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SOTER summary file for Central and Eastern Europe (SOVEUR Project)

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Project GCP/RER/007/NET on Mapping of Soil and Terrain Vulnerability in Central and Eastern Europe, SOVEUR, was signed between the Food and Agriculture Organization of the United Nations (FAO) and the Government of the Netherlands, within the framework of the FAO/Netherlands Government Programme. In view of the specific nature of the services to be rendered, the Project activities were implemented under a Contractual Service Agreement with the International Soil Reference and Information Centre (ISRIC). It was carried out in close collaboration with specialists from soil survey institutes in Belarus, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Moldova, Poland, Romania, the Russia Federation (West of the Urals), Slovak Republic and the Ukraine, who collated the various national data sets using uniform guidelines.

ABSTRACT

A *SOTER summary file* has been compiled to aid end-users with limited programming experience. It has been derived from the full-scale Soil and Terrain (SOTER) database and a set of "derived soil properties" for Central and Eastern Europe (SOVEUR). As such, the summary file presents aggregated information by SOTER unit: each included Terrain Component and Soil Component is characterized in terms of its major land form, parent material, and dominant soil unit (FAO Revised Legend). This information is followed by a list of "derived soil properties" consisting of median values for soil pH, organic carbon content, cation exchange capacity, base saturation, sand, silt, and clay content, USDA soil textural class, and bulk density for both the topsoil (0-0.3 m) and subsoil (0.3-1 m). Generalized information about the soil drainage class and rootable soil depth is presented also for each soil unit. The SOTER summary file is available both in DBF and ASCII-delimited format. As such it can be easily linked with the soil geographical data for the SOVEUR region, using GIS, providing input for a wide range of exploratory studies at the observational scale (1:2,5000,000). More detailed assessments should be based on an analysis of the full-scale SOTER database for the SOVEUR region.

1. INTRODUCTION

The SOVEUR project on Mapping of Soil and Terrain Vulnerability in Central and Eastern Europe developed a geo-referenced Soil and Terrain (SOTER) database for 13 countries in Central and Eastern Europe, including Belarus, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Moldova, Poland, Romania, the Russian Federation (West of the Urals), Slovak Republic and the Ukraine. This SOTER database was produced at an observational scale of 1:2.5 million, according to uniform guidelines and criteria (see Batjes and Van Engelen, 1997).

The current report presents a "SOTER summary file" for the SOVEUR area. It has been extracted from the full-scale SOTER database for the region, complemented with a selection of "derived soil data". The summary file has been compiled to facilitate end-user access to the soil and terrain data for the SOVEUR region. The file can serve as input for a wide range of environmental studies, at an observational scale.

The report first outlines the SOTER mapping approach and database structure (Section 2). Subsequently the procedure for making the SOTER summary file is described (Section 3). Concluding remarks are made in Section 4. The structure of the SOTER summary file is presented in Appendix 1. Coding conventions, for the non-numerical attributes, are documented in Appendix 2.

2. FULL-SCALE SOTER DATABASE

2.1 Mapping approach

SOTER is a land resources information system based on the concept that features of land — and those of its component terrain and soils — are the result of interacting physical, biological and social processes over time.

In many respects the SOTER mapping approach resembles physiographic soil mapping. The main difference lies in the emphasis that the SOTER methodology puts on the terrain-soil relationships in comparison to what is often done in traditional soil mapping, notably at the considered scale of 1:2.5 million.

The guiding principle in the SOTER methodology therefore is the identification of areas of land with a distinctive and often repetitive pattern of landform, slope, parent material, and soils (Fig. 1). Uniform expanses of land distinguished in this manner (i.e., Terrain Units) are called SOTER units. These units can be delineated in various ways, depending on the type of source materials available; detailed procedures for mapping SOTER units are given elsewhere (Van Engelen and Wen, 1995; Batjes and Van Engelen, 1997).

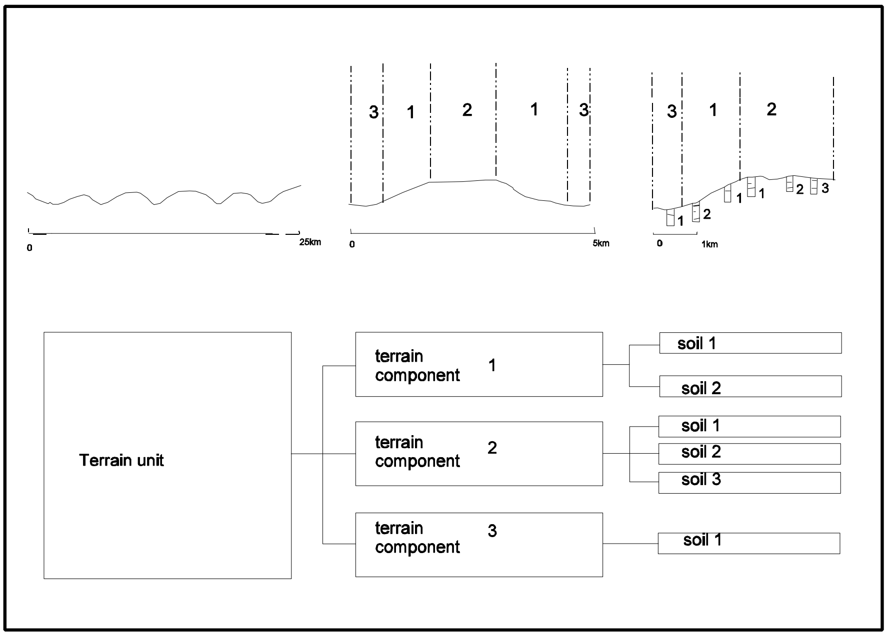

Fig. 1. Schematic representation of a SOTER unit having 3 terrain components and 6 soil components. (Source: Van Engelen and Wen, 1995)

2.2 Database structure

Each SOTER database consists of two main elements, a geometric component and an attribute database (Fig. 2).

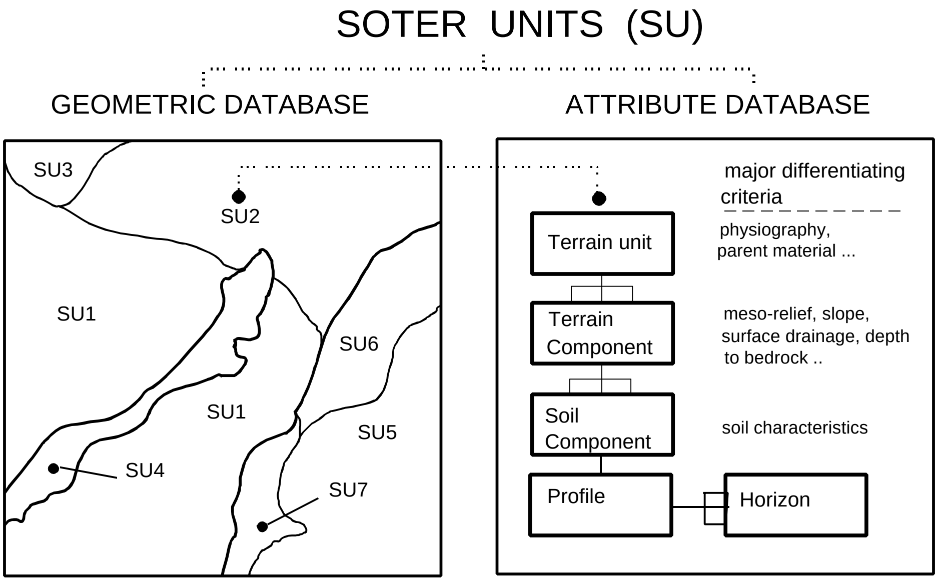

Fig. 2. SOTER units (SU) as shown on geometric database (map) and characterized in the attribute database

The *geometric data base* holds information on the location, extent, and topology of each SOTER unit. Spatial information on the geometry is handled with commercially available Geographic Information System (GIS) software. Each SOTER unit has a unique identifier in the geometric database (NEWSUID; see App. 1). This "primary key" provides the logical link to the attribute data with respect to its constituent Terrain Units, Terrain Component(s) and Soil Component(s) (Fig. 1). The exact location of the individual components of a SOTER unit cannot be mapped explicitly at the reference scale of 1:2.5 million, but the hierarchical structure and SOTER unit composition can be documented in the attribute data base (Fig. 2).

The *attribute data base* comprises several thematic files, the contents of which can be handled by a Relational Database Management System (RDBMS) using a set of uniquely defined primary keys (Tempel, 1997). As a result, interpretations of the attributes of each combination of terrain component and soil component, can be generated for each SOTER unit. These results can then be mapped using GIS.

3. SOTER SUMMARY FILE

3.1 Structure and contents

Interpretations of the full-scale SOTER database, as schematically depicted in Figure 2, require a good knowledge of relational database handling systems and a good understanding of the SOTER database structure. This may form an obstacle to end-users with limited programming expertise. Thus, in order to facilitate access to the data, a so-called *SOTER summary file* has been prepared.

The file incorporates information held in the Terrain (Unit), Terrain Component, Soil Component, Profile and Horizon data files of the SOTER system. Being a summary file, it only presents information for selected of characteristics by SOTER unit (App. 1). These include the Terrain Component and Soil Component number plus data on major landform, parent material, and soil unit code (according to FAO, 1988). The relative extent of each soil unit (or Soil Component) in a SOTER unit is also listed.

The soil unit code permits to link a selection of "derived soil data" to each unique combination of Terrain Unit, Terrain Component and Soil Component considered on the 1:2,5000,000 scale SOTER map (see Batjes, 2000a). While this leads to "data redundancy", in terms of data storage, it also greatly facilitates access to the data as (most) end-users need no longer define "relations" between the various data sets using the appropriate primary keys. As a result, overall user-friendliness of the SOTER data is greatly enhanced.

The set of "derived soil properties" considered includes: median soil pH_{water}, organic carbon content, cation exchange capacity, base saturation, sand, silt, and clay content, bulk density — both for the topsoil (0-0.3 m) and subsoil (0.3-1 m) — as well as information about the USDA soil textural class, soil drainage class and rootable soil depth.

The structure of the SOTER summary file is presented in Appendix 1, and the coding conventions in Appendix 2. Abbreviations for soil units codes are according to the Revised Legend of FAO (1988).

The SOTER summary file, which is presented both in a DBF and ASCII-delimited format, can easily be linked with the soil geographic data for the SOVEUR region using GIS with NEWSUID as the primary key.

3.2 Applicability

Prior to using the set of "derived soil data", modellers and other user-groups should familiarize themselves with the methodologies, (profile) data sets, and pedotransfer rules used (see Batjes, 2000 a, b). Keeping this in mind, the current set of "derived soil data" should be seen as a first approximation. Although based on the "best soil data" currently available of the SOVEUR region, some of these are known to be "patchy and of uncertain quality" (see Batjes, 1999).

4. CONCLUSIONS

- A summary file has been generated to facilitate access to the information held in the full-scale SOTER database for the SOVEUR region. When linked to the geographic data, using GIS, it can be used to obtain a broad overview of selected soil conditions for the region at a scale of 1:2,5000,000.

- Modellers should familiarize themselves with the assumptions and pedotransfer rules used to develop the set of "derived soil data", prior to using the SOTER summary file.

- More specific studies of soil and terrain conditions in Central and Eastern Europe should be based on an analysis of the full-scale SOTER geographic and attribute databases.

- SOTER summary files, of the type described in this report, should be prepared for all continental SOTER databases, including the one available for South America and the Caribbean (FAO, ISRIC, UNEP and CIP, 1998), in order to enhance their accessibility to a wide group of end-users.

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APPENDICES

App. 1 Structure of SOTER summary file

Field Name	Type	Width	Dec	Description
NEWSUID	Character	6		SOTER unit ID
TCID	Numeric	1	0	Terrain Component ID
SCID	Numeric	1	0	Soil Component ID
LNDF	Character	2		Major landform
LITH	Character	3		Parent material
CLAF	Character	3		Soil unit code (FAO, 1988)
PROP	Numeric	3	0	Relative extent of SCID (soil unit) in SOTER unit
PHH2O_TOP	Numeric	6	2	Median pH(H_2O) for the topsoil (x_TOP)
PHH2O_SUB	Numeric	6		Median pH(H_2O) for the subsoil (x_SUB)
ORGC_TOP	Numeric	6	2	As above, but for organic carbon (g C kg^{-1}, i.e. pro mille)
ORGC_SUB	Numeric	6	2	As above, but for organic carbon (g C kg^{-1})
CEC_TOP	Numeric	6	2	As above, but for CEC_{soil} ($cmol_c$ kg^{-1})
CECL_SUB	Numeric	6	2	As above, but for CEC_{soil} ($cmol_c$ kg^{-1})
BSAT_TOP	Numeric	6	2	As above, but for base saturation (%)
BSAT_SUB	Numeric	6	2	As above, but for base saturation (%)
SAND_TOP	Numeric	6	2	As above, but for sand (wt %)
SAND_SUB	Numeric	6	2	As above, but for sand (wt %)
SILT_TOP	Numeric	6	2	As above, but for sand (wt %)
SILT_SUB	Numeric	6	2	As above, but for silt (wt %)
CLAY_TOP	Numeric	6	2	As above, but for clay (wt %)
CLAY_SUB	Numeric	6	2	As above, but for clay (wt %)
TEXT_TOP	Character	3		USDA soil textural class
TEXT_SUB	Character	3		USDA soil textural class
BULK_TOP	Numeric	6	2	As above, but for bulk density (g cm^{-3})
BULK_SUB	Numeric	6	2	As above, but for bulk density (g cm^{-3})
DRAIN	Character	2	N	FAO soil drainage class
DEPTCLAS	Character	1	N	Soil depth class

Notes:

1) Details on methodology, profile data set used, issues of comparability of soil analytical data obtained in the various countries/laboratories, data analysis, and pedotransfer rules to fill-in gaps in the derived data are discussed by Batjes (2000 a, b). By default, the derived soil data for Arenosols (AR) were used for areas of 'Sand Dunes' (#SA), the values for lithic Leptosols (LPq) were used for areas of 'Rock Outcrops' (#RK) and 'Crumbly Rock' (#CR), and the values for Solonchaks (SC) for areas of 'Salt Flats' (#ST). If there are no derived soil data at all for a particular mineral soil unit, the medians computed for all mineral soils combined, but excluding Arenosols, Andosols and Vertisols, have been used as best available proxies (coded as '##') (see Batjes, 2000b). In case of "miscellaneous units", such as Water bodies (#W), Glaciers (#G), Urban areas (#U), and large Quarries (#Q), the fields for derived data are left blank.
2) Values listed in the file under consideration should be seen as being the currently "best available' estimates (median) for the Capacity Controlling Properties in the SOVEUR area. All (numeric) data were rounded to one

decimal place. Totals shown for sand, silt, and clay — by depth range — may by differ from 100% due to rounding.

3) File name: SOTERSUM.DBF. Also available as ASCII-delimited file (SOTERSUM.txt)

App. 2 Coding conventions used in SOTER summary file

App. 2.1 Codes for major landforms (LNDF; after: Batjes and Van Engelen, 1997):

Code	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
SR	Ridges
SU	Mountainous highland
T	Steep land
TE	High-gradient escarpment zone
TH	High-gradient hill
TM	High-gradient mountain
TV	High-gradient valleys
#G	Glaciers and land ice
#Q	Quarries
#U	Urban areas (main towns, etc.)
#W	Water bodies

App. 2.2 Codes for parent material (LITH; after Batjes and Van Engelen, 1999):

Code	Description
I	Igneous rock
IA	Acid igneous rock
IA1	Granite
IA2	Grano-diorite
IA3	Quartz-diorite
IA4	Rhyolite
IB	Basic igneous rock
IB1	Gabbro
IB2	Basalt
IB3	Dolerite
II	Intermediate igneous rock
II1	Andesite
II2	Diorite-syenite
IU	Ultrabasic igneous rock
IU1	Peridotite
IU2	Pyroxenite
IU3	Ilmenite
M	Metamorphic rock
MA	Acid metamorphic rock
MA1	Quartzite
MA2	Gneiss
MA3	Slate
MA4	Schist
MB	Basic metamorphic rock
MB1	Slate
MB2	Schist
MB3	Gneiss rich in ferro-magnesian minerals
MB4	Metamorphic limestone (marble)
SC	Clastic sediments
SC1	Conglomerate
SC2	Sandstone
SC3	Siltstone
SC4	Shale
SC5	ironstone
SE	Evaporites
SE1	Anhydrite, gypsum
SE2	Halite
SO	Organic (sedimentary rock)
SO1	Limestone
SO2	Marl and other mixtures
SO3	Coals

Code	Description
U	Unconsolidated
UC	Colluvial unconsolidated rock
UC1	calcareous
UC2	non-calcareous
UE	Eolian unconsolidated rock
UE1	calcareous
UE2	non-calcareous
UF	Fluvial
UF1	calcareous
UF2	non-calcareous
UG	Glacial unconsolidated rock
UG1	calcareous
UG2	non-calcareous
UL	Lacustrine unconsolidated rock
UL1	calcareous
UL2	non-calcareous
UM	Marine unconsolidated rock
UM1	calcareous
UM2	non-calcareous
UO	Organic unconsolidated rock
UO1	calcareous
UO2	non-calcareous
UP	Pyroclastic unconsolidated rock
UP1	non-acid
UP2	acid

App. 2.3 Codes for soil depth classes (DRAIN; after FAO, 1990):

Code	Class	Description
V	very shallow	< 30 cm
S	shallow	30 - 50 cm
M	moderately deep	50 -100 cm
D	deep	100- 150 cm
X	very deep	≥ 150 cm

App. 2.4 Codes for (internal) drainage of the soil (DEPTCLAS; after FAO, 1990):

Code	Class	Description
E	excessively drained	Water is removed from the soil very rapidly.
S	somewhat exces. drained	Water is removed from the soil rapidly.
W	well drained	Water is removed from the soil readily but not rapidly.
M	moderately well drained	Water is removed from the soil somewhat slowly during some periods of the year. The soils are wet for short periods within rooting depth.
I	imperfectly drained	Water is removed slowly so that the soils are wet at shallow depth for a considerable period.
P	poorly drained	Water is removed so slowly that the soils are commonly wet for considerable periods. The soils commonly have a shallow water table.

App. 2.5 *Soil unit codes* (CLAF):

The dominant soils of each Soil Component (see Fig. 1) is characterized by its classification according to the Revised Legend of FAO (1990). In addition, a number of extra codes had to be introduced under the "CLAF" header to permit linkage of the various national databases in a uniform manner:

#SA:	Sand dunes	(for Russia only)
#CR:	Crumbly Rock	(for Russia only)
#RK:	Rock outcrops	(for Russia only)
#W:	Water bodies	
#G:	Glaciers and land ice	
#U:	Urban areas	(for Estonia and Czech Republic only)
#Q:	Quarries	(for Estonia only)