THE DATABASE OF THE SUBSOIL IN FLANDERS (DOV) RELATED TO SOIL AND ARCHAEOLOGICAL RESEARCH

K. Oorts[1]
V. Vanwesenbeeck[1]
M. Van Damme[1]
S. Buyle[1]

[1] Flemish government, Department of Environment, Flemish Planning Bureau for the Environment and Spatial Development (VPO), Brussels, Belgium

Corresponding author
K. Oorts, katrien.oorts@vlaanderen.be

ABSTRACT
Soil data in Flanders are included in the DOV soil database available to all users. As such, the work done by soil surveyors and scientists is still very relevant today. This paper explains what kind of soil data are included in DOV and how they can be consulted. The aim of DOV is to become the reference for sharing data, knowledge and services, about the soil and subsoil of Flanders. It concerns open data, which can be integrated and linked to other data sources. In addition to raw data, DOV offers professional knowledge and interpreted information, as well as the services and applications to activate and mobilize these data.

KEYWORDS
soil, soil data, database, DOV, soil profile, soil map, soil heritage, photographs, erosion, soil organic carbon content, landslides, archaeological research

DOI
10.5281/zenodo.3421087

1. Introduction

In Belgium, a huge amount of soil surveys has been effectuated in the 1950s to 1970s. The result of this intensive soil research is the Belgian Soil Map (Marechal and Tavernier, 1974). This large number of data is nowadays included in a database available to all users, and as such the work done by hundreds of surveyors and scientists is strongly useful still today.

Databank Ondergrond Vlaanderen (Database Subsoil Flanders) or DOV in short, connects, develops and disseminates information and knowledge about the soil and subsoil of Flanders, according to the specifications of the European INSPIRE Directive (2007). DOV is a partnership of three divisions within the Flemish government. The products of DOV can be used free of charge. DOV offers data on the themes soil, geology, geotechnics, groundwater, mineral resources and geothermics for the Flemish region. The data are publicly available through the online DOV-Verkenner, a geoviewer capable of both accessing detailed geo and non-geodata and creating and editing data. Furthermore, the data are offered for internal use through read-only databases and for public (re-)use as Open Data in the form of over a thousand data layers. Most of the data are in Dutch, but some data products are also provided in English.

2. Soil data in DOV

The paper focusses on the available soil data that can be consulted in DOV. The other themes of DOV will not be described in this paper. The theme 'soil' offers data on the following topics:

- The DOV soil database contains '**Soil locations**' ('bodemlocaties') with soil profile and soil auger data. This dataset contains both the soil data resulting from the mapping campaign of the Belgian soil map (1947-1973) as other historical or recent soil data (e.g. from archaeological investigations).

- There are **soil maps** available with different levels of detail: the Digital Soil Map of the Flemish Region (1:20 000) (Oorts et al., 2017) derived from the Soil map of Belgium (1:20 000) (Marechal and Tavernier, 1974), the Soil Association Map (1:500 000) (Tavernier and Maréchal, 1959) and the Soil Map of Belgium according to the international soil classification system World Reference Base (WRB) (Dondeyne et al., 2014 and 2015).

- **Erosion** is an important cause of soil degradation in Belgium, mainly in hilly areas with sandy loam and loamy soils. DOV offers several thematic maps focusing on soil erosion: the yearly updated potential soil erosion map on parcel level (Oorts et al., 2019), the erosion susceptibility map of the Flemish municipalities and the map with the preferential runoff.

- The **soil organic carbon content** is a good indicator of soil quality and very important in climate issues. In DOV you can find the Soil Organic Carbon Stock Maps for Belgium (40 m grid and 1 km grid) which are also incorporated in the Global Soil Organic Carbon Map (FAO and ITPS, 2018; GLOSIS - GSOCmap (v1.5.0), 2019).

- Finally, there is the susceptibility map for landslides and the actual mapped landslides (Van Den Eeckhaut and Poesen, J., 2009). **Landslides** are defined by a downslope movement of soil material.

3. The DOV-verkenner: a starting point to explore soil data

The following part will describe how the DOV soil data can be consulted in the online DOV-verkenner. When searching for soil information, the easiest way to start is to enter an address in the entry field of the online DOV-Verkenner, which will zoom to the area of interest.

The button 'kaartlagen toevoegen' (add map layer) allows the users to add the soil layers they need. For reasons of visualisation, the online Soil Map of Belgium (*Bodemkaart van België* (1:20 000)) is subdivided into 5 data layers: soil types ('bodemtypes', this layer contains all the information of the soil map), substrates ('substraten'), phases ('fasen'), variants of the parent material ('varianten van het moedermateriaal') and variants of the profile development ('varianten van de profielontwikkeling'). In order to see the necessary detailed information, the user must zoom in to at least 1:150 000.

Once the user has added the online Soil Map of Belgium in the DOV-verkenner, he can click on any location to get information about the soil type. This soil type ('bodemtype') will appear in the results ('Resultaten voor de doorprik') below the map.

By clicking on soil type ('bodemtype') in the information table, a pop-up window will open giving additional information about this soil type.

The pop-up explains the different properties/characteristics and gives a general description of this soil type. In addition, there are several interesting links to: a pdf-file of the explanatory note, the analogue original map sheet (published on 1:20 000), and the maps with the location of the original augerings of the specific map sheet

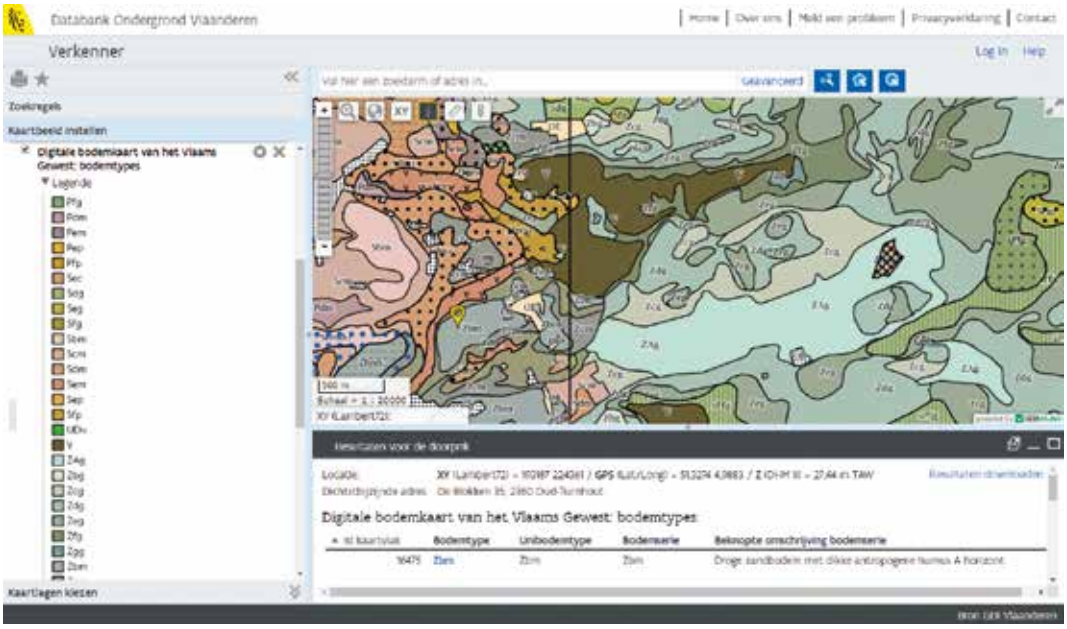

Figure 1. Visualization of the soil map in the DOV viewer.

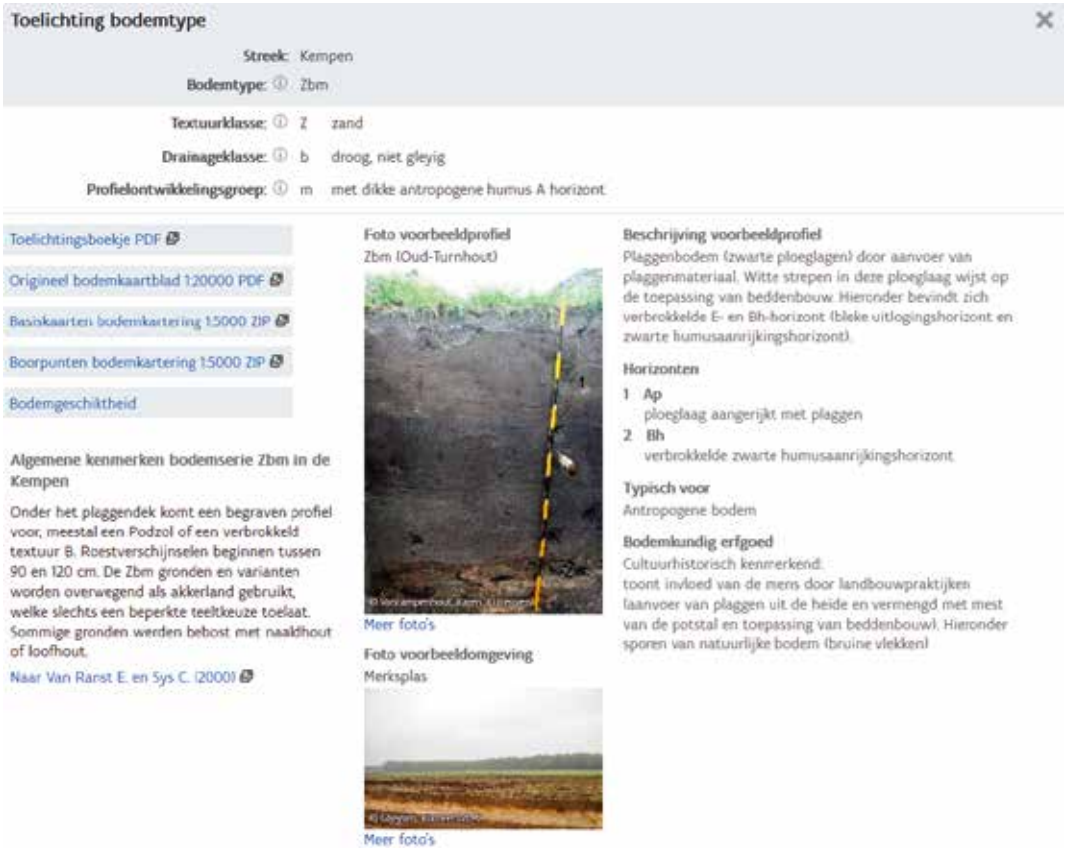

Figure 2. Pop-up window of a specific soil type.

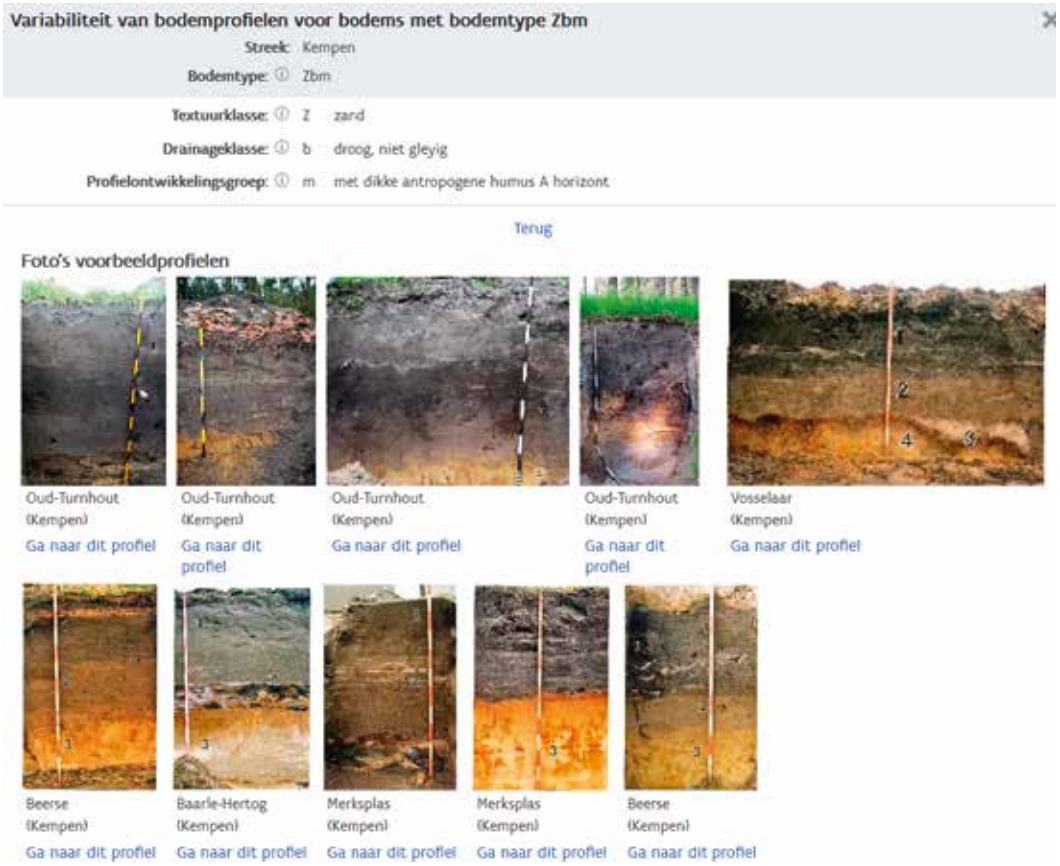

Figure 3. The variability of soil profiles for a soil type.

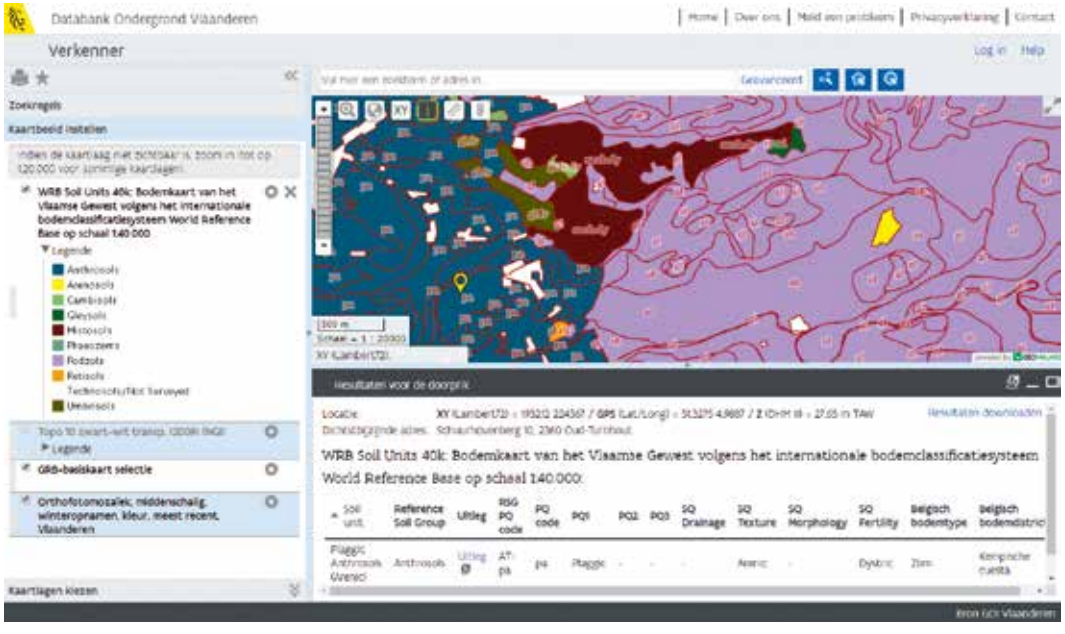

Figure 4. The Belgian soil map according to the international soil classification system WRB.

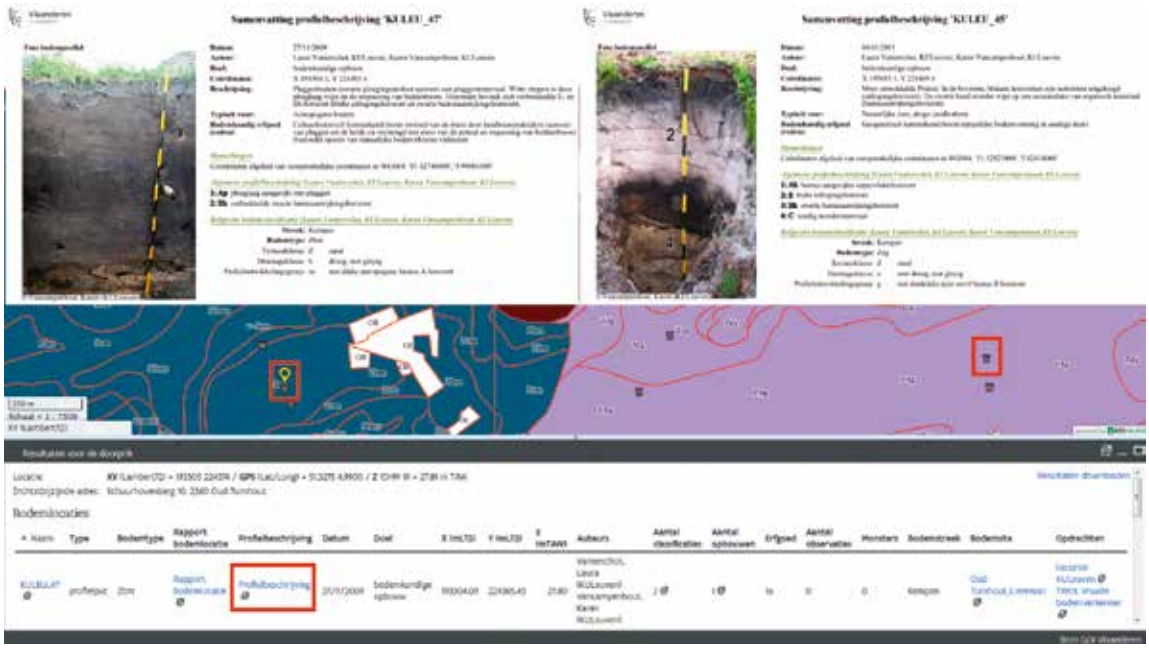

Figure 5. Example soil profiles from the layer 'Bodemlocaties' in the zone with anthropogenic and the zone with natural soils.

of the soil mapping project (analogue version on scale 1:5 000). There is also some information available on the soil suitability for different agricultural land uses from a point of view of agricultural economics.

Finally, the pop-up gives an example of a typical soil profile and its surroundings in which such a soil might occur, illustrated with photographs, a soil profile description and the soil heritage evaluation (Ampe et al., 2006). To get an idea of the variability of a certain soil type, one can click on the hyperlink 'Meer foto's'. Dondeyne et al. (2017) stated that such visual information layers should contribute to a better interpretation of the soil maps and soil data.

Below each of these profiles there can be found another hyperlink ('ga naar dit profiel'), which enables you to get a closer look at the characteristics of that specific soil profile.

The soil map according to the international soil classification system WRB gives a different view on soils in a region. For example, in Figure 4 the same region as in Figure 2 is presented. Two zones now become clearly visible on the soil map: a zone with anthropogenic soils (Anthrosols with plaggen) corresponding to former infields of the villages and a zone with natural soils (Podzols) corresponding to former outfields.

By using the layer 'Bodemlocaties' containing soil profiles from the DOV soil database, the user can select soil profiles in the zones with Anthrosols and Podzols in order to study the differences between the anthropogenic and natural soils. The soil profile descriptions of these soil profiles from the layer 'Bodemlocaties' can be visualized by clicking the link to the profile description ('Profielbeschrijving') in the results ('Resultaten voor de doorprik') for this layer.

In this way users of the DOV application have a vast amount of soil information available at their fingertips.

4. Virtual borehole

The newest tool in DOV is the 'Virtual Borehole' ('Virtuele Boring') (De Nil et al., 2018). This tool allows the user to carry out a (virtual) drilling at any location in Flanders. The result provides information on the geology, the hydrogeology and the soil type. Evidently one always needs to bear in mind that this application is the result of interpolation and interpretation. It can never replace a real drilling or a real soil profile in the field, but it can be a very practical tool for a preliminary investigation.

The 'Virtual Borehole' tool immediately proved to be very convenient and even more so when the mobile version was launched in 2018. The web application (DOV, 2018) can easily be installed on smartphone or tablet computer and can be used at any location, for example, during an excursion or when doing fieldwork.

Figure 6. The mobile version of the 'Virtual drilling' tool proves very useful in the field.

5. Conclusion

Since the start of DOV, the soil data in DOV have grown from a collection of a few GIS-layers to a soil database with many soil profiles and a large amount of data layers. Soil data from different disciplines (e.g. archaeological research, soil science, etc.) are brought together in the DOV soil database. A vast amount of soil data from numerous soil scientists, among them Roger Langohr, are already incorporated in the DOV soil database and available for soil scientists, archeologists, spatial planners, farmers, etc.
However, still many especially recent soil data are not yet incorporated in the DOV soil database. Moreover, the interest in the soil in building areas is growing but the Belgian soil mapping campaign omitted these building areas, resulting in a lack of soil information. Soil data from archaeological investigations are particularly valuable to provide recent soil information, especially for these building areas. The challenge for DOV in the coming years is to support an open, multidisciplinary soil community that shares and centralizes their data in the DOV soil database, making soil data integrated and accessible, instead of locked up in separate private databases. Regarding this, DOV offers applications and xml-import to add new soil data to the DOV soil database. A significant increase of data in the DOV soil database will facilitate an integrated multidisciplinary use of soil data for Flanders and allow updated soil maps, and several models based on soil data.

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