Soil Map 1:200.000 (BÜK 200) – The Distribution of Soils in Germany

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Abstract. The soil map 1:200,000 (BÜK 200) is prepared by the Federal Institute for Geosciences and Natural Resources (BGR) in cooperation with the Geological Services of the federal states (SGD) in the sheet line system of the Topographic Map 1:200,000 (TÜK 200) and is published in 55 individual map sheets.

The map shows the spatial distribution and association of soils and their properties. BÜK 200 is the first nation-wide consistent soil map at medium scale with full spatial coverage. By the end of 2012, 48 map sheets have been published as printed and digital versions.

The Geological Services are responsible for the content of the map and for the underlying soil information (attribute data), while BGR coordinates the quality assurance of the layout and the overall consistency of the map series. The resulting map is homogeneous and seamless, and the digital dataset holds uniform, corresponding background information on any map unit.

The map series is completely digitally produced within a Geographical Information System (GIS). Spatial and attribute data are recorded in a central database and can be used for thematic evaluations across state boundaries for soil use and soil conservation.

Keywords: soil map, soil information, soil data

1. Introduction

Nation-wide land use strategies and planning as well as soil protection require harmonized and standardized area-covering information. Such data is

provided by the digital Soil Map of Germany at scale 1:200,000 (BÜK 200) (Krug et al. 2010). The pedological data of this map, stored in a relational database, is used to demonstrate the abundance and the associations of soils and their basic properties in Germany. However, the main purpose of the BÜK 200 map series is to offer a database which allows the estimation and visualization of

- soil functions (e.g. buffer- and filter)
- soil potentials (e.g. potential agricultural yield)
- soil pollutions (e.g. current heavy metal pollution)
- soil hazards (e.g. risk of erosion)

To achieve comparable soil information throughout Germany, BGR and the soil services of the federal states have elaborated and defined BÜK 200 standards concerning the map (e.g. delineation and description of mapping units) and its database (e.g. database model, parameters, codification).

Whereas the State Soil Surveys are responsible for the accuracy of the thematic data, the BGR is co-ordinating the project and cares for the compliance with guidelines and rules, the BÜK 200-project members jointly worked out to ensure the consistency of the soil map and its underlying data.

The map series is the first nationwide soil map at medium scale. The only available spatial soil information for the whole of Germany has been a small-scaled 1:1,000,000 soil map (BÜK 1000) (Hartwich at al., 1995a) and its data background. All German states have more or less area-covering soil maps and digital soil information of medium or large scale, but these maps and the related databases vary significantly. The differences concern mapping scales, the way how the content of the soil mapping units (polygons) are characterised and how soils are aggregated to associations, the choice of attributes, the data models etc. In addition to these substantive differences the delineation of soil mapping units may vary from state to state. Thus it happens that map sheets of different states do not fit at the sheet borders. For nationwide studies and consulting the patchwork character of the data posed severe and non-acceptable obstacles. Nationwide land use planning and soil protection requires harmonised and comparable area-covering information. For this reason, in the mid 1990ies the BGR and the state soil surveys started a programme to compile and publish a digital German 1:200,000 soil map – the BÜK 200 – with a related spatial database (Hartwich et al. 1995b, Krug et al. 1998).

2. Contents of the BÜK 200

2.1. The map series

The BÜK 200 is published in the sheet line system of the Topographic Map of Germany at scale 1:200,000 (TÜK 200), and contains 55 single map sheets. Nevertheless the digital version of BÜK 200 is completely seamless – which means that there are no discontinuities at the sheet lines concerning the delineation as well as the characterization of the soil mapping units.

BÜK 200 is based on the following major principles the BGR and state soil surveys had agreed on (selection):

- The map has an overview character (according to 1:200,000 map scale).
- The map and its legend is to be elaborated according to the standards of the German Soil Mapping Guide, 4th and 5th edition (KA4, KA5; Ad-hoc-AG Boden 1994, AG Boden 2005), e.g. soil nomenclature, classification of soil textures as well as geological parent material (see *Table 1*).
- The thematic content of the map is characterized by 50 to 99 legend units for each sheet.
- The map legend is structured by soil regions and soil landscapes.
- The legend units (soil mapping units) are characterized by soil associations (dominant and associated soils).
- Each soil is described by soil typological units (e.g. soil type) in combination with soil substrate (soil texture combined with parent material).

To ensure a homogeneous map the BGR and the state soil surveys had also agreed on rules and standards concerning the

- maximum area (reference value) of a single mapping unit (polygon)
- minimum distance (reference value) between polygon boundaries, and
- the map layout (e.g. map image, surrounding legend, auxiliary maps, text fonts, color representation of the contents)

2.2. Database

To achieve not only a harmonized map series but also a homogeneous data background, it was agreed on a common approach, e.g.:

- The map contents are collected and stored in a (relational) spatial database (see *Figure 1*).
- The logical data model and the database structure follows the principle of describing the soil mapping units.
- The databases parameter-/attribute-list as well as the encoding lists are based on the specifications of “KA4 or KA5”, respectively.

- The information shown on the map is an extract and visualization respectively of the information held in the database.
- The database includes only basic soil information and no derived, calculated or laboratory data~~)~~ (see *Table 1*).
- The database fulfils the function of a general legend (the data of one general legend unit is related to several legend units of several map sheets).

Attributes:	related to soil mapping unit (SMU)	related to soil body	related to soil horizon and geological layer		
pedo-logi~~c~~eal	soil association of dominant and associated soils (soil topological unit combined with soil substrate); verbal and encoded description	soil typological unit (STU)	depth of horizon	stone and gravel content	organic matter content
		humus form	horizon	bulk density	$CaCO_3$ content
			texture	soil structure	content of geogenic carbon
geological		soil substrate	depth of layer	geo-genesis	parent material
soil water		ground water level	depth of ground water horizon		
general	kind of spatial structure of soils in the SMU	area ratio (STU/SMU)			

Table 1. The main attributes of the BÜK 200 map series

The BÜK 200 database (Krug et al. 1995) is part of the BGR Soil Information System (FISBo BGR)~~,~~ which consists of a soil profile database and a set of data evaluation procedures (method base), too. With these three components the FISBo BGR is the information and consulting base on soils for the national government as well as industry and research. Besides data supply, the tasks of the BGR include methodological research as well as reporting on current topics and providing prognoses.

By using algorithms of the method base, thematic maps can be derived from the basic spatial data – often additionally using other data bases, such as relief, land use and climate information (Krug et al. 2003)

According to the BGR tasks, information of thematic maps and basic soil maps are divided into four groups:

- soil inventories and spatial distribution of soil,
- interpretation on soil quality, potentials and functions,
- analysis of current levels of soil pollution,
- identification, analysis and representation of current risk levels for soils

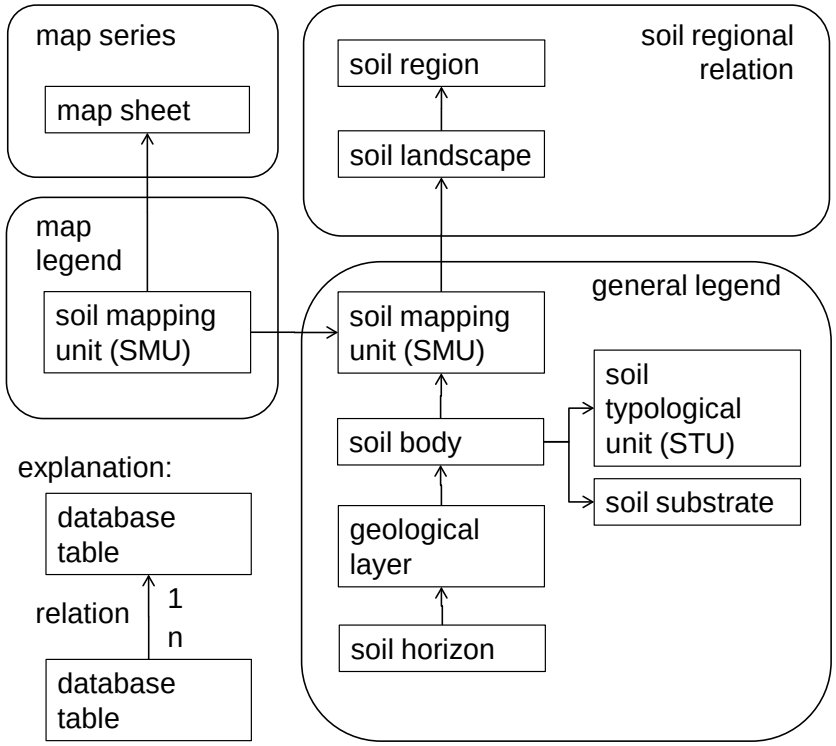

Figure 1. Simplified logical data model of the BÜK 200 database.

3. Cartographic and technical aspects of the BÜK 200

3.1. Map processing and printing technology

The first map sheet ("Munich") of BÜK 200 was published in 1997, followed by another 47 map sheets until today. As an example, *Figure 2* shows map sheet "Dresden".

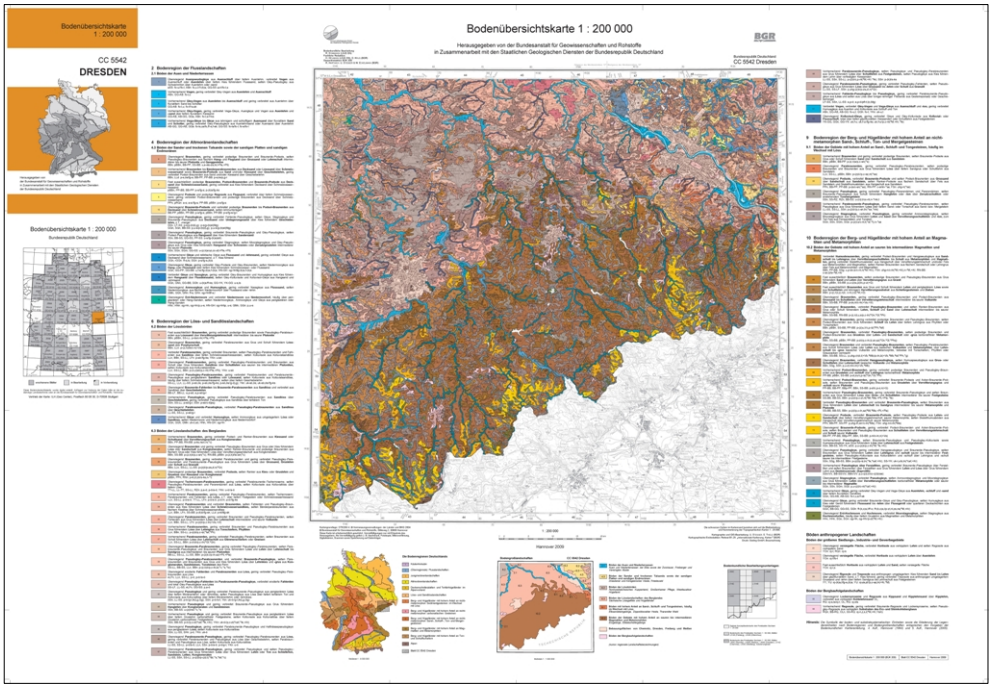

Figure 2. BÜK 200, map sheet CC5542 Dresden

The map sheets are completely processed within ArcGIS. To increase the efficiency of map production, most of the working steps have been automated using self-developed Arc Macro Language (AML) programs. For instance, to handle the extensive, varying text legends of the soil map, programs have been written to set text in a justified alignment. The text width (line length) must be given in page units (Centimeters). This is important to keep the layout standards of the BÜK200 (Stegger 1997).

Digital elevation models and the digital Geomorphological map of Germany (GMK1000) are used to check the quality of the polygon boundaries soil borders and soil unit descriptions.

The circulation of the BUEK 200 amounts currently to 1000 copies, of it 200 unfolded and 800 folded. The maps are printed with five colors (Cyan, Magenta, Yellow, Black and the special color Grey) on precast sheets of paper with a size of 100 cm x 70 cm. The images created in ArcGIS are transferred directly to the printing plates (Computer to plate).

3.2. Presentation and Distribution

As part of the EU efforts of INSPIRE (Directive 2007/2/EC) and GDI-DE (national geo-data infrastructure) to link geodata across states and make them accessible, BGR currently compiles an INSPIRE and GDI-DE compliant concept to store and provide national soil data. These are stored on a central ArcSDE server and are already provided with detailed metadata.

Besides processing and analysis of the BÜK 200 data, data presentation on the Internet has been enhanced recently. The map can be visualized on the internet by a WMS (Web Map Service) called BÜK 200 Viewer (http://www.bgr.bund.de/buek200-viewer). A Web Soil Service (WSS) providing interactive thematic evaluations of soil basic data will be added in the future.

Printed map sheets of the BÜK 200 can be purchased online (Geoshop Hannover, http://www.geoshop-hannover.de). The digital version can be downloaded from the same location free of charge.

4. Conclusion

The current task of BGR and state geological services is the completion of the map series geometry and of the soil profile database underpinning the legend information. This is accompanied by quality assurance measures and initial data evaluation regarding soil functions or soil threats. With the first soil regions completed, the derivation of a general legend, a more abstract level of map unit description, has been started recently in close cooperation with the state geological services.

The completed map series will provide the basis for the elaboration of the European 1:250,000 soil map (Finke et al., 2001), as well as for an update of the national soil map 1:1,000,000 (BÜK 1000) of 1995, for which, after the reunification of Germany 1990, the data base is rather heterogeneous as yet.

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