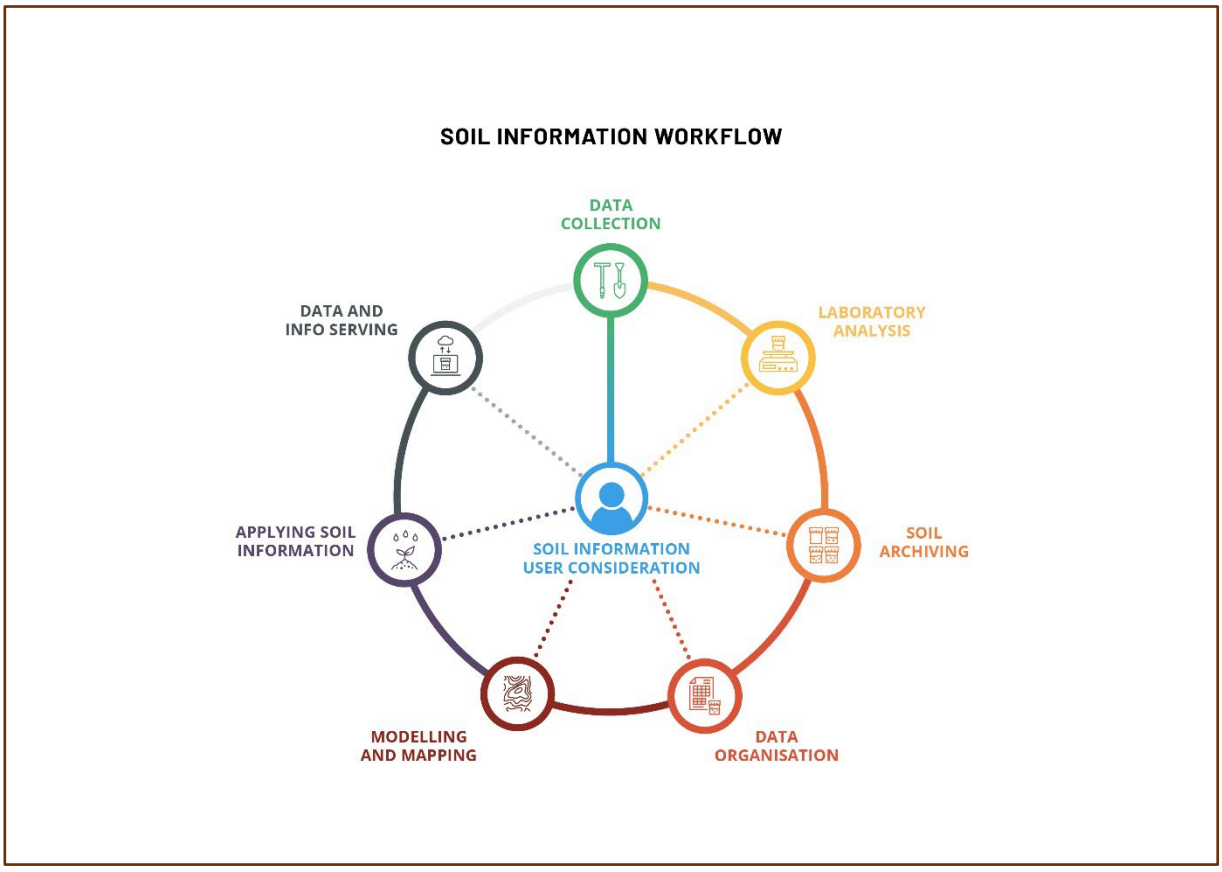
Procedures for compiling a soil and terrain database according to SOTER conventions

Niels H. Batjes

August 2022



Director, ISRIC - World Soil Information
Droevendaalsesteeg 3 (building 101)
6708 PB Wageningen
The Netherlands
E-mail: soils@isric.org

This document was prepared for the ISRIC Community of Practice

Additional information on ISRIC can be accessed through http://www.isric.org.

Citation

Batjes, N.H., 2022. Procedures for compiling a soil and terrain database according to SOTER conventions. CoP report, ISRIC – World Soil Information, Wageningen. https://dx.doi.org/10.17027/isric-wdc-soils-w9tr-p552

Contents

Figures

Summary

This document was prepared in the framework of ISRIC's Community of Practice for soil information providers. It provides a compilation of resources required to compile a Soil and Terrain (SOTER) database at (sub)national scale using existing resources (i.e., no new field work is assumed). More detailed information on the various steps required for compiling the spatial (geographic) and attribute component of a SOTER database is provided in the cited documentation. Most of the materials cited here were created in the framework of the SOTER programme and related EU-projects. SOTER databases are typically compiled in the framework of international projects.

1. Introduction

Some countries may not yet have a database holding their soil data in a standardised format. This document explains how such a database can be created, based on the general principles developed for the Soil and Terrain database (SOTER).

The SOTER programme was initiated in 1986 by the Food and Agricultural Organization of the United Nations (FAO), the United Nations Environmental Programme and ISRIC- World Soil Information, under the auspices of the International Soil Science Society (now International Union of Soil Sciences). The aim of the programme was to develop a global SOTER database at scale 1:1 million aimed to be the successor of the FAO-UNESCO Soil Map of the World.

A SOTER^{TM} database with global coverage was never achieved, but SOTER databases were developed for various regions, countries and continents. Typically, SOTER databases are developed in collaboration with a range of partners.

A SOTER database is composed of a map (in GIS polygon format) that delineates the SOTER map units themselves and a set of tables in a relational database (in MS Access or PostgreSQL format) with terrain and soil data. The information in the tables can be linked to the units of the map through unique identifiers as described below.

Consistent use of the SOTER methodology ensures standard procedures for data harmonisation are applied. This meets the requirements under Pillar 4 of the Global and European Soil Partnership (FAO-GSP 2016) and compliance with INSPIRE (2015) data protocols.

Generally, a SOTER database at 1:250,000 scale is considered appropriate to support soil and land use policy development at subnational and national scale. Alternatively, geo-statistical, digital soil mapping approaches may be used for this Poggio (2021).

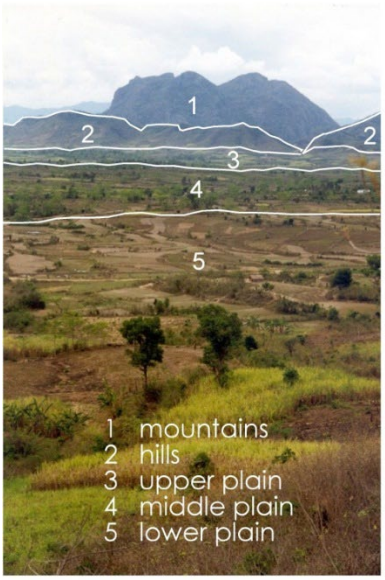
This report brings together materials that can be used to compile a national SOTER database. These documents/approaches were developed in the framework of various international projects, most recently the EU-funded eSOTER and SOTER Danube project.

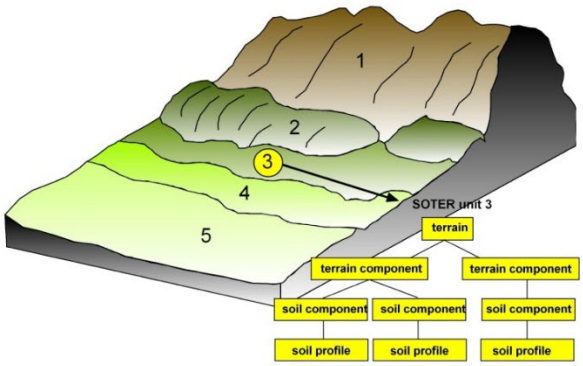
Chapter 2 provides a brief overview of the SOTER methodology. Chapter 3 provides links to resources for mapping SOTER terrain units as developed during the eSOTER project. Chapter 4 refers to the template for the SOTER database and forms for entering data. The 'data entry' tool itself is available in Microsoft-Access format. The data model follows the conventions of the SOTER procedures Manual (van Engelen and Dijkshoorn 2013), with some structural changes required to improve the database structure itself, but not the SOTER conventions themselves (Batjes and Ribeiro 2019a, b).

2. SOTER methodology

SOTER is a land resources information system based on the concept whereby features of the land - in which terrain and soil occur - incorporate processes and systems of interrelationships between physical, biological and social processes over time (van Engelen and Dijkshoorn 2013).

Central to the SOTER methodology is the identification (delineation) of areas of land with a distinctive, often repetitive, pattern of landform, lithology, surface form, slope, parent material, and soil. These are named SOTER units. Each SOTER unit (polygon in the GIS) thus represents one unique combination of terrain and soil characteristics. Figure 1 represents a landscape with five different SOTER units (van Engelen and Dijkshoorn 2013). SOTER unit 3, for example, consists of one terrain type, consisting of an association of two terrain components, the first having two soil components and the second one soil component. Each soil component is characterised using a regionally representative soil profile.





Unit	*SOTER unit description*
1	one terrain type with one terrain component and one soil component
2	one terrain type consisting of an association of two terrain components each having a particular soil component
3	one terrain type, consisting of an association of two terrain components, the first having two soil components and the second one soil component. Each soil component is characterised using a regionally representative soil profile.
4	one terrain type, consisting of an association of two terrain components, the first having one soil component, the second having an association of three soil components
5	one terrain type with one terrain component, having an association of two soil components

Figure 1. Relation between SOTER units and their composing parts as characterised in the database

Each SOTER database is composed of two components:

1) Geometric component: Describes the location and extent of each SOTER unit (polygon) and its topology (shapes, neighbours and hierarchy of delineations). The corresponding information is managed using GIS (Geographic information System), *in casu* ArcMap (ESRI®) or QGIS (open source) (see Figure 2).

2) Attribute component: Specifies the characteristics of the geometric object (i.e., given SOTER unit). These attributes, as described in Chapter 4, are managed in a Relational Database Management System (RDBMS*), in casu* an MS-Access® database.

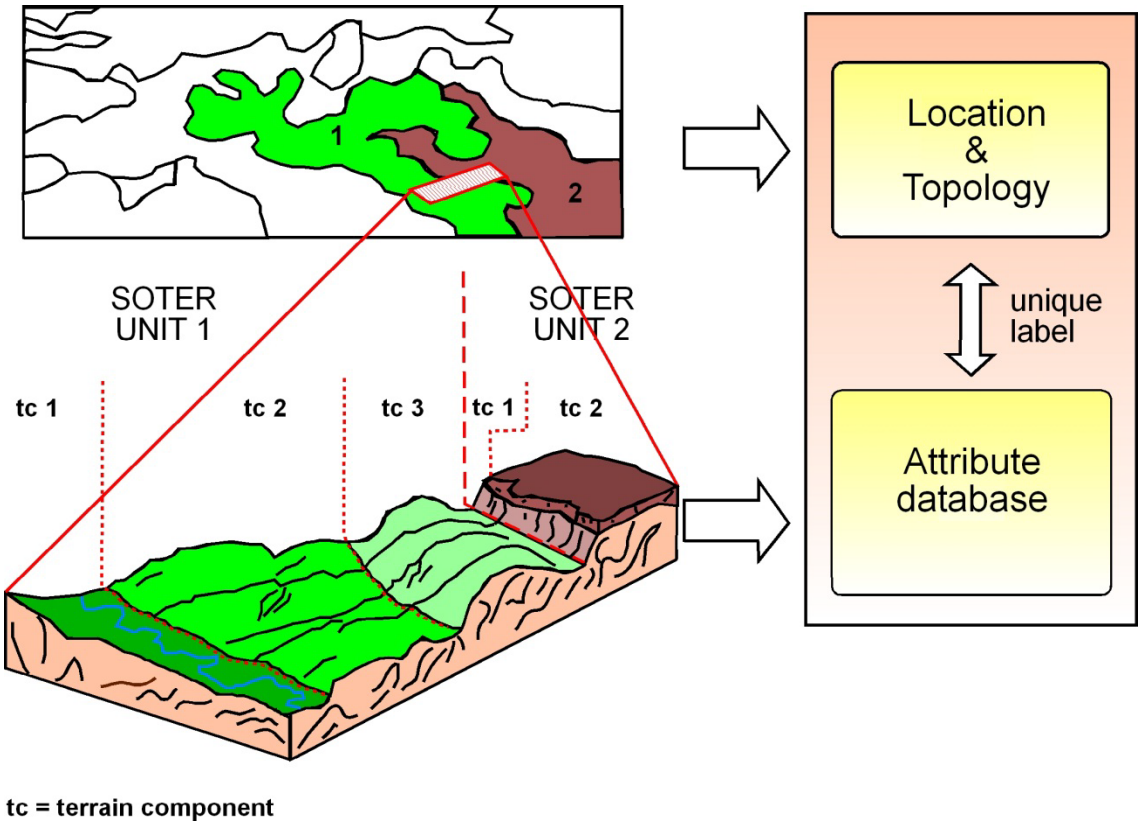


Figure 2. Schematic representation of a SOTER database with its geographic and attribute component (conventional case).

Information held in the GIS and RDBMS can be linked through the unique label (SUID) for the given polygon or SOTER unit ID. In transnational SOTER databases, unique labels for each polygon will consist of the country code (ISOC) and terrain number (SUID).

3. Mapping SOTER terrain units

The following materials are available to compile the geographic component of a SOTER database:

- 'An SRTM-based procedure to delineate SOTER terrain units on 1:1 and 1:5 million scales' (Dobos *et al.* 2005) [1].

The above procedure has been slightly modified for application during the eSOTER project:

- '1:1 million scale SOTER geometric databases of the terrain units for the windows in Europe, Morocco and China' (Dobos 2010) [2].

Finally, there is a zip-file containing the procedure developed to generate e-SOTER maps at scale 1:1M. The procedure runs in ArcInfo [3]. It was later used by JRC to generate the spatial component for the SOTER Danube project; the approach considers hypsometry (i.e., elevation above mean sea level in meter), slope, relief intensity, and surface conditions as main differentiating criteria (see App. 1 in Ruiperez Gonzalez and Batjes (2019)).

In principle, the above building blocks should suffice to create the geographic component of a SOTER database for your region of interest (scale 1:250,00 to 1:1 million). Inherently, some knowledge of GIS and soil science will be required.

4. Compiling the attribute tables

Procedures for creating the SOTER attribute tables, that further characterise the above delineated SOTER terrain units, are provided in 'Updated MS-Access SOTER template for the EU Danube basin project with worked examples (with datasets)' (Batjes and Ribeiro 2019b) [4]. The data model itself is available here [5].

Detailed guidelines for filling the SOTER attribute data, developed during the SOTER project for Danube basin countries, are provided in 'Guidelines for compiling a 1:250,000 SOTER database' (Batjes and Ribeiro 2019a) [6].

Appendix 5 in the later document describes worked examples for two cases. The *first example* is for a 'conventional' SOTER database with compound map units (see Figure 2); each SOTER (terrain) unit

[1] http://eusoils.jrc.it/ESDB_Archive/eusoils_docs/other/SOTER/SOTER_endre.pdf
[2] https://www.esoter.net/sites/default/files/Deliverable%20D3.pdf

[3] https://www.esoter.net/sites/default/files/e-SOTER-procedure-delivery-2011-04-28.zip

[4] https://www.isric.org/sites/default/files/Report01_SOTER_Danube_Database_2019-09-12_0.pdf

[5] https://www.isric.org/documents/document-type/updated-ms-access-soter-template-eu-danube-basin-project-worked-examples
[6] https://www.isric.org/sites/default/files/Report03_SOTER_Danube_TechGuidelines_20210209_0.pdf

may be comprised of several terrain components having one to several soil components. Each of these soil components is then represented by a regionally representative profile in the database. The *second example* is for a case where all SOTER units are considered to consist of one terrain component having one or more soil components (Figure 3). Again, each of these soil components is characterised by a representative soil profile. The second approach is similar to that used for the eSOTER project and and SOTER Danube basin project.

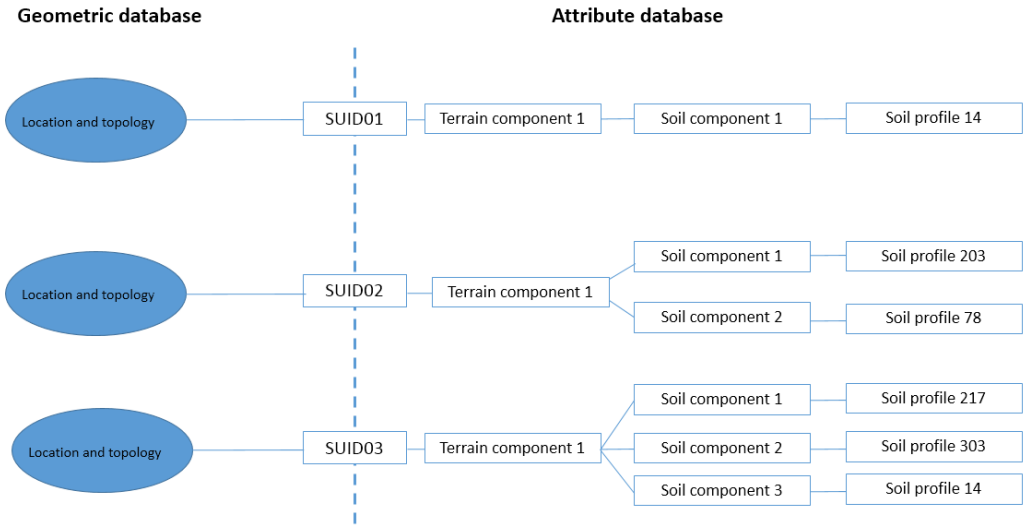


Figure 3. Schematic representation of a 'simplified' SOTER database with its geographic and attribute data component (simplified case).

Examples of pre-filled terrain unit shapefiles for the Danube basin countries are given elsewhere (Ruiperez Gonzalez and Batjes 2019) [7].

5. Creating INSPIRE compliant files

Finally, a 'Developer and user manual' (Van Genuchten 2021) [8] explains how SOTER GIS and attribute databases can be exported in INSPIRE (2015) compliant XML/GML format.

[7] https://www.isric.org/sites/default/files/Report02_SOTER_Danube_GIS_201906_0.pdf

[8] https://www.isric.org/sites/default/files/Report05_ExportingDanubeBasinSOTERdatabases2INSPIREcompliantGML_SOTER.pdf

6. Concluding remarks

This document provides the building blocks for compiling a SOTER database.

Developing a SOTER database is not a simple task.

Technical support from ISRIC in this respect is only conceivable within the framework of an externally funded project.

7. References

Batjes NH and Ribeiro E 2019a. *Guidelines for compiling a 1:250,000 SOTER database (Deliverabe A5, EU JRC Service Contract #936108, Collection of soil data in SOTER format from 14 Danube strategy countries, at scale 1:250 000). [Project report 3]*, ISRIC - World Soil Information, Wageningen, 59 p. https://www.isric.org/sites/default/files/Report03_SOTER_Danube_TechGuidelines_20210209.pdf

Batjes NH and Ribeiro E 2019b. *Updated MS-Access SOTER template for the EU Danube basin project with worked examples (Deliverabes A1, A2 and A4 EU JRC Service Contract Nr. 936108, Collection of soil data in SOTER format from 14 Danube strategy countries, at scale 1:250 000.) [Project report 1]*, ISRIC - World Soil Information, Wageningen, 30 p. https://www.isric.org/sites/default/files/Report01_SOTER_Danube_Database_2019-09-12.pdf

Dobos E 2010. *1:1 million scale SOTER geometric databases of the terrain units for the windows in Europe, Morocco and South China* eSOTER EU project #211578 87 p. https://www.esoter.net/sites/default/files/Deliverable%20D3.pdf

Dobos E, Daroussin J and Montanarella L 2005. *An SRTM-based procedure to delineate SOTER terrain units on 1:1 and 1:5 million scales*. EUR 21571 EN, European Communities, Institute of Environment & Sustainability, Joint Research Centre, Ispra (IT), 62 p. http://eusoils.jrc.it/ESDB_Archive/eusoils_docs/other/SOTER/SOTER_endre.pdf

FAO-GSP 2016. *Pillar 4 Implementation Plan -- Towards a Global Soil Information System*, Rome, 36 p. http://www.fao.org/3/a-bl102e.pdf

INSPIRE 2015. INSPIRE Data specifications - Infrastructure for spatial information in the European Community, European Commission Joint Research Centre. http://inspire.ec.europa.eu/index.cfm/pageid/2

Poggio L, de Sousa L, Batjes NH, Heuvelink GBM, Kempen B, Riberio E and Rossiter D 2021. SoilGrids 2.0: producing soil information for the globe with quantified spatial uncertainty. *SOIL* https://doi.org/10.5194/soil-7-217-2021

Ruiperez Gonzalez M and Batjes NH 2019. *Country terrain unit shapefiles of the EU Danube basin (Deliverabe A3 EU JRC Service Contract No. 936108, Collection of soil data in SOTER format from 14 Danube strategy countries, at scale 1:250 000) [Project report 2]*, ISRIC - World Soil Information, Wageningen, 25 p. https://www.isric.org/sites/default/files/Report02_SOTER_Danube_GIS_201906.pdf

van Engelen VWP and Dijkshoorn JA 2013. *Global and National Soils and Terrain Digital Databases (SOTER) - Procedures manual (Ver. 2.0)*. ISRIC Report 2013/04, IUSS, ISRIC and FAO, Wageningen, 198 p. http://www.isric.org/sites/default/files/isric_report_2013_04.pdf

Van Genuchten P 2021. *Exporting Danube Basin SOTER databases to INSPIRE compliant XML/GML format: Developer and user manual (Deliverabe A6, A7 and part of D.B1 and D.B2). EU JRC Service Contract No. 936108, Collection of soil data in SOTER format from 14 Danube strategy countries, at scale 1:250 000) [Project report 5]*, ISRIC - World Soil Information, Wageningen, 12, with software and GML files p. https://www.isric.org/sites/default/files/Report_5_ExportingDanubeBasinSOTERdatabases2INSPIREcompliantGML_SOTER_niels.pdf