and referential integrity for file **PROFILE**: progress

[6] The attribute codes file **CODES_GB.DBF** and the country codes file **ISOCODE.DBF**.

3.4 Leaving SOTER

You can quit the SOTER data management system either

- through Data management menu option Exit
- by pressing keys <**Alt**> and <**X**> simultaneously. This option only works when the Data management pulldown menu is open

APPENDIX Example database

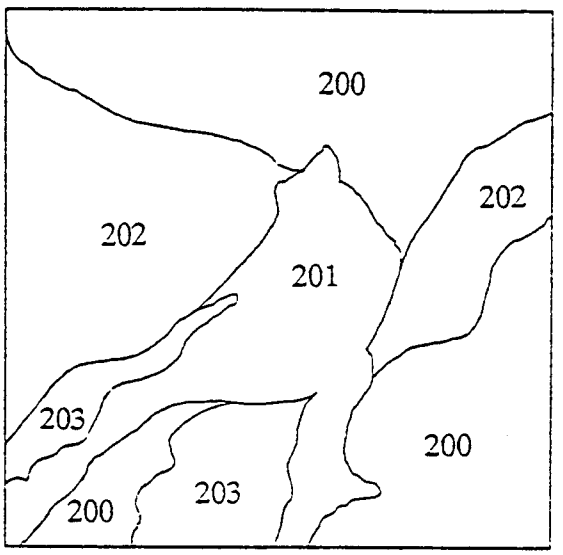


Figure 1

Part of the SOTER map of country XX

Figure 1 represents (part of) a very simple SOTER map of country XX 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 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 XXAC123 and XYAC713 - the latter from another country!).

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 XXEC906) 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 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 XXVI988, for SOTER unit 203 is 100%

TERRAIN

ISO	SUID
XX	200
XX	201
XX	202
XX	203

TERRAIN COMPONENT

ISO	SUID	TCID	PROP	MRSF
XX	200	1	40	H
XX	200	2	30	R
XX	200	3	15	T
XX	200	4	15	T
XX	201	1	60	D
XX	201	2	20	T
XX	201	3	20	R
XX	202	1	100	H
XX	203	1	100	S

SOIL COMPONENT

ISO	SUID	TCID	SCID	PROP	PRID
XX	200	1	1	25	XXEC539
XX	200	1	2	15	XXAC713
XX	200	2	1	15	XXEC906
XX	200	2	2	15	XXAC123
XX	200	3	1	15	XXEC936
XX	200	4	1	15	XXEC821
XX	201	1	1	60	XXAC150
XX	201	2	1	20	XYAC713
XX	201	3	1	20	XXAC123
XX	202	1	1	50	XXDL364
XX	202	1	2	35	XXEC906
XX	202	1	3	15	XXDL538
XX	203	1	1	100	XXVI121

PROFILE

PRID
XXAC123
XXAC150
XYAC713
XXDL364
XXDL538
XXEC539
XXEC821
XXEC906
XXEC936
XXOB237
XXOB493
XXVI121

Figure 2

The example database

APPENDIX 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
CY 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, Rep. of
KP Korea, Dem. Peopl. Rep.
KW Kuwait
KG Kyrgystan
LA Lao, People's Democratic Republic.
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

APPENDIX SOTER indexes.

Database file	Tag name	Index expr
TERRAIN.DBF	PK FK1	iso+STR(PADR(LT
TERRCOMP.DBF	PK FK1	iso+STR iso+STR
SOILCOMP.DBF	PK FK1	iso+STK(PADR(LTRIM(prid),12)
PROFILE.DBF	PK FK1 FK2	PADR(LTRIM(prid),12) PADR(LTRIM(pdid),12) PADR(LTRIM(labo),12)
REPHORIZ.DBF	PK	PADR(LTRIM(prid),12)+STR(honu,10)
LANDUSE.DBF	PK FK1	ISO+STR(suid,10)+date+PADR(LTRIM(luse),3) iso+STR(suid,10)
VEGETAT.DBF	PK FK1	ISO+STR(suid,10)+date+PADR(LTRIM(vege),5) iso+STR(suid,10)
LABNAME.DBF	PK	PADR(LTRIM(labo),5)
LABMETH.DBF	PK FK1 FK2	PADR(LTRIM(labo),5)+date+PADR(LTRIM(attr),3) PADR(LTRIM(labo),5) PADR(LTRIM(amid),5)
ANAMETH.DBF	PK	PADR(LTRIM(amid),5)
SOURCMAP.DBF	PK	PADR(LTRIM(mapi),12)
PROFILDB.DBF	PK	PADR(LTRIM(TRIM(pdid),5)
CLIMSTAT.DBF	PK	PADR(LTRIM(stid),6)
CLIMDAT.DBF	PK FK1 FK2	PADR(LTRIM(TRIM(stid),6)+kind PADR(LTRIM(TRIM(stid),6) PADR(LTRIM(TRIM(soid),6)
CLIMSOUR.DBF	PK	PADR(LTRIM(soid),6)

System data file	Tag name	Index expression
CODES_GB.DBF	PK F1	fieldname+PADR(LTRIM(alphacode),12) fieldname
ISOCODE.DBF	PK	iso