Working Paper and Preprint

94/05

Global and National

Soils and Terrain Digital Databases

(SOTER)

Database Structure

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June 1994

ATIONAL SOIL REFERENCE AND INFORMATION CENTRE

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Foreword

This paper describes the outline of a database structure for the non-spatial attribute data of SOTER, the Global and National Soils and Terrain Digital Databases.
The delineated database structure is basically system-independent, i.e. it has been developed with no particular database system in mind. The only assumption made with regard to the implementation of the database structure is the use of a relational database management system (RDBMS). An RDBMS is one of the most effective and flexible tools for storing and managing the non-spatial attributes in the SOTER database (Pulles, 1988)[1]. System development and implementation at ISRIC as envisaged with regard to the non-spatial SOTER attribute database in the near future will employ dBASE IV, versions 1.5 and higher.
The database structure as discussed in this paper is based on the attributes as listed in the SOTER manual, 5th edition (ISRIC, 1993)[2].
The following SOTER databases will be discussed in addenda to this paper

- Land cover,
- Profile source, Source map, and Laboratory data (jointly referred to as "Reference information"), and
- Climate

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Wageningen, April 1994,
Piet Tempel

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[1] Pulles, J.H.M., 1988. A model for a soils and terrain digital database. Working paper and preprint 88/8. ISRIC, Wageningen.

[2] ISRIC, 1990. Global and national soils and terrain digital databases (SOTER): procedures manual. Ed. V.W.P. van Engelen ... et al. ISRIC, Wageningen. p. 115.

Relational database concepts, a review

Data definition in this paper adheres to the basics of relational database theory. However, not all relational systems support all aspects of the relational data model, notably the concepts of primary key and domain. Therefore, these systems do not support the notion of entity integrity and referential integrity either. The user will have to find ways to enforce these rules in order to warrant data integrity. This makes a concise definition of the domain that underlies each attribute of utmost importance.

Review of some important concepts in relational database theory:

Relation; A relation on domains D1, D2, ..., Dn (not necessarily all distinct) consists of a **heading** and a **body**:

The heading consists of a fixed set of attributes A1, A2, ..., An, such that each attribute Ai corresponds to exactly one of the underlying attributes Di, with i = 1, 2, ..., n.

The body consists of a time-dependent set of tuples, where each tuple in turn consists of a set of attribute-value pairs (Ai:vi)(i = 1, 2, ..., n), one such pair for each attribute Ai in the heading. For any given attribute-value pair (Ai:vi), vi is a value from the unique domain Di that is associated with the attribute Ai.
n is the degree of the relation.

Tuple; A row, or record, in a relation;

Attribute; A column, or field in a relation;

Primary key; Unique identifier for the relation - that is, a column or combination of columns with the property that, at any given time, no two rows of the relation contain the same value in that column, or combination of columns;

Foreign key; An attribute (or attribute combination) in one relation R2 whose values are required to match those of the primary key of some relation R1 (relations R1 and R2 not necessarily distinct). Both keys should be defined on the same underlying domain.

Data value; The smallest unit of data in the relational model is an individual data type (e.g. weight % of silt particles, or CEC). Such values are considered to **atomic** that is, they are not decomposable as far as the model is concerned.

Domain[1]; A set of data values, all of the same type. Thus domains are pools of values from which one or more attributes (columns) draw their actual values. Note that, at any given time, there will typically be values included in a given domain that do not currently appear in any of the attributes that correspond to that domain. For example, the value 8 may well appear in the domain of terrain component subcodes - i.e. it is a legal subcode - but no terrain component 8 actually appears in the terrain component table.

Properties of relations, i.e. rules that relations have to adhere to:

1) There are no duplicate tuples. Thus, in a relation the primary key always exists.

2) Tuples are unordered (top to bottom). The order of the tuples (records) in a relation does not convey any information.

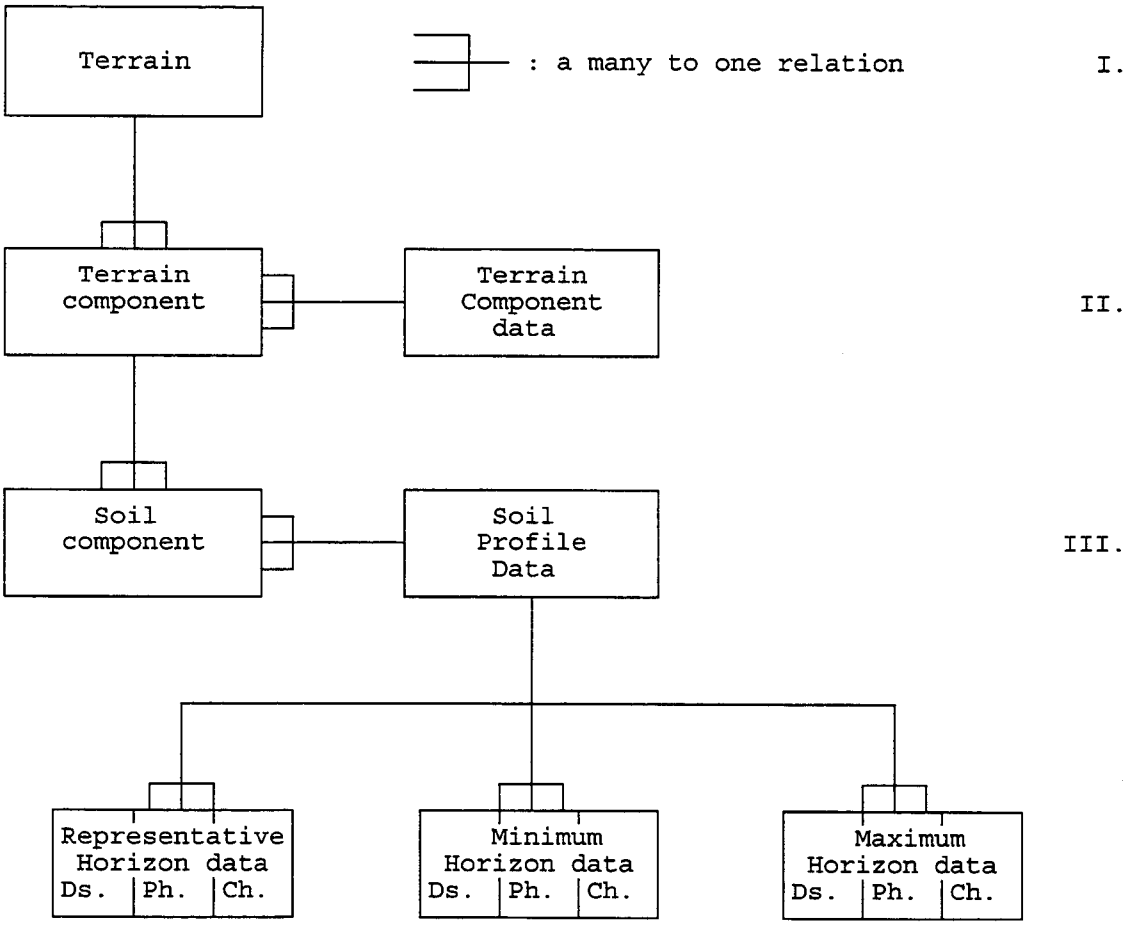
3) Attributes are unordered (left to right). The order of the attributes in a relation does not convey any information. Strictly speaking, there is no such thing as, say, the **third** attribute of a relation.

4) All simple attribute values are atomic. At every row-and-column position within the table, there always exists precisely one value, never a set of values. In other words, relations do not contain repeating groups.

[1] In relational terms actually a **simple** domain, as distinguished from **composite** domains. A composite domain is defined as the cartesian product of some collection of simple domains. For example, the composite domain DATE could be defined as the Cartesian product of the sinple domains MONTH (1, 2, ... 12), DAY (1, 2, ... 7) and YEAR (00, 01, ... 99). Any attribute defined on a composite domain would in turn be a composite attribute, with component simple attributes.

Database structure

A schematic representation of the database structure is presented in the block diagram below. All blocks in this figure represent separate relations in the non-spatial SOTER attribute database.



I Terrain unit level
II Terrain component level
III Soil component level

Ds. Descriptive characteristics
Ph. Physical characteristics
Ch. Chemical characteristics

The uppermost level of generalization in the database is represented by the terrain unit. The terrain unit relation (TERRAIN) is a subset of the population of all possible terrain units that can be discerned. Each terrain unit consists of at least one, possibly more terrain components. The terrain component relation (TERRAIN COMPONENT) represents the intermediate level of data generalization. It is a subset of the population of all possible terrain components. In turn, each terrain component is composed of at least one, possibly more, soil components. The soil component represents the lowest level of generalization in the database. Relation SOIL COMPONENT is a subset of the population of all possible soil components. Within their respective population subsets, each terrain unit, terrain component, and soil component[2] is a distinctive object.

The SOTER unit

A SOTER unit can be defined as any mappable surface feature (in effect an area, not necessarily contiguous) in the SOTER database. That is, mappable at a scale 1 : 1 million, and adhering to the conventions in the SOTER manual with regard to the extent of a map polygon.
Each SOTER unit is assigned an identification code (ID) that is unique within the SOTER database at issue. This SOTER unit ID is merely a sequential number, starting with an arbitrary value. As yet, there will be no need for concern of a globally unique code at the national level.
The SOTER unit ID allows retrieval from the database of all terrain unit, terrain component and soil component data, either in combination or separately. The inclusion of the three levels of differentiation in the attribute database does not imply that all components of a SOTER unit can be represented on a map, as the size of individual of individual components, or the intricacy of their occurence may preclude cartographic presentation. The areas shown on a SOTER map can thus correspond to any of the three levels of differentation of a SOTER unit: terrain units, terrain components, or soil components. The components not mapped out are known to exist, and their attributes are included in the database, although their exact location cannot be displayed on a 1:1 million map.
SOTER units are in effect mapping units. Mapping units on a SOTER map are to be labelled with their corresponding SOTER unit ID's.

For an example of the cross links between the various relations in a small SOTER database, see appendix A.

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[2] Each soil component is characterized by one **representative profile**. Attribute values of the representative profile are considered to be modal for the entire soil component.

Definition of SOTER relations

A relation consists of a heading and a body. Definition of a relation only requires definition of the heading, since the number of tuples (the "cardinality") in the body is, of course, zero at that time, i.e. the relation is empty, does not contain any data at the moment of its definition.
Domains should be specified as part of the relation definition. Each attribute definition should contain a reference to the corresponding domain: specify the name of a domain, its data value type (integer, float, character, string, logical, or date), the unit in which the domain values are expressed, and all permissible domain values.

Relation TERRAIN

Terrain, in the SOTER context, is defined as an area characterized by a particular combination of landform and lithology. It also possesses one or more typical combinations of surface form, mesorelief, parent material aspects and soil. These form the rationale for a further subdivision of terrain into terrain components and soil components.
Relation TERRAIN stores the specific attribute values for distinct terrain units. This relation represents the highest level in the database hierarchy, i.e. the highest level of data generalization and organization.
Since at least all terrain units are mappable, assigning SOTER unit ID's will start at the terrain unit level. The terrain unit ID is one of the candidate keys for relation TERRAIN. This attribute can be used as the SOTER unit ID of the terrain unit as well at the same time. Thus, for a terrain unit the terrain unit ID and SOTER unit ID are identical. For that reason only the SOTER unit ID will be used in relation TERRAIN, disregarding the terrain unit ID.
Primary key is attribute 1, the SOTER unit identification code. Attribute 3, the source map identification code, is a **foreign key** to relation SOURCE MAP in the "source map" (reference information) database.
Relation TERRAIN has degree 13, i.e. a heading that is a set of 13 attributes. These attributes will be described hereafter;

Attribute 1;

Name	: SUID		
Description	: Soter Unit IDentification code		
Domain	: Name	SOTER unit identification code	
	Unit	N/A	
	Data value type	integer	
	Values	all integers in the range from 1 to 9999	

Attribute 2;
Name: DATE
Description : DATE of data collection
Domain : Name year
Unit year
Data value type integer
Values all integers in the range from base up to the current year.

Attribute 3;
Name : MAPI
Description : source MAP Id
Domain : Name source map identification code
Unit N/A
Data value type string
Values Any suitable code is permitted provided it identifies a unique (i.e. single) source map.

Attribute 4;
Name : MNEL
Description : absolute MiNimum ELevation above sealevel
Domain : Name altitude
Unit metres
Data value type integer
Values all integers in the range from -999 to 9999

Attribute 5;
Name : MXEL
Description : absolute MaXimum ELevation above sealevel
Domain : Name altitude
Unit metres
Data value type integer
Values all integers in the range from -999 to 9999

Attribute 6;
Name : SLOP
Description : dominant SLOPe angle, prevailing in the terrain unit
Domain : Name slope angle
Unit percent
Data value type integer
Values all integers in the range from 0 to 99

Attribute 7;
Name : RELI
Description : RELIef intensity, median difference between highest/lowest
Domain : Name relief intensity
Unit metres per kilometer
Data value type integer
Values all integers in the range from 0 to 9999

Attribute 8;
Name : LNDF
Description : major LaNDForm
Domain : Name major landform code
Unit N/A
Data value type string
Values 'L', 'LP', 'LL', 'LD', 'LF', 'LV', 'S', 'SM', 'SH', 'SE', 'SR', 'SU', 'SP', 'T', 'TM', 'TH', 'TE', 'TV', 'C', 'CV', 'CD', 'CL'

Attribute 9;
Name : RSLO
Description : Regional SLOpe
Domain : Name regional slope code
Unit N/A
Data value type string
Values 'W', 'F', 'G', 'U', 'R', 'S', 'T', 'V', 'CU', 'DO', 'RI', 'TE', 'IN', 'DU', 'IN', 'WE', 'KA'

Attribute 10;
Name : HYPS
Description : HYPSometric level
Domain : Name hypsometry code
Unit N/A
Data value type character
Values '1', '2', '3', '4', '5', '6', '7', '8', '9', '10', '11', '12'

Attribute 11;
Name : DISS
Description : degree of DISSection
Domain : Name dissection code
Unit N/A
Data value type character
Values '1', '2', '3'

Attribute 12;
Name : LITH
Description : general LITHology
Domain : Name lithology code
Unit N/A
Data value type string
Value See table 3 of the SOTER procedures manual.

Attribute 13;

Name	:	WATE	
Description	:	permanent WATEr surface	
Domain	:	Name	Area coverage percentage
		Unit	percent
		Data value type	integer
		Values	all integers in the range from 0 to 99

The second level in the database hierarchy refers to areas within each terrain unit with a particular (pattern of) surface form, slope, mesorelief and - in areas covered by unconsolidated material - texture of parent material. The area referred to is called a terrain component. In order to minimize data storage and maintenance requirements, the attribute values for similar terrain components within different terrain units are entered only once in the database. However, terrain components do vary with respect to their percentage occurence in a terrain unit, even if they are identical in all other attribute values.
Therefore, two relations are required to store all attribute values for the terrain component:

- a TERRAIN COMPONENT relation;
- a TERRAIN COMPONENT DATA relation.

A **mappable** terrain component covers the entire area of the terrain unit it is part of, i.e. the terrain unit is composed of merely one terrain component.

Relation TERRAIN COMPONENT

The TERRAIN COMPONENT relation indicates the SOTER unit/terrain to which the terrain component belongs, and the percentage it occupies within that terrain (15-100%). It also contains a reference to the TERRAIN COMPONENT DATA relation.
Primary key is a combination of attribute 14, the SOTER unit identification code, and attribute 15, the Terrain component number.
Attribute 16, the terrain component data subcode, is a **foreign key** to relation TERRAIN COMPONENT DATA. Attribute 14, the SOTER unit identification code, is a **foreign key** to relation TERRAIN.
Relation TERRAIN COMPONENT has degree 4, i.e. a heading that is a set of 4 attributes. These attributes will be described hereafter;

Attribute 14;

Name	:	SUID	
Description	:	Soter Unit IDentification code	
Domain	:	Name	SOTER unit identification code
		Unit	N/A
		Data value type	integer
		Values	all integers in the range from 1 to 9999

Attribute 15;
Name : TCID
Description : Terrain Component number
Domain : Name terrain component sequence number
Unit N/A
Data value type integer
Values all integer values in the range from 1 to 9

Attribute 16;
Name : PROP
Description : PROPortion of **SOTER unit!**
Domain : Name Area coverage percentage
Unit percent
Data value type integer
Values all integers in the range from 15 to 100

Attribute 17;
Name : TCDC
Description : Terrain Component Data Code
Domain : Name Terrain component data code
Unit N/A
Data value type string
Values all valid combinations of SOTER unit ID's and terrain component numbers, separated by a slash.

Relation TERRAIN COMPONENT DATA

The TERRAIN COMPONENT DATA relation contains a reference (by means of the terrain component data code) to the terrain component to which the terrain component data apply. **Primary key** is attribute 18, the terrain component data code. There are no foreign keys. Relation TERRAIN COMPONENT DATA has degree 16, i.e. a heading that is a set of 16 attributes. These attributes will be described hereafter;

Attribute 18;
Name : TCDC
Description : Terrain Component Data Code
Domain : Name Terrain component data code
Unit N/A
Data value type string
Values all valid combinations of SOTER unit ID's and terrain component ID's, separated by a slash.

Attribute 19;
Name : SCGR
Description : Slope Characteristics, dominant slope GRadient
Domain : Name slope
Unit percent
Data value type integer
Values all integers in the range from 0 to 99

Attribute 20;
Name : SCDL
Description : Slope Characteristics, estimated Dominant Length of slope
Domain : Name length
Unit metres
Data value type integer
Values all integers in the range from 0 to 99999

Attribute 21;
Name : SCFM
Description : Slope Characteristics, ForM of dominant slope
Domain : Name dominant form slope code
Unit N/A
Data value type character
Values 'U', 'C', 'V', 'I'

Attribute 22;
Name : MRSF
Description : Meso Relief, local Surface Form
Domain : Name local surface form code
Unit N/A
Data value type character
Values 'H', 'M', 'K', 'R', 'T', 'G', 'S', 'D', 'L'

Attribute 23;
Name : MRAH
Description : Meso Relief, Average Height
Domain : Name height/depth
Unit metres
Data value type integer
Values all integers in the range from 0 to 999

Attribute 24;
Name : MRPR
Description : Meso Relief, PRoportion of SOTER unit
Domain : Name Area coverage percentage
Unit percent
Data value type integer
Values all integers in the range from 1 to 100

Attribute 25;
Name : LITH
Description : LITHology of (un)consolidated surficial materials
Domain : Name lithology code
Unit N/A
Data value type string
Values See table 3 of the SOTER procedures manual.

Attribute 26;
Name : TEXT
Description : TEXTure group of non-consolidated parent material
Domain : Name texture group code
Unit N/A
Data value type character
Values 'Y', 'C', 'L', 'S', X'

Attribute 27;
Name : BEDR
Description : average depth to consolidated BEDRock
Domain : Name depth
Unit metres
Data value type integer
Values all integers in the range from 0 to 99

Attribute 28;
Name : SDRA
Description : Surface DRAinage of the terrain component
Domain : Name surface drainage code
Unit N/A
Data value type character
Values 'E', 'S', 'W', 'R', V'

Attribute 29;
Name : GWAT
Description : depth to Ground WATer
Domain : Name depth
Unit metres
Data value type integer
Values all integers in the range from 0 to 99

Attribute 30;
Name : FLFR
Description : FLooding, FRequency
Domain : Name flooding frequency code
Unit N/A
Data value type character
Values 'N', 'D', 'W', 'M', 'A', 'B', 'F', 'T', 'R', 'U'

Attribute 31;

Name	: FLDU		
Description	: FLooding, DUration		
Domain	: Name	flooding duration code	
	Unit	N/A	
	Data value type	character	
	Values	'1', '2', '3', '4', '5', '6', '7'	

Attribute 32;

Name	: FLST		
Description	: FLooding, STarting months		
Domain	: Name	flooding start month sequence	
	Unit	N/A	
	Data value type	string	
	Values	a maximum of three integers in the range from 1 to 12, separated by slashes (month numbering; january is 01, december is 12)	

The third level in the database hierarchy refers to areas within each terrain component with predominantly a single soil. These areas are called soil components. They are characterized according to the FAO/UNESCO Soil Map of the World Legend. The criteria used for separating soil components within each terrain component are based on FAO diagnostic horizons and properties.
Again, in order to minimize data storage and maintenance requirements, the attribute values for similar soil components within a terrain component should be entered only once in the database. However, also soil components do vary with respect to their percentage occurence in a terrain component, even if they are identical in all other attribute values. Therefore, two relations would be required to store all attribute values for the soil components:

- a SOIL COMPONENT relation;

- a SOIL COMPONENT DATA relation.

Actually, such a situation will hardly ever arise in the database, i.e. the simultaneous occurence of two soil components with identical attributes[3]. For that reason, both relations SOIL COMPONENT DATA and SOIL COMPONENT can be merged into one SOIL COMPONENT relation.
A **mappable** soil component covers the entire area of the terrain unit it is part of, i.e. the terrain unit is composed of merely one soil component (in turn, the terrain component will also be mappable, covering the entire area of the terrain unit it is part of).

[3] Very likely their percentages of occurrence in a terrain component will be dissimilar.

Relation SOIL COMPONENT

This relation links a soil component to its enclosing terrain unit in relation TERRAIN, to its enclosing terrain component in relation TERRAIN COMPONENT, and to a (representative) soil profile in relation PROFILE. Relation SOIL COMPONENT indicates, among others, what area percentage within a SOTER unit is occupied by a certain soil.
Primary key is a combination of attribute 33, the SOTER unit identification code, attribute 34, the terrain component number and attribute 35, the soil component number.
Attribute 33 is a **foreign key** to relation TERRAIN. The combination of attributes 33 and 34 is a **foreign key** to relation TERRAIN COMPONENT. Attribute 37, the profile identification subcode, is a **foreign key** to relation PROFILE.
Relation SOIL COMPONENT has degree 15, i.e. a heading that is a set of 15 attributes. These attributes will be described hereafter;

Attribute 33;
Name : SUID
Description : Soter Unit IDentification code
Domain : Name SOTER unit identification code
Unit N/A
Data value type integer
Values all integers in the range from 1 to 9999

Attribute 34;
Name : TCID
Description : Terrain Component (IDentification) number
Domain : Name terrain component sequence number
Unit N/A
Data value type integer
Values all integer values in the range from 1 to 9

Attribute 35;
Name : SCID
Description : Soil Component (IDentification) number; a sequence number within the containing terrain component.
Domain : Name soil component sequence number
Unit N/A
Data value type integer
Values all integer values in the range from 1 to 9

Attribute 36;
Name : PROP
Description : PROPortion of **SOTER unit!**
Domain : Name Area coverage percentage
Unit percent
Data value type integer
Values all integers in the range from 15 to 100

Attribute 37;
Name : PRID
Description : PRofile IDentification code
Domain : Name (national) profile identification code
Unit N/A
Data value type string
Values ISO country code followed by a (national) profile identification code. Any national code is permitted provided it is unique at a national level

Attribute 38;
Name : NRPR
Description : Number of Reference PRofiles
Domain : Name quantity
Unit N/A
Data value type integer
Values all integer values in the range from 1 to 99

Attribute 39;
Name : POSI
Description : relative POSItion of soil component within terrain component
Domain : Name soil component position code
Unit N/A
Data value type character
Values 'H', 'M', 'L', 'D', 'A'

Attribute 40;
Name : RKSC
Description : RocKiness of soil component, Surface Cover
Domain : Name area coverage code
Unit N/A
Data value type character
Values 'N', 'V', 'F', 'C', 'M', 'A', 'D'

Attribute 41;
Name : STSC
Description : STooniness of soil component, Surface Cover
Domain : Name area coverage code
Unit N/A
Data value type character
Values 'N', 'V', 'F', 'C', 'M', 'A', 'D'

Attribute 42;
Name : ERTY
Description : observable ERosion, TYpe of erosion
Domain : Name erosion type code
Unit N/A
Data value type character
Values 'N', 'S', 'R', 'G', 'T', 'P', 'W', 'L', 'A','D', 'Z', 'U'

Attribute 43;
Name : ERAA
Description : observable ERosion, Area Affected
Domain : Name area affected code
Unit N/A
Data value type character
Values '1', '2', '3', '4', '5'

Attribute 44;
Name : ERDE
Description : observable ERosion, DEgree of erosion
Domain : Name erosion degree code
Unit N/A
Data value type character
Values 'S', 'M', 'V', 'E'

Attribute 45;
Name : SCAP
Description : Sensitivity to CAPping and sealing
Domain : Name sensitivity to capping code
Unit N/A
Data value type character
Values 'N', 'W', 'M', 'S'

Attribute 46;
Name : RDEP
Description : Rootable DEPth
Domain : Name rootable depth code
Unit N/A
Data value type character
Values 'V', 'S', 'M', 'D', 'X'

Attribute 47;

Name	:	RELA	
Description	:	RELAtion to other soil components	
Domain	:	Name	text string
		Unit	N/A
		Data value type	string
		Values	a free format space of 254 characters is available to succinctly indicate the relationship between this soil component and adjoining soil components

In SOTER, each soil component will be characterized by a fully described and analysed representative profile (chosen from among one or more reference profiles). General information concerning the entire representative profile will be stored in

- the PROFILE relation

Each profile is made up of a number of diagnostic horizons with common as well as private characteristics. The latter will be stored in yet another table,

- the HORIZON relation.

Relation PROFILE

This relation links a representative soil profile to a soil component. The PROFILE relation carries general information on the profile and its constituent layers.
Primary key is attribute 48, the profile identification code. Attribute 49, the (national) soil profile database identification code, is a **foreign key** to relation PROFILE DATABASE in the "profile database" (reference information) database. Attribute 55, the laboratory identification code, is a **foreign key** to relation LABORATORY ANALYSIS in the "laboratory" (reference information) database.
Relation profile has degree 15, i.e. a heading that is a set of 15 attributes. These attributes will be described hereafter;

Attribute 48;

Name	:	PRID	
Description	:	PRofile IDentification code	
Domain	:	Name	(national) profile identification code
		Unit	N/A
		Data value type	string
		Values	ISO country code followed by a (national) profile identification code. Any national code is permitted provided it is unique at a national level

Attribute 49;
Name : PDID
Description : (national) soil Profile Database IDentification code
Domain : Name profile database code
Unit N/A
Data value type string
Values all valid ISRIC codes for soil profile databases; ISO country code + sequence code

Attribute 50;
Name : LATI
Description : LATItude
Domain : Name geographical latitude north
Unit decimal degrees (lattitudes in the southern hemisphere are negative)
Data value type float
Values all numerical values in the range from minus (-)90.00 to plus (+)90.00

Attribute 51;
Name : LONG
Description : LONGitude
Domain : Name geographical longitude east
Unit decimal degrees (longitudes in the western hemisphere are negative)
Data value type float
Values all numerical values in the range from minus (-)180.00 to plus (+)180.00

Attribute 52;
Name : ELEV
Description : ELEVation of the representative profile above sealevel
Domain : Name altitude
Unit metres
Data value type integer
Values all integers in the range from -999 to 9999

Attribute 53;
Name : DATE
Description : DATE of sampling (and profile description)
Domain : Name sampling date
Unit date (string)
Data value type date
Values all allowable dates (format: MM/YYYY).

Attribute 54;
Name : LABO
Description : LABOratory identification code
Domain : Name ISRIC soil laboratory identification code
Unit N/A
Data value type string
Values all valid ISRIC codes for soil laboratories; ISO country code + sequence code

Attribute 55;
Name : DRAI
Description : DRAInage class for the soil component (FAO, 1990)
Domain : Name drainage class code
Unit N/A
Data value type character
Values 'E', 'S', 'W', 'M', 'I', 'P', 'V'

Attribute 56;
Name : INFR
Description : INFiltration Rate class
Domain : Name infiltration rate class code
Unit N/A
Data value type character
Values 'V', 'S', 'D', 'M', 'R', 'Y', 'E'

Attribute 57;
Name : ORGA
Description : surface ORGAnic matter
Domain : Name surface organic matter code
Unit N/A
Data value type character
Values 'F', 'H', 'S'

Attribute 58;
Name : CLAF
Description : CLAssification of the soil profile according to the revised Fao soil map of the world legend (FAO, 1990)
Domain : Name FAO Soil Map unit
Unit N/A
Data value type string
Values See legend of FAO Soil Map of the World

Attribute 59;
Name : CLAV
Description : CLAssification of the soil profile according to the revised fao soil map of the world legend, Version year of publication
Domain : Name: FAO Soil Map Legend publication year
Unit: year
Data value type: integer
Values: integers 1974 and 1988

Attribute 60;
Name : CLAN
Description : original CLAssification of the representative profile according to a national classification system
Domain : Name: National Soil Map unit
Unit: N/A
Data value type: string
Values: See legend of National Soil Map that has been used for the characterization.

Attribute 61;
Name : STAX
Description : Soil TAXonomy classification
Domain : Name: Soil Taxonomy classification code
Unit: N/A
Data value type: string
Values: See Soil Taxonomy, FAO 1989

Attribute 62;
Name : PHAS
Description : PHASe, any potential limiting factor related to surface or subsurface features of the terrain
Domain : Name: (FAO-ISRIC) phase code
Unit: N/A
Data value type: string
Values: coding of phases currently used by FAO in the FAO-ISRIC Soil DataBase (FAO, 1990): 'DU', 'FR', 'GI', 'IN', 'LI', 'PF', 'PH', SO', 'PC', 'PG', 'PE', 'ST', 'SS', 'YE', 'CL'
A note should be made on the code for any new phase recognised.

Each soil profile is made up of a number of diagnostic horizons with common as well as different characteristics. General information concerning the entire representative profile will be stored in the PROFILE relation just described, specific horizon information will be stored in different, yet closely related HORIZON tables or relations:

- the REPRESENTATIVE (profile) HORIZON DATA relation,
- the MINIMUM (profile) HORIZON DATA relation, and
- the MAXIMUM (profile) HORIZON DATA relation.

The REPRESENTATIVE HORIZON DATA relation contains attribute values that are taken from the representative profile for a soil component. The representative profile and its descriptive attribute values are considered to be **modal** for the entire soil component, modal meaning here "most frequently occurring".
In the absence of analytical data, an estimate by a qualified expert will be an acceptable database entry. It is referred to as an "Expert Estimate". Expert estimates are entered in the REPRESENTATIVE HORIZON DATA relation as negative values. Where appropriate these attribute values will be marked in a different way for attributes that accept negative values. As a consequence zero values are not acceptable as expert estimates.

The MINIMUM HORIZON DATA relation contains minimum attribute values for diagnostic horizons from all available profiles within a soil component.
The MAXIMUM HORIZON DATA relation contains maximum attribute values for diagnostic horizons from all available profiles within a soil component.

Including all three attribute sets in one relation would yield an unmanageable large data file. For that reason the attribute sets have been accomodated in three separate relations.
Within all three HORIZON relations a further breakdown into three separate data sets is possible according to the nature of the horizon data: 1) descriptive characteristics, 2) chemical characteristics, and 3) physical characteristics. Although the relational model proper does not justify such a breakdown, it might proof beneficial for data entry, maintenance and management.

In contrast to the HORIZON relations, up to relation PROFILE entries for all attributes have been mandatory. The "attribute status" will indicate wether an entry for an attribute in a HORIZON relation is mandatory.

Relation REPRESENTATIVE HORIZON DATA

This relation carries attribute values for the horizons that have been discerned in the representative profile of a soil component. **Primary key** is a combination of attribute 63, the

profile identification code, and attribute 64, the horizon number. The former is also **foreign key** to relation PROFILE, linking a soil profile horizon to its parent profile.
Entries that are expert estimates are denoted by a minus (-) sign in relation REPRESENTATIVE HORIZON DATA.
Relation REPRESENTATIVE HORIZON DATA has degree 48, i.e. a heading that is a set of 48 attributes. These attributes will be described hereafter;

Attribute 63;
Name : PRID
Description : PRofile IDentification code
Domain : Name (national) profile identification code
Unit N/A
Data value type string
Values ISO country code followed by a (national) profile identification code. Any national code is permitted provided it is unique at a national level
Status : mandatory

Attribute 64;
Name : HONU
Description : HOrizon Number
Domain : Name horizon sequence number
Unit N/A
Data value type integer
Values all integer values in the range from 1 to (preferrably not more than) 5
Status : mandatory

Attribute 65;
Name : DIAH
Description : DIAgnostic Horizon
Domain : Name diagnostic horizon code
Unit N/A
Data value type string
Values 'HI', 'MO', 'FI', 'UM', 'OC', 'AR', 'NA', 'CB', 'SP', 'FA', 'CA', 'PC', 'GY', 'PG', 'SU', 'AL'
Status : mandatory

Attribute 66;
Name : DIAP
Description : DIAgnostic Property
Domain : Name diagnostic property code
Unit N/A
Data value type string
Values 'TC', 'AD', 'CO', 'CA', 'RO', 'FA', 'FI', 'FL', 'GE', 'GL', 'GY', 'IN', 'NI', 'OR', 'PE', 'PL', 'SA', 'SI', 'SM', 'SO', 'SL', 'HU', 'SU', 'TO', 'VE', 'WM'
Status : mandatory

Attribute 67;
Name : HODE
Description : HOrizon DEsignation
Domain : Name master horizon & subordinate characteristics code
Unit N/A
Data value type string
Values See section 2.1 of the Guidelines for Soil Description (FAO-ISRIC, 1990).
Status : not mandatory

Attribute 68;
Name : HBDE
Description : Horizon lower (upper in case of **O** horizon) Boundary, DEpth
Domain : Name depth
Unit centimetres
Data value type integer
Values all integers in the range from 0 to 999
Status : mandatory

Attribute 69;
Name : HBDI
Description : Horizon Boundary, DIstinctness to underlying horizon
Domain : Name horizon boundary distinctness code
Unit N/A
Data value type character
Values 'A', 'C', 'G', 'D'
Status : not mandatory

Attribute 70;
Name : MSCM
Description : Munsell Soil Colour, Moist
Domain : Name Munsell soil colour code
Unit N/A
Data value type string
Values all legitimate Munsell colour codes, or combinations of these codes. Only integers and chromas are accepted.
Status : mandatory

Attribute 71;
Name : MSCD
Description : Munsell Soil Colour, Dry
Domain : Name Munsell soil colour code
Unit N/A
Data value type string
Values all legitimate Munsell colour codes, or combinations of these codes. Only integers and chromas are accepted.
Status : not mandatory

Attribute 72;
Name : STGR
Description : soil STructure, GRade or development
Domain : Name structure grade code
Unit N/A
Data value type character
Values 'N', 'W', 'M', 'S'
Status : not mandatory

Attribute 73;
Name : STSI
Description : soil STructure, SIze class
Domain : Name structure elements size class code
Unit N/A
Data value type character
Values 'V', 'F', 'M', 'C', 'X'
Status : not mandatory

Attribute 74;
Name : STTY
Description : soil STructure, TYpe
Domain : Name soil structure type code
Unit N/A
Data value type character
Values 'P', 'R', 'C', 'A', 'S', 'G', 'B', 'M', 'N', 'W'
Status : mandatory

Attribute 75;
Name : MINA
Description : MINeral fragments, Abundance
Domain : Name mineral fragments abundance class code
Unit N/A
Data value type character
Values 'N', 'V', 'F', 'C', 'M', 'A', 'D'
Status : mandatory

Attribute 76;
Name : MINS
Description : MINeral fragments, Size
Domain : Name mineral fragments size class code
Unit N/A
Data value type character
Values 'V', 'F', 'M', 'C'
Status : not mandatory

Attribute 77;
Name : SDVC
Description : SanD, Very Coarse
Domain : Name fine earth fraction weight percentage
Unit percent
Data value type integer
Values all integers in the range from 0 to 100.
Status : not mandatory

Attribute 78;
Name : SDCO
Description : SanD, COarse
Domain : Name fine earth fraction weight percentage
Unit percent
Data value type integer
Values all integers in the range from 0 to 100.
Status : not mandatory

Attribute 79;
Name : SDME
Description : SanD, MEdium
Domain : Name fine earth fraction weight percentage
Unit percent
Data value type integer
Values all integers in the range from 0 to 100.
Status : not mandatory

Attribute 80;
Name : SDFI
Description : SanD, FIne
Domain : Name fine earth fraction weight percentage
Unit percent
Data value type integer
Values all integers in the range from 0 to 100.
Status : not mandatory

Attribute 81;
Name : SDVF
Description : SanD, Very Fine
Domain : Name fine earth fraction weight percentage
Unit percent
Data value type integer
Values all integers in the range from 0 to 100.
Status : not mandatory

Attribute 82;
Name : SDTO
Description : SanD, TOtal
Domain : Name fine earth fraction weight percentage
Unit percent
Data value type integer
Values all integers in the range from 0 to 100.
Status : mandatory

Attribute 83;
Name : STPC
Description : SilT, PerCentage
Domain : Name weight percentage in fine earth fraction
Unit percent
Data value type integer
Values all integers in the range from 0 to 100.
Status : mandatory

Attribute 84;
Name : CLPC
Description : CLay, PerCentage
Domain : Name weight percentage in fine earth fraction
Unit percent
Data value type integer
Values all integers in the range from 0 to 100.
Status : mandatory

Attribute 85;
Name : PSCL
Description : Particle Size CLass
Domain : Name particle size class code
Unit N/A
Data value type character
Values 'S', 'LS', 'SL', 'SIL', 'SI', 'L', 'SCL', 'CL', 'SICL', 'SC', 'SIC', 'C'
Status : not mandatory

Attribute 86;
Name : BULK
Description : BULK density
Domain : Name bulk density value
Unit kg/dm3
Data value type float
Values all floating values from 0 to 99.99
Status : mandatory

Attribute 87;
In relation REPRESENTATIVE HORIZON DATA (water) tension and associated moisture content will be stored as atomic values:

Attribute 87a
Name : MCT1
Description : Moisture Content at (water) Tension 1 = -33 KPa
Domain : Name soil moisture content
Unit (volume) percent
Data value type integer
Values all integers from 1 to 100
Status : not mandatory

Attribute 87b
Name : TEN2
Description : (Water) tension 2, between field capacity (-33 KPa) and wilting point (-1500 KPa)
Domain : Name water tension (matric suction)
Unit (minus) KPa
Data value type integer
Values all integers from 33 to 1500
Status : not mandatory

Attribute 87c
Name : MCT2
Description : Moisture Content at (water) Tension 2
Domain : Name soil moisture content
Unit (volume) percent
Data value type integer
Values all integers from 1 to 100
Status : not mandatory

Attribute 87d
Name : TEN3
Description : (Water) tension 3, between field capacity (-33 KPa) and wilting point (-1500 KPa)
Domain : Name water tension (matric suction)
Unit (minus) KPa
Data value type integer
Values all integers from 33 to 1500
Status : not mandatory

Attribute 87e
Name : MCT3
Description : Moisture Content at (water) Tension 3
Domain : Name soil moisture content
Unit (volume) percent
Data value type integer
Values all integers from 1 to 100
Status : not mandatory

Attribute 87f
Name : TEN4
Description : (Water) tension 4, between field capacity (-33 KPa) and wilting point (-1500 KPa)
Domain : Name water tension (matric suction)
Unit (minus) KPa
Data value type integer
Values all integers from 33 to 1500
Status : not mandatory

Attribute 87g
Name : MCT4
Description : Moisture Content at (water) Tension 4
Domain : Name soil moisture content
Unit (volume) percent
Data value type integer
Values all integers from 1 to 100
Status : not mandatory

Attribute 87h
Name : MCT5
Description : Moisture Content at (water) Tension 5 = -1500 KPa
Domain : Name soil moisture content
Unit (volume) percent
Data value type integer
Values all integers from 1 to 100
Status : not mandatory

Attribute 88;
Name : HYDC
Description : saturated HYDraulic Conductivity
Domain : Name hydraulic conductivity
Unit cm/hour
Data value type float
Values all floating values from 0 to 999.9
Status : not mandatory

Attribute 89;
Name : INFR
Description : INFiltration Rate
Domain : Name infiltration rate
Unit cm/hour
Data value type float
Values all floating values from 0 to 999.9
Status : not mandatory

Attribute 90;
Name : PHAQ
Description : pH (H2O, or AQua)
Domain : Name pH value
Unit pH
Data value type float
Values all floating values from 0 to 99.9
Status : mandatory

Attribute 91;
Name : PHKC
Description : pH (KCl)
Domain : Name pH value
Unit pH
Data value type float
Values all floating values from 0 to 99.9
Status : not mandatory

Attribute 92;
Name : ELCO
Description : ELectrical COnductivity
Domain : Name EC value
Unit dS/m
Data value type float
Values all floating values from 0 to 99.9
Status : not mandatory

Attribute 93;
Name : EXCA
Description : EXchangeable Calcium
Domain : Name exchangeable Ca
Unit cmol(+)/kg
Data value type float
Values all floating values from 0 to 99.9
Status : not mandatory

Attribute 94;
Name : EXMG
Description : EXchangeable Magnesium
Domain : Name exchangeable Mg
Unit cmol(+)/kg
Data value type float
Values all floating values from 0 to 99.9
Status : not mandatory

Attribute 95;
Name : EXNA
Description : EXchangeable Natrium
Domain : Name exchangeable Na
Unit cmol(+)/kg
Data value type float
Values all floating values from 0 to 99.9
Status : not mandatory

Attribute 96;
Name : EXCK
Description : EXChangeable potassium (K)
Domain : Name exchangeable K
Unit cmol(+)/kg
Data value type float
Values all floating values from 0 to 99.9
Status : not mandatory

Attribute 97;
Name : EXAL
Description : EXchangeable Aluminium
Domain : Name exchangeable Al
Unit cmol(+)/kg
Data value type float
Values all floating values from 0 to 99.9
Status : not mandatory

Attribute 98;
Name : EXAC
Description : EXchangeable ACidity (as determined in 1N KCl)
Domain : Name exchangeable acidity
Unit cmol(+)/kg
Data value type float
Values all floating values from 0 to 99.9
Status : not mandatory

Attribute 99;
Name : CECS
Description : Cation Exchange Capacity of the Soil at pH 7.0
Domain : Name CEC soil
Unit cmol(+)/kg
Data value type float
Values all floating values from 0 to 999.9
Status : mandatory

Attribute 100;
Name : TCEQ
Description : Total Carbonate EQuivalent
Domain : Name carbonates content
Unit g/kg
Data value type float
Values all floating values from 0 to 99.9
Status : not mandatory

Attribute 101;
Name : GYPS
Description : GYPSum content
Domain : Name gypsum content
Unit g/kg
Data value type float
Values all floating values from 0 to 99.9
Status : not mandatory

Attribute 102;
Name : TOTC
Description : TOTal organic Carbon
Domain : Name total organic carbon content
Unit g/kg
Data value type float
Values all floating values from 0 to 99.9
Status : mandatory for topsoil (i.e. first 25 cm, or A horizon)

Attribute 103;
Name : TOTN
Description : TOTal Nitrogen
Domain : Name total nitrogen content
Unit g/kg
Data value type float
Values all floating values from 0 to 99.99
Status : not mandatory

Attribute 104;
Name : P2O5
Description : P2O5 content in 1% citric acid
Domain : Name P2O5 content
Unit mg/kg
Data value type integer
Values all integers from 0 to 99
Status : not mandatory

Attribute 105;
Name : PRET
Description : Phosphate RETention
Domain : Name phosphate retention percentage
Unit percent
Data value type integer
Values all integers from 0 to 100
Status : not mandatory

Attribute 106;
Name : FEDE
Description : Fe, Dithionite Extractable
Domain : Name weight percentage
Unit percent
Data value type integer
Values all integers from 0 to 100
Status : not mandatory

Attribute 107;
Name : FEPE
Description : Fe, Pyrophosphate Extractable
Domain : Name weight percentage
Unit percent
Data value type integer
Values all integers from 0 to 100
Status : not mandatory

Attribute 108;
Name : ALDE
Description : Al, Dithionite Extractable
Domain : Name weight percentage
Unit percent
Data value type integer
Values all integers from 0 to 100
Status : not mandatory

Attribute 109;
Name : ALPE
Description : Al, Pyrophosphate Extractable
Domain : Name weight percentage
Unit percent
Data value type integer
Values all integers from 0 to 100
Status : not mandatory

Attribute 110;
Name : CLAY
Description : CLAY mineralogy
Domain : Name clay mineralogy code
Unit N/A
Data value type string
Values 'AL', 'CH', 'IL','IN', 'KA', 'MO', 'SE', 'VE'
Status : not mandatory

Relation MINIMUM HORIZON DATA

This relation contains minimum attribute values deduced from all reference profiles that are associated with a representative profile. **Primary key** is a combination of attribute 111, the profile identification code, and attribute 112, the horizon number. The former is also **foreign key** to relation PROFILE, linking minimum attribute values for diagnostic horizons to a representative profile. For descriptive characteristics, such as particle size class, the least explicit manifestation of the characteristic among the reference profiles should be entered as the minimum value for the attribute standing for the characteristic.
Relation MINIMUM HORIZON DATA has degree 37, i.e. a heading that is a set of 47 attributes. These attributes have all been described previously under relation SINGLE HORIZON DATA.

Relation MAXIMUM HORIZON DATA

This relation contains maximum attribute values deduced from all reference profiles that are associated with a representative profile. **Primary key** is a combination of attribute 148, the profile identification code, and attribute 149, the horizon number. The former is also **foreign key** to relation PROFILE, linking maximum attribute values for diagnostic horizons to a re-

presentative profile. For descriptive characteristics, such as particle size class, the most explicit manifestation of the characteristic among the reference profiles should be entered as the maximum value for the attribute representing the characteristic.
Relation MAXIMUM HORIZON DATA has degree 37, i.e. a heading that is a set of 37 attributes. These attributes have all been described previously under relation SINGLE HORIZON DATA.

Summary of data structure;

Relation TERRAIN

No	Field	Data type	Key?	Null?	Format
1	SUID	Numerical	P	NOT NULL	9999
2	DATE	Numerical			9999
3	MAPI	String			12 * A
4	MNEL	Numerical			9999
5	MXEL	Numerical			9999
6	SLOP	Numerical			99
7	RELI	Numerical			9999
8	LNDF	Character			AA
9	RSLO	Character			AA
10	HYPS	Character			99
11	DISS	Character			9
12	LITH	String			AA9
13	WATE	Numerical			999

Relation TERRAIN COMPONENT

No	Field	Data type	Key?	Null?	Format
14	SUID	Numerical	P, F	NOT NULL	9999
15	TCID	Numerical	P	NOT NULL	9
16	PROP	Numerical			999
17	TCDC	String	F	NOT NULL	9999/9

Relation TERRAIN COMPONENT DATA

No	Field	Data type	Key?	Null?	Format
18	TCDC	String	P	NOT NULL	9999/9
19	SCGR	Numerical			99
20	SCDL	Numerical			99999
21	SCFM	Character			A
22	MRSF	Character			A
23	MRAH	Numerical			999
24	MRPR	Numerical			999
25	LITH	String			AA9
26	TEXT	Character			A
27	BEDR	Numerical			99

28	SDRA	Character		A
29	GWAT	Numerical		99
30	FLFR	Character		A
31	FLDU	Character		9
32	FLST	String		999999

Relation SOIL COMPONENT

No	Field	Data type	Key?	Null?	Format
33	SUID	Numerical	P, F	NOT NULL	9999
34	TCID	Numerical	P, F	NOT NULL	99
35	SCID	Numerical	P, F	NOT NULL	99
36	PROP	Numerical			999
37	PRID	String	F	NOT NULL	12 * A
38	NRPR	Numerical			99
39	POSI	Character			A
40	RKSC	Character			A
41	STSC	Character			A
42	ERTY	Character			A
43	ERAA	Character			9
44	ERDE	Character			A
45	SCAP	Character			A
46	RDEP	Character			A
47	RELA	Character			(254 * A)

Relation PROFILE

No	Field	Data type	Key?	Null?	Format
48	PRID	String	P	NOT NULL	12 * A
49	PDID	String			AA999
50	LATI	Numerical			999.99
51	LONG	Numerical			999.99
52	ELEV	Numerical			9999
53	DATE	Date (string)			99/9999
54	LABO	String			AA999
55	DRAI	Character			A
56	INFR	Character			A
57	ORGA	Character			A
58	CLAF	String			AAA
59	CLAV	Numerical			9999
60	CLAN	String			30 * A
61	STAX	String			12 * A
62	PHAS	String			AA

Relation REPRESENTATIVE HORIZON DATA

No	Field	Data type	Key?	Null?	Format
63	PRID	String	P, F	NOT NULL	12 * A
64	HONU	Numerical	P	NOT NULL	9
65	DIAH	String			AA
66	DIAP	String			AA
67	HODE	String			AAAAA
68	HBDE	Numerical		NOT NULL	999
69	HBDI	Character			A
70	SCMO	String		NOT NULL	10 * A
71	SCDR	String			10 * A
72	STGR	Character			A
73	STSI	Character			A
74	STTY	Character		NOT NULL	A
75	MINA	Character		NOT NULL	A
76	MINS	Character			A
77	SDVC	Numeric			999
78	SDCO	Numeric			999
79	SDME	Numeric			999
80	SDFI	Numeric			999
81	SDVF	Numeric			999
82	SDTO	Numeric		NOT NULL	999
83	STPC	Numeric		NOT NULL	999
84	CLPC	Numeric		NOT NULL	999
85	PSCL	Character			AAAA
86	BULK	Numeric		NOT NULL	99.99
87a	MCT1	Numeric			999
87b	TEN2	Numeric			9999
87c	MCT2	Numeric			999
87d	TEN3	Numeric			9999
87e	MCT3	Numeric			999
87f	TEN4	Numeric			9999
87g	MCT4	Numeric			999
87h	MCT5	Numeric			999
88	HYDC	Numeric			999.9
89	INFR	Numeric			999.9
90	PHAQ	Numeric		NOT NULL	99.9
91	PHKC	Numeric			99.9
92	ELCO	Numeric			99.9
93	EXCA	Numeric			99.9
94	EXMG	Numeric			99.9
95	EXNA	Numeric			99.9
96	EXCK	Numeric			99.9
97	EXAL	Numeric			99.9
98	EXAC	Numeric			99.9

99	CECS	Numeric	NOT NULL	999.9
100	TCEQ	Numeric		99.9
101	GYPS	Numeric		99.9
102	TOTC	Numeric	NOT NULL	99.9
103	TOTN	Numeric		99.99
104	P2O5	Numeric		99
105	PRET	Numeric		999
106	FEDE	Numeric		999
107	FEPE	Numeric		999
108	ALDE	Numeric		999
109	ALPE	Numeric		999
110	CLAY	String		AA

Relation MINIMUM HORIZON DATA

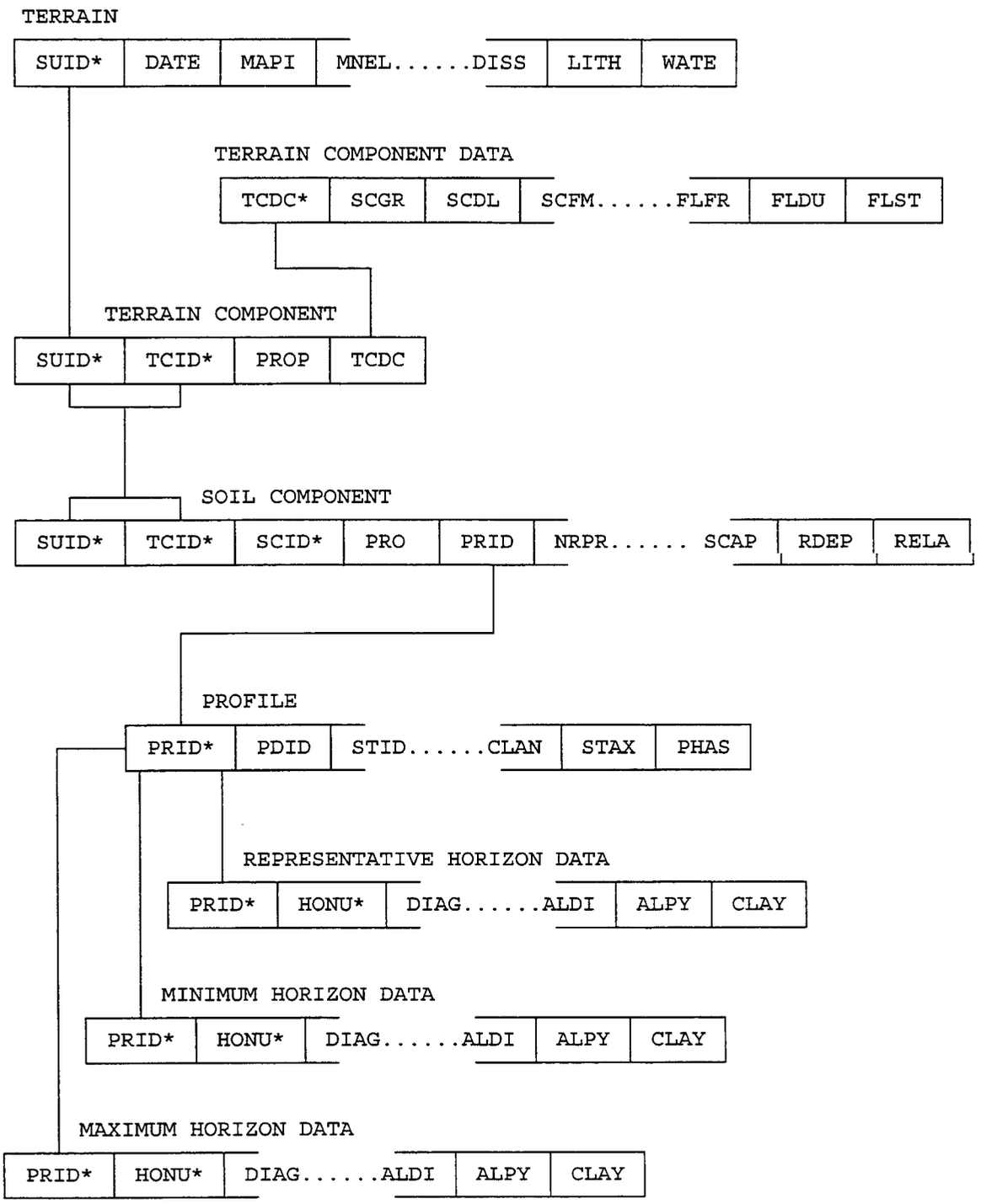
No	Field	Data type	Key?	Null?	Format
111	PRID	String	P, F	NOT NULL	12 * A
112	HONU	Numerical	P	NOT NULL	9
113	MINA	Character		NOT NULL	A
114	MINS	Character			A
115	SDVC	Numeric			999
116	SDCO	Numeric			999
117	SDME	Numeric			999
118	SDFI	Numeric			999
119	SDVF	Numeric			999
120	SDTO	Numeric		NOT NULL	999
121	STPC	Numeric		NOT NULL	999
122	CLPC	Numeric		NOT NULL	999
123	PSCL	Character			AAAA
124	BULK	Numeric		NOT NULL	99.99
125a	MCT1	Numeric			999
125b	TEN2	Numeric			9999
125c	MCT2	Numeric			999
125d	TEN3	Numeric			9999
125e	MCT3	Numeric			999
125f	TEN4	Numeric			9999
125g	MCT4	Numeric			999
125h	MCT5	Numeric			999
126	HYDC	Numeric			999.9
127	INFR	Numeric			999.9
128	PHAQ	Numeric		NOT NULL	99.9
129	PHKC	Numeric			99.9
130	ELCO	Numeric			99.9
131	EXCA	Numeric			99.9
132	EXMG	Numeric			99.9

133	EXNA	Numeric		99.9
134	EXCK	Numeric		99.9
135	EXAL	Numeric		99.9
136	EXAC	Numeric		99.9
137	CECS	Numeric	NOT NULL	999.9
138	TCEQ	Numeric		99.9
139	GYPS	Numeric		99.9
140	TOTC	Numeric	NOT NULL	99.9
141	TOTN	Numeric		99.99
142	P2O5	Numeric		99
143	PRET	Numeric		999
144	FEDE	Numeric		999
145	FEPE	Numeric		999
146	ALDE	Numeric		999
147	ALPE	Numeric		999

Relation MAXIMUM HORIZON DATA

No	Field	Data type	Key?	Null?	Format
148	PRID	String	P, F	NOT NULL	12 * A
149	HONU	Numerical	P	NOT NULL	9
150	MINA	Character		NOT NULL	A
152	MINS	Character			A
153	SDVC	Numeric			999
154	SDCO	Numeric			999
155	SDME	Numeric			999
156	SDFI	Numeric			999
157	SDVF	Numeric			999
158	SDTO	Numeric		NOT NULL	999
159	STPC	Numeric		NOT NULL	999
160	CLPC	Numeric		NOT NULL	999
161	PSCL	Character			AAAA
162	BULK	Numeric		NOT NULL	99.99
163a	MCT1	Numeric			999
163b	TEN2	Numeric			9999
163c	MCT2	Numeric			999
163d	TEN3	Numeric			9999
163e	MCT3	Numeric			999
163f	TEN4	Numeric			9999
163g	MCT4	Numeric			999
163h	MCT5	Numeric			999
164	HYDC	Numeric			999.9
165	INFR	Numeric			999.9
166	PHAQ	Numeric		NOT NULL	99.9
167	PHKC	Numeric			99.9

168	ELCO	Numeric		99.9
169	EXCA	Numeric		99.9
170	EXMG	Numeric		99.9
171	EXNA	Numeric		99.9
172	EXCK	Numeric		99.9
173	EXAL	Numeric		99.9
174	EXAC	Numeric		99.9
175	CECS	Numeric	NOT NULL	999.9
176	TCEQ	Numeric		99.9
177	GYPS	Numeric		99.9
178	TOTC	Numeric	NOT NULL	99.9
179	TOTN	Numeric		99.99
180	P2O5	Numeric		99
181	PRET	Numeric		999
182	FEDE	Numeric		999
183	FEPE	Numeric		999
184	ALDE	Numeric		999
185	ALPE	Numeric		999


TERRAIN
SUID*
DATE
MAPI
MNEL.....DISS
LITH
WATE
TERRAIN COMPONENT DATA
TCDC*
SCGR
SCDL
SCFM.....FLFR
FLDU
FLST
TERRAIN COMPONENT
SUID*
TCID*
PROP
TCDC
SOIL COMPONENT
SUID*
TCID*
SCID*
PRO
PRID
NRPR..... SCAP
RDEP
RELA
PROFILE
PRID*
PDID
STID.....CLAN
STAX
PHAS
REPRESENTATIVE HORIZON DATA
PRID*
HONU*
DIAG.....ALDI
ALPY
CLAY
MINIMUM HORIZON DATA
PRID*
HONU*
DIAG.....ALDI
ALPY
CLAY
MAXIMUM HORIZON DATA
PRID*
HONU*
DIAG.....ALDI
ALPY
CLAY

Appendix A: example database

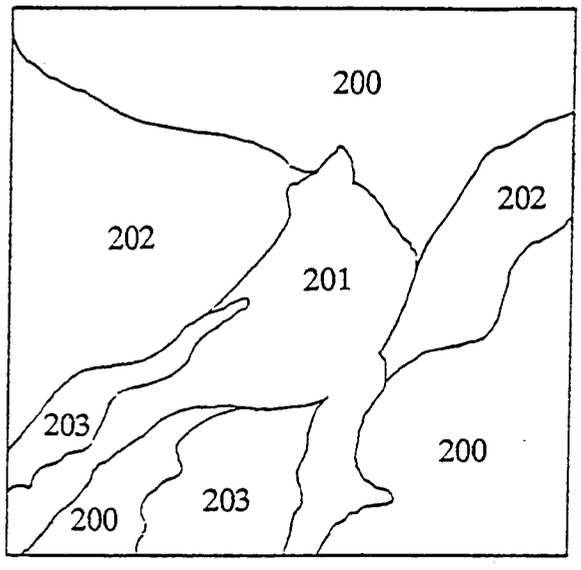


Figure 1 represents a very simple SOTER map with only four SOTER units (or, mapping units) having SOTER unit ID's 200, 201, 202 and 203.

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

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 COMPONT

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

PROFILE

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

ADDENDUM I

Database Structure for Land Use and Vegetation data

Introduction

Land cover characteristics - Land use and Vegetation - will be stored in two separate relations. 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. Obsolete land cover data are not deleted from the database, thus providing a historical record of land use and vegetation.
Land cover data is recorded at SOTER unit level. Hence, digitizing separate land cover boundaries is not necessary, and a simple link is provided between soil/terrain data in the non-spatial SOTER attribute database and the land cover database.

The land cover database consists of merely two relations

- relation LAND USE
- relation VEGETATION

Relation LAND USE

This relation links land use types, possibly at various dates, to a SOTER unit in relation TERRAIN.
Primary key is a combination of attribute 1, the SOTER unit identification code, attribute 2, the observation date, and attribute 3, the land use class.
Attribute 1, the SOTER unit identification code, is a **foreign key** to relation TERRAIN.
Attributes 1 and 2 can be used as a **foreign key** to relation VEGETATION.
Relation LAND USE has degree 4, i.e. a heading that is a set of 4 attributes. These attributes will be described hereafter;

Attribute 1;
Name : SUID
Description : Soter Unit IDentification code
Domain : Name SOTER unit identification code
Unit N/A
Data value type integer
Values all integers in the range from 1 to 9999

Attribute 2;
Name : DATE
Description : DATE of land use observation
Domain : Name date
Unit date
Data value type string
Values all allowable dates (date format: MMYYYY)

Attribute 3;
Name : LUSE
Description : Land USE class
Domain : Name land use class
Unit N/A
Data value type string
Values all valid land use class codes (see SOTER manual, annex no 3)

Attribute 4;
Name : PROP
Description : PROPortion of soter unit under specified land use type
Domain : Name Area coverage percentage
Unit percent
Data value type integer
Values all integers in the range from 0 to 100

Relation VEGETATION

This relation links vegetation types, possibly at various dates, to a SOTER unit in relation TERRAIN.
Primary key is a combination of attribute 5, the SOTER unit identification code, attribute 6, the observation date, and attribute 7, the present native vegetation class.
Attribute 5, the SOTER unit identification code, is a **foreign key** to relation TERRAIN.
Attributes 5 and 6 can be used as a **foreign key** to relation LAND USE.
Relation VEGETATION has degree 4, i.e. a heading that is a set of 4 attributes. These attributes will be described hereafter;

Attribute 1;
Name : SUID
Description : Soter Unit IDentification code
Domain : Name SOTER unit identification code
Unit N/A
Data value type integer
Values all integers in the range from 1 to 9999

Attribute 2;
Name : DATE
Description : DATE of native vegetation observation
Domain : Name date
Unit date
Data value type string
Values all allowable dates (date format: MMYYYY)

Attribute 3;
Name : VEGE
Description : present native VEGEtation class
Domain : Name vegetation class
Unit N/A
Data value type string
Values all valid vegetation **subclass** and **type** codes (see SOTER manual, annex 4).

Attribute 4;
Name : PROP
Description : PROPortion of soter unit under specified vegetation
Domain : Name Area coverage percentage
Unit percent
Data value type integer
Values all integers in the range from 0 to 100

Summary of data structure;

Relation LAND USE

No	Field	Data type	Key?	Null?	Format
1	SUID	Numerical	P, F	NOT NULL	9999
2	DATE	Date	P	NOT NULL	99/9999
3	LUSE	String	P		AA9
4	PROP	Numerical			999

Relation VEGETATION

No	Field	Data type	Key?	Null?	Format
1	SUID	Numerical	P, F	NOT NULL	9999
2	DATE	Date	P	NOT NULL	99/9999
3	VEGE	String	P		AAAA9
4	PROP	Numerical			999

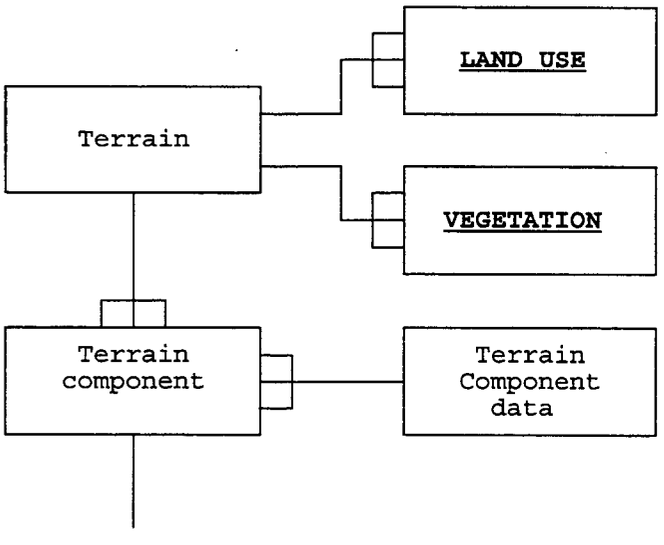
LAND USE

SUID*	DATE*	LUSE*	PROP

VEGETATION

SUID*	DATE*	VEGE*	PROP

Database structure:



Example database:

LAND USE

SUID	DATE	LUSE	PROP	
200	011975	AP1	45	Non-irrigated cultivation
200	111983	AP2	35	Irrigated cultivation
200	031991	AP1	37	Non-irrigated cultivation
201	041977	U	100	Unused
201	041989	AA1	10	Shifting cultivation
202	041990	SR	100	Residential use
203	051989	AP1	37	Non-irrigated cultivated
203	051990	AP2	40	Irrigated cultivation
203	051991	AP2	88	Irrigated cultivation

VEGETATION

SUID	DATE	VEGE	PROP	
200	011989	VA4	85	Tall grassland with woody synusia
200	111992	VA5	55	Tall grassland, no woody synusia
201	031962	IVE2	90	Non-raised bog
201	051965	IVE2	88	Non-raised bog
201	051988	IVE1	72	Raised bog
202	101991	IVD2	100	Mainly lichen tundra
203	081954	IIA1	55	Evergreen broad-leaved woodland
203	041979	IIA2	40	Evergreen needle-leaved woodland
203	071991	IIA2	57	evergreen needle-leaved woodland

ADDENDUM II

Database Structure for Climate data

Introduction

Climate data are normally collected 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 sets can be split up in two major subsets that have been accommodated in a likewise number of relations:

- relation CLIMATE STATION, containing climate station particulars;
- relation CLIMATE DATA, containing (average) monthly climate data.

A third relation contains references to climate data sources:

- relation DATA SOURCE

CLIMATE STATION

This relation contains climate station particulars.
Primary key is attribute 1, the climate station identification code. There are no foreign keys in relation CLIMATE STATION.
Relation CLIMATE STATION has degree 5, i.e. a heading that is a set of 5 attributes. These attributes will be described hereafter;

Attribute 1;

Name	: STID	
Description	: climate STation IDentification code	
Domain	: Name	climate station code
	Unit	N/A
	Data value type	string
	Values	all valid combinations of a two-character ISO country code followed by a four-digit sequential number

Attribute 2;

Name	: STNA	
Description	: climate STation NAme	
Domain	: Name	climate station name
	Unit	N/A
	Data value type	string
	Values	All valid climate station names

Attribute 3;

Name	: LATI	
Description	: LATItude of the climate station	
Domain	: Name	geographical latitude north
	Unit	decimal degrees (latitudes in the southern hemisphere are negative)
	Data value type	float
	Values	all numerical values in the range from minus (-)90.00 to plus (+)90.00

Attribute 4;

Name	: LONG	
Description	: LONGitude of the climate station	
Domain	: Name	geographical longitude east
	Unit	decimal degrees (longitudes in the western hemisphere are negative)
	Data value type	float
	Values	all numerical values in the range from minus (-)180.00 to plus (+)180.00

Attribute 5;

Name	: ALTI	
Description	: ALTItude above/below sealevel of climate station	
Domain	: Name	altitude
	Unit	metres
	Data value type	integer
	Values	all integers in the range from -999 to 9999, negative values for stations below sealevel

CLIMATE DATA

This relation contains the actual climate data (average and/or total monthly and annual values for a number of climate characteristics) from the climate stations.
Primary key is a combination of attribute 6, the climate station identification code, and attribute 7, the kind of climate data. Attribute 6 is also **foreign key** to relation CLIMATE STATION. Attribute 8, cimate data source identification code, is a **foreign key** to relation DATA SOURCE.
Relation CLIMATE DATA has degree 19, i.e. a heading that is a set of 19 attributes. These attributes will be described hereafter;

Attribute 6;
Name : STID
Description : climate STation IDentification code
Domain : Name climate station code
Unit N/A
Data value type string
Values all valid combinations of a two-character ISO country code followed by a four-digit sequential number

Attribute 7;
Name : KIND
Description : KIND of climate data
Domain : Name climate data type code
Unit N/A
Data value type string
Values For legitimate climate data type codes see annex A.

Attribute 8;
Name : SOID
Description : cimate data SOurce IDentification code
Domain : Name source identification code
Unit N/A
Data value type string
Values All legitimate codes for the main source of data for each separate kind of data. The climate data source identification code is primary key in relation DATA SOURCE

Attribute 9;
Name : FTYR
Description : FirsT YeaR of the observation period
Domain : Name year
Unit year
Data value type integer
Values all integers in the range from 0 to 9999

Attribute 10;
Name : LTYR
Description : LasT YeaR of the observation period
Domain : Name year
Unit year
Data value type integer
Values all integers in the range from 0 to 9999

Attribute 11;
Name : NYRS
Description : Number of YeaRS of record in the observation period
Domain : Name year
Unit year
Data value type integer
Values all integers in the range from 0 to 999

Attribute 12;
Name : JANU
Description : average monthly data value for JANUary over the number of years recorded. The climate data type is specified by attribute 7
Domain : dependent on the value of attribute 7; see annex A.

Attribute 13;
Name : FEBR
Description : average monthly data value for FEBRuary over the number of years recorded. The climate data type is specified by attribute 7
Domain : dependent on the value of attribute 7; see annex A.

Attribute 14;
Name : MARC
Description : average monthly data value for MARCh over the number of years recorded. The climate data type is specified by attribute 7
Domain : dependent on the value of attribute 7; see annex A.

Attribute 15;
Name : APRI
Description : average monthly data value for APRIl over the number of years recorded. The climate data type is specified by attribute 7
Domain : dependent on the value of attribute 7; see annex A.

Attribute 16;
Name : MAY
Description : average monthly data value for MAY over the number of years recorded. The climate data type is specified by attribute 7
Domain : dependent on the value of attribute 7; see annex A.

Attribute 17;
Name : JUNE
Description : average monthly data value for JUNE over the number of years recorded. The climate data type is specified by attribute 7
Domain : dependent on the value of attribute 7; see annex A.

Attribute 18;
Name : JULY
Description : average monthly data value for JULY over the number of years recorded. The climate data type is specified by attribute 7
Domain : dependent on the value of attribute 7; see annex A.

Attribute 19;
Name : AUGU
Description : average monthly data value for AUGUst over the number of years recorded. The climate data type is specified by attribute 7
Domain : dependent on the value of attribute 7; see annex A.

Attribute 20;
Name : SEPT
Description : average monthly data value for SEPTember over the number of years recorded. The climate data type is specified by attribute 7
Domain : dependent on the value of attribute 7; see annex A.

Attribute 21;
Name : OKTO
Description : average monthly data value for OKTOber over the number of years recorded. The climate data type is specified by attribute 7
Domain : dependent on the value of attribute 7; see annex A.

Attribute 22;
Name : NOVE
Description : average monthly data value for NOVEmber over the number of years recorded. The climate data type is specified by attribute 7
Domain : dependent on the value of attribute 7; see annex A.

Attribute 23;
Name : DECE
Description : average monthly data value for DECEmber over the number of years recorded. The climate data type is specified by attribute 7
Domain : dependent on the value of attribute 7; see annex A.

Attribute 24;
Name : ANNU
Description : the ANNUal data value over the number of years recorded (average or total). The climate data type is specified by attribute 7
Domain : dependent on the value of attribute 7; see annex A.

DATA SOURCE

This relation links a climate data source to (long-term) climate observations in relation CLIMATE DATA.
Primary key is attribute 25, the climate data source identification code. There are no foreign keys in relation DATA SOURCE.
Relation DATA SOURCE has degree 2, i.e. a heading that is a set of 2 attributes. These attributes will be described hereafter;

Attribute 25;
Name : SOID
Description : climate data SOurce IDentification code
Domain :

Name	source identification code
Unit	N/A
Data value type	string
Values	all valid combinations of a two-character ISO country code followed by a four-digit sequential number

Attribute 26;
Name : SOUR
Description : data SOURce
Domain :

Name	data source name/description
Unit	N/A
Data value type	string
Values	all possible names/descriptions of climate data sources

Summary of data structure;

Relation CLIMATE STATION

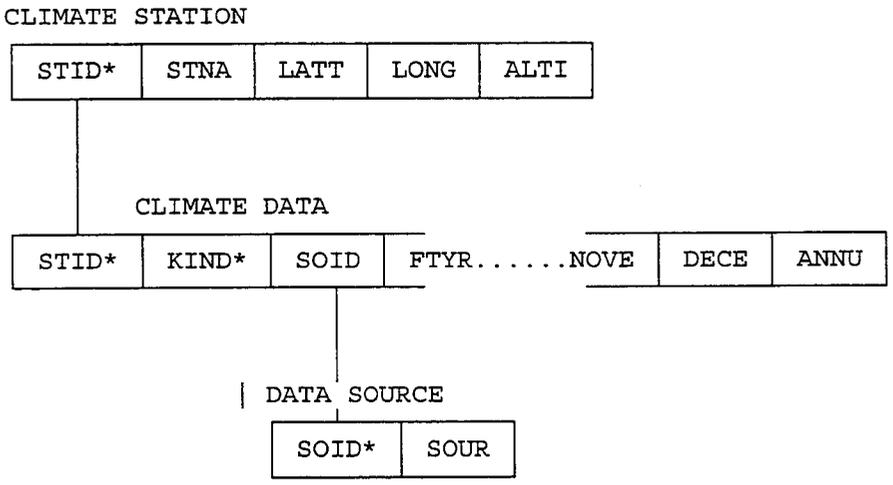
No	Field	Data type	Key?	Null?	Format
1	STID	String	P	NOT NULL	AA9999
2	STNA	String			40 * A
3	LATT	Numerical			9999.99
4	LONG	Numerical			9999.99
5	ALTI	Numerical			9999

Relation CLIMATE DATA

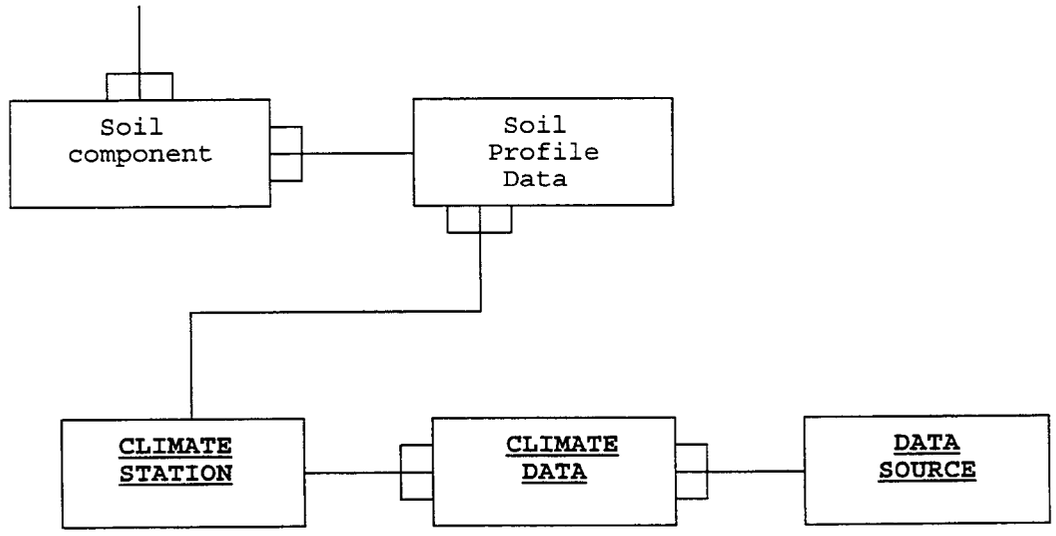
No	Field	Data type	Key?	Null?	Format
6	STID	String	P, F	NOT NULL	AA9999
7	KIND	String	P	NOT NULL	AAAA
8	SOID	String	F		12 * A
9	FTYR	Numerical			9999
10	LTYR	Numerical			9999
11	NYRS	Numerical			9999
12	JANU	Numerical			99999.99
13	FEBR	Numerical			99999.99
14	MARC	Numerical			99999.99
15	APRI	Numerical			99999.99
16	MAY	Numerical			99999.99
17	JUNE	Numerical			99999.99
18	JULY	Numerical			99999.99
19	AUGU	Numerical			99999.99
20	SEPT	Numerical			99999.99
21	OCTO	Numerical			99999.99
22	NOVE	Numerical			99999.99
23	DECE	Numerical			99999.99
24	ANNU	Numerical			99999.99

Relation DATA SOURCE

No	Field	Data type	Key?	Null?	Format
25	SOID	String	P	NOT NULL	AA9999
26	SOUR	String			40 * A



Database structure:



ANNEX A

Climate characteristics

All climate characteristics relevant to SOTER have been grouped in boxes:

Climate characteristics group				
Name	Unit	type	Range/format	Mand.

The Name column contains abbreviated names (in upper case) for all climate characteristics in a group. Permissible climate data type codes (attribute 11 in relation CLIMATE DATA) are all abbriviated names in this column.
The Type column indicates the data value type of a climate characteristic, such as integer, float, string, etc.
An "M" in the Mand(atory) column indicates that an entry for that particular climate characteristic is mandatory.
Since attributes 12 to 24 in relation CLIMATE DATA must be able to accommodate every possible climate characteristic, field with of these attributes should be at least 99999.99.

Rainfall				
RAIN	mm	Integer	0 - 9999	M
RDAY	N/A	Integer	0 - 366	
RMAX	mm	Integer	0 - 999	
RR75	mm	Integer	0 - 99999	

Temperature				
TEMP	°C	Float	-99.9 - 99.9	
TMIN	°C	Float	-99.9 - 99.9	M
TMAX	°C	Float	-99.9 - 99.9	M

Radiation/sunshine				
RADI	MJ/m2/day	Float	0 - 999.99	M
SUNH	hours	Float	0 - 24	M
CLOU	octas	Integer	0 - 8	

Either radiation or sunshine hours is mandatory; radiation is preferable to sunshine hours.

Humidity				
VAPP	mbar	Float	0 - 99.9	M
HUMI	percent	Float	0 - 100	M
HMIN	percent	Float	0 - 100	
HMAX	percent	Float	0 - 100	

Either vapour pressure or relative humidity is mandatory; vapour pressure is preferrable to relative humidity.

Wind				
WIND	m/sec	Float	0 - 999.9	
WDAY	m/sec	Float	0 - 999.9	
WNIG	m/sec	Float	0 - 999.9	
WDIR	degrees	Integer	0 - 360	

WDIR, the prevailing wind direction, is expressed in degrees of the compass card. North is 0°, East is 90°, South is 180°, and West is 270°.

Risck or occurrence of adverse weather events				
WRIS	N/A	Float	0 - 1	

Evaporation				
EPAN	mm	Integer	0 - 9999	
ECOL	mm	Integer	0 - 9999	
EPIC	mm	Integer	0 - 9999	

Evapotranspiration				
PETP	mm	Integer	0 - 9999	
PETH	mm	Integer	0 - 9999	
PETT	mm	Integer	0 - 9999	

ADDENDUM III

Database structure for the Profile source data, Source map data, and Laboratory data (jointly referred to as "Reference" data)

Introduction

The relations described in this paper convey information concerning the data sources used in the SOTER unit compilation process, the laboratories responsible for soil sample analysis and the applied analysis techniques and methods, and the regional/national institutions administering national profile databases and/or collections. This information is jointly called "reference" information.

Relation SOURCE MAP contains information on the type of source map, its scale, location and year of issue. Since also the geographical map boundaries are included, a Geographical Information System may be used to indicate the exact position or coverage of the source map within the SOTER map.

Relation LABORATORY contains the identification codes and associated names of the laboratories responsible for the analysis of the soil samples taken from a specific profile.
Relation LABORATORY METHOD refers to the analysis techniques and methods used by a laboratory for the assesment of a specific profile horizon attribute.
Relation ANALYTICAL METHOD lists method codes and descriptions of all possible analysis techniques and methods used for the assesment of all possible profile horizon attributes.

Relation PROFILE DATABASE contains information on 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.

Relation SOURCE MAP

This relation links a source map to a SOTER unit in relation TERRAIN.
Primary key is attribute 1, the source map identification code. There are no foreign keys in relation SOURCE MAP.
Relation SOURCE MAP has degree 9, i.e. a heading that is a set of 9 attributes. These attributes will be described hereafter;

Attribute 1;

Name	: MAPI	
Description	: source MAP Id	
Domain	: Name	source map identification code
	Unit	N/A
	Data value type	string
	Values	Any suitable code is permitted provided it identifies a unique (i.e. single) source map.

Attribute 2;

Name	: TITL	
Description	: source map TITLe	
Domain	: Name	source map title
	Unit	N/A
	Data value type	string
	Values	All valid source map titles

Attribute 3;

Name	: YEAR	
Description	: YEAR of publication of the source map	
Domain	: Name	year
	Unit	year
	Data value type	integer
	Values	all integers in the range from 0 to 9999

Attribute 4;

Name	: SCAL	
Description	: SCALe of the source map	
Domain	: Name	map scale
	Unit	N/A
	Data value type	integer
	Values	All integers in the range from 1 to 9,999,999

Attribute 5;

Name	: MLAT	
Description	: Minimum LATitude on the source map	
Domain	: Name	geographical latitude north
	Unit	decimal degrees (latitudes in the southern hemisphere are negative)
	Data value type float	
	Values	all numerical values in the range from minus (-)90.00 to plus (+)90.00

Attribute 6;

Name	: MLON	
Description	: Minimum LONgitude on the source map	
Domain	: Name	geographical longitude east
	Unit	decimal degrees (longitudes in the western hemisphere are negative)
	Data value type	float
	Values	all numerical values in the range from minus (-) 180.00 to plus (+)180.00

Attribute 7;

Name	: XLAT	
Description	: maXimum LATitude on the source map	
Domain	: Name	geographical latitude north
	Unit	decimal degrees (latitudes in the southern hemisphere are negative)
	Data value type	float
	Values	all numerical values in the range from minus (-)90.00 to plus (+)90.00

Attribute 8;

Name	: XLON	
Description	: maXimum LONgitude on the source map	
Domain	: Name	geographical longitude east
	Unit	decimal degrees (longitudes in the western hemisphere are negative)
	Data value type	float
	Values	all numerical values in the range from minus (-) 180.00 to plus (+)180.00

Attribute 9;

Name	: TYPE	
Description	: source map TYPE	
Domain	: Name	map type
	Unit	N/A
	Data value type	character
	Values	'S', 'M', 'O'

Relation LABORATORY

This relation links a (soil) laboratory name to a representative profile in relation PROFILE, and to a soil sample attribute analysis in relation LABORATORY METHOD.
Primary key is attribute 1, the laboratory identification code. There are no foreign keys in relation LABORATORY.

Relation LABORATORY has degree 2, i.e. a heading that is a set of 2 attributes. These attributes will be described hereafter;

Attribute 1;

Name	: LABO	
Description	: LABOratory identification code	
Domain	: Name	ISRIC soil laboratory identification code
	Unit	N/A
	Data value type	string
	Values	all valid ISRIC codes for soil laboratories; ISO country code + sequence code

Attribute 2;

Name	: LNAM	
Description	: Laboratory NAMe	
Domain	: Name	laboratory name
	Unit	N/A
	Data value type	string
	Values	all valid laboratory names

Relation LABORATORY METHOD

This relation links a soil sample attribute analysis to a representative profile in relation PROFILE, to a (soil) laboratory in relation LABORATORY, and to an analysis method or technique in relation ANALYSIS METHOD.
Primary key is a combination of attribute 3, the laboratory identification code, attribute 4, the date of laboratory method introduction, and attribute 5, the profile horizon attribute analyzed. Attribute 3 is also a **foreign key** to relation LABORATORY. Attribute 6, the laboratory method, is a **foreign key** to relation ANALYSIS METHOD.
Relation LABORATORY METHOD has degree 4, i.e. a heading that is a set of 4 attributes. These attributes will be described hereafter;

Attribute 3;

Name	: LABO	
Description	: LABOratory identification code	
Domain	: Name	ISRIC soil laboratory identification code
	Unit	N/A
	Data value type	string
	Values	all valid ISRIC codes for soil laboratories; ISO country code + sequence code

Attribute 4;

Name	: DATE		
Description	: DATE of laboratory method introduction		
Domain	: Name	laboratory method introduction date	
	Unit	month/year	
	Data value type	string (date)	
	Values	all allowable dates (format: MMYYYY).	

Attribute 5;

Name	: ATTR		
Description	: profile horizon ATTRibute analyzed		
Domain	: Name	horizon attribute number	
	Unit	N/A	
	Data value type	string	
	Values	SOTER manual attribute numbers, ranging from '77', '78',.. ,.... '109', '110'.	

Attribute 6;

Name	: AMID		
Description	: Analytical Method IDentification code		
Domain	: Name	analytical method code	
	Unit	N/A	
	Data value type	string	
	Values	all combinations of horizon attribute numbers 77 to 110 and method sequence numbers, starting with 1. The horizon attribute number and method sequence number are separated by a slash ('/').	

ANALYTICAL METHOD

This relation links an analysis method or technique to soil sample attribute analyses in relation LABORATORY METHOD.
Primary key is attribute 7, the analytical method identification code. There are no foreign keys in relation ANALYSIS METHOD.
Relation ANALYSIS METHOD has degree 2, i.e. a heading that is a set of 2 attributes. These attributes will be described hereafter;

Attribute 7;

Name	: AMID	
Description	: Analytical Method IDentification code	
Domain	: Name	analytical method code
	Unit	N/A
	Data value type	string
	Values	all combinations of horizon attribute numbers 77 to 110 and method sequence numbers, starting with 1. The horizon attribute number and method sequence number are separated by a slash ('/').

Attribute 8;

Name	: AMET	
Description	: Analytical METhod	
Domain	: Name	analytical method description
	Unit	N/A
	Data value type	string
	Values	all valid analytical method descriptions

Relation PROFILE DATABASE

This relation links a (national) soil profile collection or database to a representative profile in relation PROFILE.
Primary key is attribute 1, the soil Profile Database identification code. There are no foreign keys in relation PROFILE DATABASE.
Relation SOURCE MAP has degree 2, i.e. a heading that is a set of 2 attributes. These attributes will be described hereafter;

Attribute 1;

Name	: PDID	
Description	: (national) soil Profile Database IDentification code	
Domain	: Name	profile database code
	Unit	N/A
	Data value type	string
	Values	all valid ISRIC codes for soil profile databases; ISO country code + sequence code

Attribute 2;

Name	: DOWN	
Description	: profile Database OWNer (name of institute or organization)	
Domain	: Name	institute/organization name and address
	Unit	N/A
	Data value type	string
	Values	all valid institute or organization names and addresses (in full)

Summary of data structure;

Relation SOURCE MAP

No	Field	Data type	Key?	Null?	Format
1	MAPI	String	P	NOT NULL	12 * A
2	TITL	String			40 * A
3	YEAR	Numerical			9999
4	SCAL	Numerical			9999999
5	MLAT	Float			999.99
6	MLON	Float			999.99
7	XLAT	Float			999.99
8	XLON	Float			999.99
9	TYPE	Character			A

Relation LABORATORY

No	Field	Data type	Key?	Null?	Format
1	LABO	String	P	NOT NULL	AA999
2	LNAM	String			40 * A

Relation LABORATORY ANALYSIS

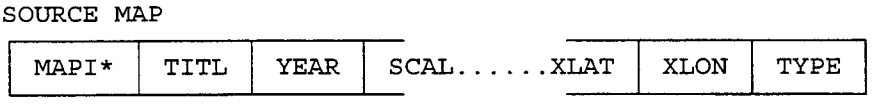
No	Field	Data type	Key?	Null?	Format
3	LABO	String	P, F	NOT NULL	AA999
4	DATE	Date/string	P	NOT NULL	999999
5	ATTR	String	P	NOT NULL	999
6	AMID	String	F	NOT NULL	999/9

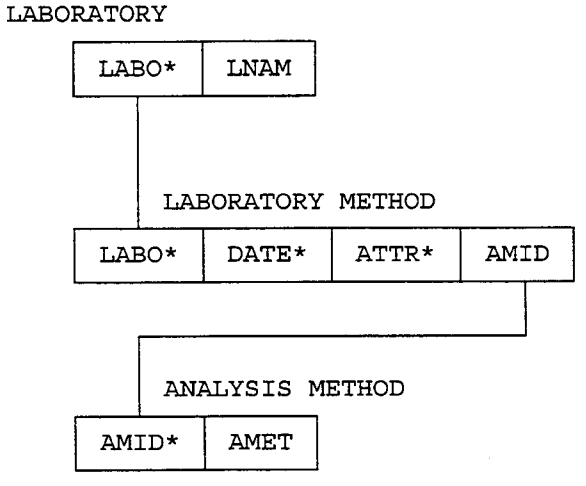
Relation ANALYSIS METHOD

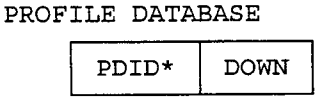
No	Field	Data type	Key?	Null?	Format
7	AMID	String	P	NOT NULL	999/9
8	AMET	String			40 * A

Relation PROFILE DATABASE

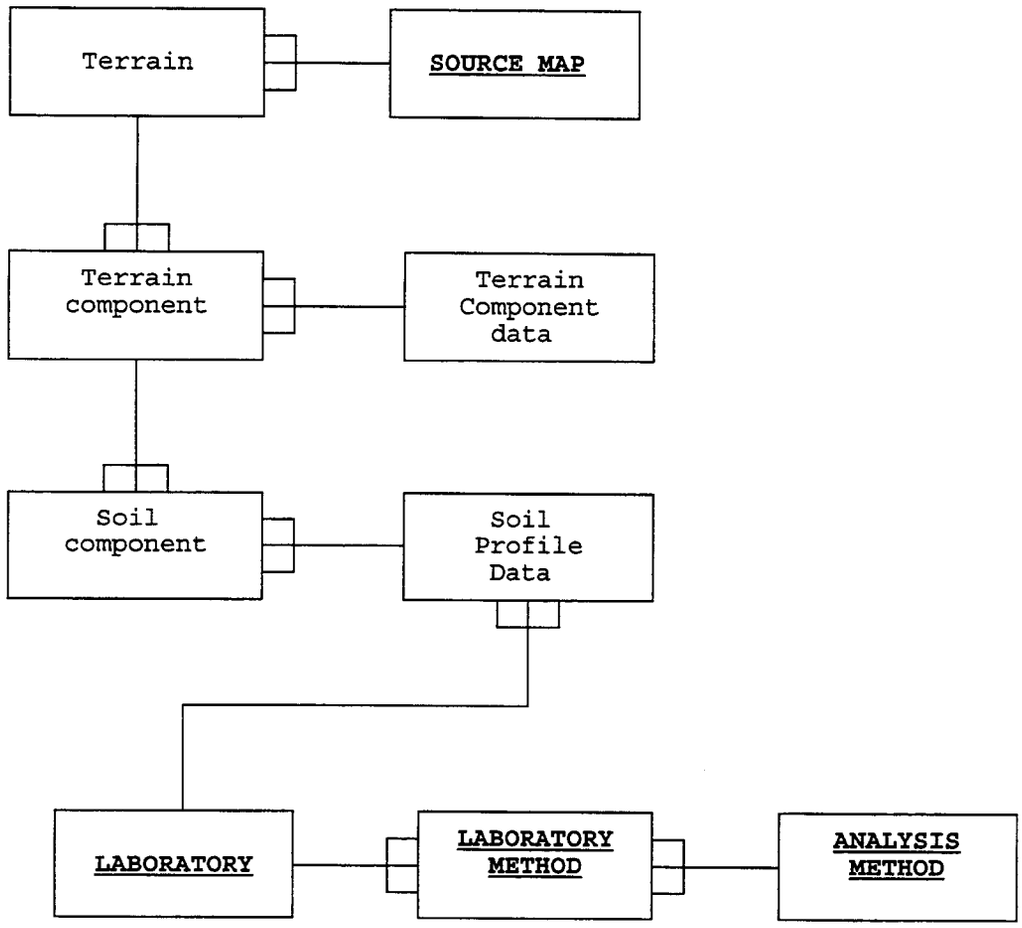
No	Field	Data type	Key?	Null?	Format
1	PDID	String	P	NOT NULL	AA999
2	DOWN	String		40 * A	







Database structure:



Example database for laboratory data:

LABORATORY

LABO	LNAM
NL009	ISRIC Wageningen, Netherlands
NL011	Inst. Bodemvruchbaarheid, Oosterbeek, Netherlands
US007	USDA Nat. Lab., Washington DC, USA
BE002	Inst. Land & Water Management, Leuven, Belgium

LABORATORY ANALYSIS

PRID	ATTR	LABO	DATE	AMID
AC713	101	NL009	091988	101/2
AC713	96	US007	051988	96/3
AC713	76	US007	111988	76/1
AC713	79	US007	111988	76/1
EC906	101	NL011	041985	101/1
EC906	95	NL011	041985	95/1
EC906	106	BE002	021986	106/2
OB493	101	US007	041972	101/1
OB493	96	NL009	121971	96/1
OB493	106	US007	041972	106/2

ANALYSIS METHOD

AMID	AMET
101/1	ISO 202228.9
101/2	ISRIC lab. standard 207 (methode Van Wijck).
101/3	ISO 202228.9
96/1	ISRIC lab. standard 122-a (enhanced)
96/3	McKinley & Alpert, St. Un. of South Carolina, 1985
76/1	USDA standard 1223
95/1	ISO203091.6nl
106/1	Methode Clauwaert, Gent University, 1974
106/2	USDA standard 122/1225 (Montgomery)