Soil Science Society of Belgium

Thematic day 2017

“Soil resources mapping: past, present and future”

Wednesday, 5 December 2017

The royal Academies of Belgium for Science and the Arts

Brussels

Prelude

Nobody will contest the fact that in many cases soil maps are old, but the one who claims that it is dated is accurately wrong. For example, since its construction, the soil map of Belgium has been widely used for supporting decisions on land use, soil suitability, hazard monitoring, civil-technical applications etc… In the process the map was subject of country-wide ground-truthing and opportunities/ pitfalls of the maps and the supporting database were surfacing. This has led to numerous new research actions so as to complement the map and/or the database for new geo-applications. Examples of such upgrading are:

- Development of pedotransfer functions to estimate soil-physical properties-
- Derivation of model parameters for soil mapping units to calculate nitrogen hazard of groundwater-
- Parameters to predict phosphate through flow from soil profiles-
- Development of decision support systems for land use policy to mitigate climate change

As a consequence of past area-wide land management actions the moisture class of many soil units has changed over the years. Though the update of the soil moisture classes has been the subject of research projects, we still are not yet there to predict with confidence the soil moisture status of many of our soilscapes.

Whereas till rather recently, the soil map of Belgium remained on the shelves, with limited access for outsiders, it has now been disclosed for the broader public. Through geo-locket web-applications such as https://dov.vlaanderen.be/dovweb/html/bodemloketten.html and http://geoportail.wallonie.be/walonmap the map is on our fingertips now and is presently under exploration and scrutiny by all of us.

Big progress has also been the establishment of the 1/250.000 soil association map of Flanders and Wallonia in WRB, so as to make it compatible with the European Database. In the process of its construction, numerous problems with the old maps were solved by supplementary field work. Furthermore the maps of the Polders were a special challenge in this mapping process, as they were never published in the formal legend of the soil map of Belgium.

New mapping techniques have also reshaped the scene of soil mapping over the years. How have tools such as proximal sensing, statistical sampling, high-resolution LIDAR imagery made our maps more robust to support decisions?

The purpose of this thematic day is to bring together all actors and stakeholders of the Soil Map of Belgium, so as to come up with the state-of-the-art of the present soil map of Belgium and its application. We do hope that the outcome of this day will be a road map for future applications and research related to the archive of legacy soil data.

Programme

Theme 1: The Soil Map of Belgium, past, present and future

9:00 – 9:30
Keynote 1 : Soil Mapping, Soil Map Legend, Soil Classification – (Old) Belgian Stories.
Roger. Langohr (Roger.langohr@skynet.be)
9 :30 – 9 :50
The secrets of the sand: how the soil map of the Campine opens new avenues for understanding land-use patterns. Karen Vancampenhout (Karen.vancampenhout@kuleuven.be)
9:50 – 10:10

Where are we? Where shall we go to? Reflections on the past and the future of the soil map of Belgium
Stefaan Dondeyne (stefaan.dondeyne@kuleuven.be)
10:10 – 10:30
A new packaging for the Digital Soil Map of Wallonia?
Xavier Legrain (xavier.legrain@ulg.ac.be)
10 :30 – 11 :00
Coffee break + Poster session

Theme 2: Use of soil maps and underlying databases

11:00 – 11:20
Soil map of Belgium: from hardcopy to illustrated web access
Katrien Oorts (katrien.oorts@vlaanderen.be)
11:20 – 11:40
Predicting allergenic tree species distributions from the Belgian soil map and a grid-based databank of vascular plants
Michiel Stas, Sander Heylen, Raf Aerts, Andy Delcloo, Nicolas Dendoncker, Rafiq Hamdi , Marijke Hendricks, Catherine Linard, Tim Nawrot, An Van Nieuwenhuyse, Jean-Marie Aerts, Ben Somers, Jos Van Orshoven (michiel.stas@kuleuven.be)
11:40 – 12:00
Geochemical quality of public parks and playgrounds in Brussels
Valérie Cappuyns and Louise Schepens (Valerie.Cappuyns@kuleuven.be)
12:00 – 12:20
Soil Organic Carbon mapping in croplands by airborne APEX images using LUCAS topsoil database
Fabio Castaldi, Bas van Wesemael, Sabine Chabrillat (bas.vanwesemael@uclouvain.be)
12:20 – 12:40
Synthetic poster presentations (3 minutes per poster)

12 :40 – 14 :00 Lunch Break – Board meeting of SSSB + Poster session

Theme 3: From legacy maps to useful updated GIS layers

14:00 – 14:30
Keynote 2: Past soil survey experiences as a source of inspiration for future soil research.
Johan Bouma johan.bouma@planet.nl
14:30 – 14:50
Drainage class maps: update needs and legacy value
Peter Finke, Geert Baert, Johan Van de wauw, Martine Swerts (Peter.Finke@UGent.be)
14:50 – 15:10
Potential of using LiDAR-data for updating the drainage class of the soil map of Flanders
Roelens, J.; Dondeyne, S.; Van Orshoven, J.; Diels, J. (jennifer.roelens@kuleuven.be)
15:10 – 15:30
The potential of electromagnetic induction surveying for detailed soil mapping
Timothy Saey, Marc Van Meirvenn (Timothy.Saey@ugent.be)

15:30 – 16:00 Coffee Break + Poster session

Theme 4: Soil mapping in global perspective

16:00 – 16:20
"The impact of soil mapping on soil moisture and radiance modeling"
Bechtold, M., De Lannoy, G.J.M., Koster, R.D., Reichle, R.H., Mahanama, S.P., Liu, Q. (michel.bechtold@kuleuven.be)
16:20 – 16:40
The Belgian contribution to the Global Soil Organic Carbon Stock map
Caroline Chartin, Suzanna Lettens, Pieter Verschelde, Sabine Buyle, Katrien Oorts, Patrick Engels, Bruno De Vos, Bas van Wesemael (bas.vanwesemael@uclouvain.be)
16:40 - 17:00
Harmonisation of a soil map at the continental scale: the map of the Soil Atlas of Africa
Olivier De witte (Olivier.Dewitte@africamuseum.be)
17:00 – 17:20
Closing remarks

List of Posters

1. **'Spatial analysis of an urban fill through electromagnetic soil sensing'**

   Christin Bobe, Ellen Van De Vijver, Marc Van Meirvenne (Christin.Bobe@UGent.be)

2. **Estimating the spatial distribution of urban soil from land cover data: the case of Flanders**

   Van de Vijver, E., **Delbecque N**., Verdoodt, A., Van Meirvenne, M. & Seuntjens, P. (Nele.Delbecque@UGent.be)

3. **Quantifying the long-term impact of agriculture on soil profiles and sedimentredistribution – the case of Lauwerdal (N. France)**

   Nick Krekelbergh1, Stefaan Dondeyne2, Amaury Frankl1 (Nick.Krekelbergh@UGent.be)

4. **How do soil patterns influence crop growth?**
   Preliminary geophysics & remote sensing data combination for precision fertigation in potato fields.

   DUMONT Gaël[1*], VON HEBEL Chris[2], PICCARD Isabelle[3], REYNAERT Sophie[4], JANSSENS Pieter[4], VAN DER KRUK Jan[2], GARRE Sarah[1] (gdumont@uliege.be)

5. **The 'DOV-verkenner': the web portal to information of the (sub)soil of Flanders**

   Katrien Oorts[1,*], Sabine. Buyle[1], Marleen Van Damme[1], Linsey Vanthounout[1], Veerle Vanwesenbeeck[1], and Martien Swerts[1] (katrien.oorts@vlaanderen.be)

6. **Mapping soils from terrain features – the case of Nech Sar National Park southern Ethiopian Rift Valley**

   Shetie Gatew[1,2], Stefaan Dondeyne[2], Jennifer Roelens[2], Jan Nyssen[3], Karen Vancampenhout[4], Jozef Deckers[2] (Shetieg@yahoo.com)

Oral presentations

Theme 1: The Soil Map of Belgium, past, present and future

Soil Mapping, Soil Map Legend, Soil Classification – (Old) Belgian Stories.

Roger. Langohr (Roger.langohr@skynet.be)

Soil Mapping, Soil Map Legend, Soil Classification – (Old) Belgian Stories.

Webster dictionary:

Classification: orderly classification of plants and animals according to their presumed natural relationships. *Taxonomy*: the study of the general principles of scientific classification.
Systematics: 1. the science of classification; 2a: a system of classification; 2b: the classification and study of organisms with regard to their natural relationships.

Some preliminary musings

No legend, no soil map. All soil maps have a legend, which can be considered as a "classification". Most of these legends have at least two hierarchical levels. They all can be considered as "taxonomies".
To mention that a map legend is "not a classification" (see FAO Soil Map Legend of the World) makes no sense and is related to diplomatic constraints rather than a basic scientific approach.
To call a national soil classification "Soil Taxonomy" reflects a certain (tentative of) supremacy over all the others.

Here comes Belgium

When comparing the legends of most soil maps in the world, the legend of the Belgian Soil Map (BSM), stands out for its particular construction. Although the ambition to apply this type of soil classification for drawing up a very detailed map at national level, its simplicity is striking.
This approach is compared with the other types of soil map legend construction used around the world. The positive and negative aspects of these methodologies are further reviewed while considering the constraints the Belgian soil scientists were facing shortly after WWII.
The Belgian soil map legend is further discussed through the reaction of foreign colleagues (the hostilities are open; how the negative (wall) supersedes the positive (bridge)).
The story behind the initial selection of some soil characteristics in the Belgian legend versus what was done in other countries are commented.
Some weird situations such as the loss of the Bt horizon on the Ardennes and the conflict between the colour- and structure B (cambic) and the clay eluvial E horizon are examined
Finally some comments are given about the practice of the "priority approach" when mapping soils (why are there so many Podzols in northern Belgium, and why are Bt horizons so widespread in Middle Belgium).

The secrets of the sand: how the soil map of the Campine opens new avenues for understanding land-use patterns. Karen Vancampenhout (Karen.vancampenhout@kuleuven.be)

Where are we? Where shall we go to? Reflections on the past and the future of the soil map of Belgium

Stefaan Dondeyne (stefaan_dondeyne@yahoo.co.uk)

Department of Earth and Environmental Sciences, University of Leuven, Belgium

Drawing from lessons learned while converting the legend of the Soil Map of Belgium to the international soil classification system "WRB", I want to reflect on the past and the future of the Soil Map of Belgium. Soil maps are prepared to enable more numerous, more accurate and more useful predictions to be made for specific purposes than that could have been made otherwise, i.e. in the absence of location-specific information about soils. In the aftermath of WWII, and given the then prevailing concern for food security, the Belgian soil survey project started in 1948 to have a planning tool for promoting agricultural development and boosting agricultural production. Belgian soil scientists widely collaborated internationally, and so concepts from Soil Taxonomy, while this classification system was still being developed, were readily integrated into the Belgian soil classification system. Concluded in the early 1990s, the Belgian soil survey project yielded the most detailed soil map of the work at national level. Today, the original maps together with the auxiliary soil sample data and reports have been digitised and are freely available through web applications set-up by the Flemish and Walloon regional administrations. The maps and data are widely used for environmental studies, as input for process based models and for guiding field investigations as e.g. conducted by archaeologists.

The Belgian soil classification system is original for having and open, non-hierarchical structure which, surprisingly, is fully compatible with geographical information systems. Nevertheless, only very few soil surveyors must have realised that "their soil maps" would eventually be entered into geospatial databases. Presumably, what they had in mind, is that the maps would orientation map users in the soilscape to identify potentials and constraints for agricultural development, much like topographic maps are used by hikers to find their way through forests and mountains. Besides the explicit information, the soil maps contain implicit information relevant e.g. for understanding soil-water dynamics or for assessing soil organic carbon stocks, but which require some deeper insights than what can be directly understood from the literal definitions provided by the map legend. Moreover, as the soil survey has been conducted during more than four decades, inevitable inconsistencies cropped up, both across map sheets and across areas. Moreover, given that the base maps used during the field surveys where 19th century cadastral plans, boundary of soil mapping units are not always accurate.

Despite the value of the maps, changes in land-use together with inconsistency in the maps as well as relatively large un-surveyed areas which were outside agricultural land, make it imperative that our soil information layers get updated. Chances are, however, very slim that we will get a similar extensive soil survey ever funded again. The developments in digital soil mapping, combined with detailed digital terrain data (particularly LiDAR) and the ever expanding earth resources databases, as e.g. the "Databank Ondergrond Vlaanderen", offer plenty of opportunities for updating our soil information layers. Let these reflections be a call for developing a protocol on how our efforts should be coordinated.

A new packaging for the Digital Soil Map of Wallonia?

Xavier Legrain (xavier.legrain@uliege.be), Brieuc Michel, Mathilde Roda & Gilles Colinet

Gembloux Agro-Bio Tech (ULiège) – BIOSE Dpt – Water-Soil-Plant Exchanges

The digitalisation of the soil map of Belgium and the structuring of the information delivered by its legend was a true milestone toward numerous new applications and consideration of soils in some decision-making processes. The recent free and easy access of the soil map via geo web-applications accentuates this positive trend.

Now the time has come to go a step further in order :

(i) to enhance and harmonize the information imbedded in the map ;
(ii) to adjust the product according to current media and tools ;
(iii) to adapt the product according to needs and level of awareness of users ;
(iv) to strengthen the existing links with the historical profile database and with other thematic maps.

This presentation aims to examine and detail these objectives and the underlying motivations, supported by numerous concrete examples. In this respect, some effective or planned achievements on the Digital soil map of Wallonia will be displayed.

Theme 2: Use of soil maps and underlying databases

Soil map of Belgium: from hardcopy to illustrated web access

Katrien Oorts[1,*], Sabine. Buyle[1], Marleen Van Damme[1], Linsey Vanthounout[1], Veerle Vanwesenbeeck[1], and Martien Swerts[1]

[1] Vlaams Planbureau voor Omgeving, Departement Omgeving, Vlaamse Overheid, 1000 Brussel

*Corresponding author: katrien.oorts@vlaanderen.be

From 1947 till the early 70's, a comprehensive systematic survey of the Belgian soil was carried out, resulting in soil data, hard copy maps and explanatory notes. The hard copy map was digitalized during the '90s, whereas in Flanders, during the last 8 years, great efforts were made to put all the data and background information of the soil map of Belgium online available in a user friendly way.

In 2014, the explanatory notes, scans of the hard copy soil maps (both scale 1:5000 and 1:20.000) and the 'Eenduidige legende voor de digitale bodemkaart van Vlaanderen (E. Van Ranst & C. Sys' (2000)) were linked with the digital soil map of Flanders.

In June 2017, a new corrected version of the Belgian soil map of Flanders came available:

- Soil map polygons of **3 military domains** were added (Kamp van Brasschaat, Kamp van Beverlo and vliegveld van Klein Brogel);
- Several **corrections** were made with a.o. corrections of old classifications in map sheet 51W, wrongly digitalized soil complexes and errors in the soil map;
- A **'Unibodemtype' (unisoiltype)** was introduced that gives for all soil map polygons the classification according to the Belgian morphogenetic soil classification system.

Finally, in October 2017, **photographs and profile descriptions of 750 reference soil profiles** were linked with the digital soil map of Flanders in order to give the user more insight into the soil profile development, characteristics and the coherence of the Flemish soil types. These 750 soil profiles are centralised in the new **DOV soil database** of Databank Ondergrond Vlaanderen (DOV), which brings together very diverse soil data in one central database.

The resulting **online 'Bodemkaart (1:20.000) van België'** can be consulted in the **online DOV-verkenner** (figure 1). In order to see the necessary detailed information of the soil map, you have to zoom in to at least 1:150.0000. For reasons of visualisation the online soil map (**Bodemkaart (1:20.000) van België**) is further subdivided into 5 data layers: 'bodemtypes' (contains all the information of the soil map), 'substraten', 'fasen', 'varianten van het moedermateriaal' en 'varianten van de profielontwikkeling'.

By simply clicking a soil map polygon, a new window 'Resultaten voor de doorprik' opens with the soil type and the unisoiltype. By clicking the blue soil type, a pop-up 'Toelichting bodemtype' appears. First of all, the different components and the general characteristics of the soil type are explained. If available, a photograph and a soil profile description, representative of the soil type of the selected soil map polygon, are given. Whenever more than one representative soil profile is available for a specific soil type, the variability of soil profiles for that soil type is visualised. Finally, for each location the scan of the original soil map sheet (scale 1:20.000), the information booklet of the map sheet and the basic maps at scale 1:5.000 can be downloaded.

Next to this, the dataset '**Bodemprofielen**' shows soil profile data of the DOV soil database. The **datasets 'Bodemprofielen kartering Belgische bodemkaart'** and **'Oppervlaktemonsters kartering Belgische bodemkaart'** contain the descriptions and analytical results of the 7020 soil profiles and surface samples from the historical Aardewerk-Vlaanderen-2010 database. At last, as a further step towards international standardization, the **'Bodemkaart van België volgens World Reference Base (WRB)'** is the translation of the soil map of Belgium into the WRB soil classification system.

A fast way to these and other soil datasets is through the DOV bodemloketten. By clicking a map image, you are brought directly to that map in the online DOV-verkenner. Web services of the DOV datasets are also available. Please contact DOV (dov@vlaanderen.be) if you have any questions or if you want your soil data to be imported in the DOV soil database.

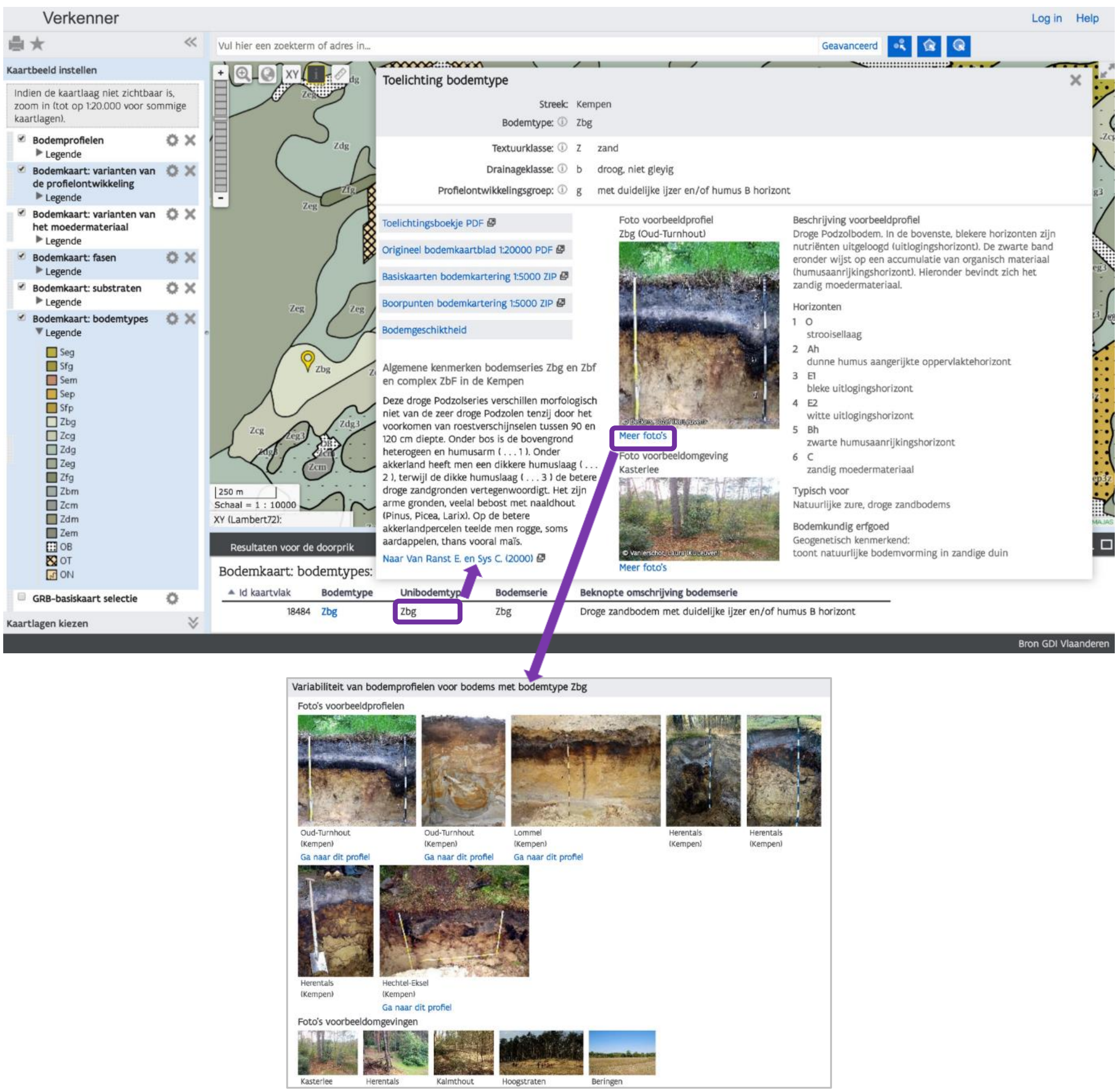

Figure 1: The online soil map for the Flemish part of Belgium in the DOV-verkenner.

Predicting allergenic tree species distributions from the Belgian soil map and a gridded presence database of vascular plants

Michiel Stas[1,2]*, Sander Heylen[1], Raf Aerts[1,3], Andy Delcloo[4], Nicolas Dendoncker[5], Rafiq Hamdi[4] , Marijke Hendricks[6], Catherine Linard[5], Tim Nawrot[7], An Van Nieuwenhuyse[3,8], Jean-Marie Aerts[2], Ben Somers[1], Jos Van Orshoven[1]

[1] KU Leuven, Division Forest, Nature and Landscape, Faculty of Bioscience Engineering, Leuven, Belgium
[2] KU Leuven, Division Measure, Model & Manage Bioresponses, Faculty of Bioscience Engineering, Leuven, Belgium
[3] Belgian Scientific Institute of Public Health (WIV-ISP), Health and Environment unit, Brussels, Belgium
[4] Royal Meteorological Institute of Belgium, Brussels, Belgium
[5] University of Namur, Department of Geography, Namur, Belgium
[6] Belgian Scientific Institute of Public Health (WIV-ISP), Mycology and Aerobiology, Brussels, Belgium
[7] University Hasselt, Centre for Environmental Sciences, Hasselt, Belgium
[8] KU Leuven, Dpt. of Public Health, Faculty of Medicine, Leuven, Belgium
*Corresponding author: ir. Michiel Stas, michiel.stas@kuleuven.be

Abstract

Tree pollen are a major source of aeroallergens which trigger allergic reactions in sensitized people. Climate change increases the burden of tree-related allergic diseases as higher temperatures and changes in precipitation patterns increase the duration and intensity of pollination of allergenic tree species such as birch (*Betula spp.*). Information on the distribution of allergenic tree species may be helpful to quantify the potential exposure to tree allergens but to date such detailed species distribution maps are lacking. To address this issue, we modelled the probability of occurrence of the thirteen most prominent allergenic tree species in Flanders.

We used maximum entropy modelling to calculate probabilities of tree species occurrence based on presence-only data sourced from an open access databank of plant species distributions in Flanders and environmental variables related to the potential natural distribution of tree species in Flanders. Soil texture was used as a proxy for soil fertility and soil drainage class as a proxy for soil moisture. Both variables were derived from the Belgian Soil Map resampled to 1×1 km grid cells. We used landscape types from the Biological Valuation Map and average lowest and highest ground water from Ecoplan as additional environmental predictor variables.

Species distribution models were more meaningful than a random distribution for all thirteen allergenic tree species. The Area Under Curve (AUC) varied between 0.53 for *Salix* and 0.92 for *Platanus*. Texture class and drainage class were consequently among the most important variables contributing to the models. Probabilities of occurrence were converted to distribution maps using varying expert-based thresholds for the different allergenic tree species. A combined alpha diversity map of allergenic tree species shows hotspots of allergenic tree species diversity in the Campine region and a lower diversity in more industrialised or agriculture dominated parts of Flanders.

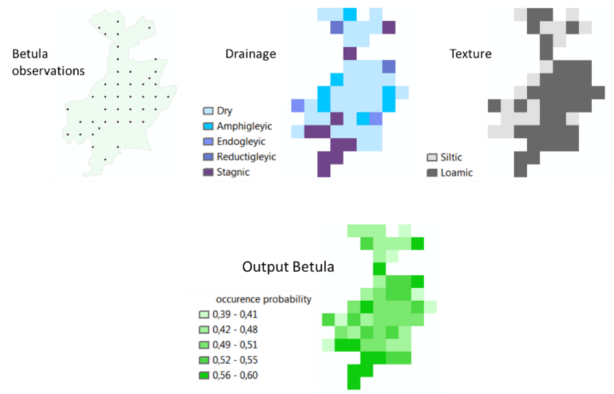

Figure 1: Maximum entropy model for occurrence of Betula spp. based on Betula observations in Florabank and environmental variables derived from the Belgian Soil map.

Geochemical quality of public parks and playgrounds in Brussels

Valérie Cappuyns and Louise Schepens

KU Leuven, Faculty of Economics and Business, Centre for Economics and Corporate sustainbility (CEDON), Warmoesberg 26, 1000 Brussels. E-mail: valerie.cappuyns@kuleuven.be

Problem statement and aim

Urban soils significantly contribute to the quality of life in urban areas, and since the introduction of the group of Technosols in the WRB, the research on these kind of soils remarkably increased. Although urban soils have many beneficial functions, the benefits provided by green parks and playgrounds are probably most acknowledged by the general public. Children living in the city spent a big part of their time outside playing at the park and on the playgrounds. As they are exploring their environment, health can be negatively affected by contaminated soil they ingest or inhale. Although urban geochemical maps are generally based on the total concentration of metals in soils and focus on "hotspots" where human exposure is potentially high, they are an essential starting point in environmental and human health risk assessment. The aim of this study was to assess the geochemical quality of soils of public parks and playgrounds in Brussels. Additionally, the relationship between concentrations of major and trace elements, organic carbon content, pH, and the location and age of the parks and playgrounds was investigated.

Methods

60 surface soil samples (upper 10 cm) were taken from public parks and playgrounds in the city of Brussels. The samples were analysed for Al, As, Ba, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, and Zn by ICP-OES after Aua Regia destruction; organic carbon content was determined with the Walkley and Black method; electrical conductivity and pH were determined in soil extracts at a liquid/solid ratio of 10 l/kg.

Statistical analysis of the results was performed using IBM SPSS Statistics 22 for Windows. The software package QGIS 2.18.3 'Las Palmas' was used to plot the sampling points (as well as element concentrations of elements) on a map.

Results and discussion

The results obtained in this study show that the concentrations of As, Cd, Cr, Cu, Ni, Pb and Zn in playground soils are far below the remediation standards of the Brussels Capital region. These concentrations are also rather low compared to published investigations of playground soils in other cities in the world. In the park soils, however, Pb- and Zn-concentrations exceeded the soil remediation standards at some locations. There was no significant difference between concentrations of trace elements in soils in the centre of Brussels and outside the centre. However, average concentrations of Zn, Cd, Cu and Pb in park soils were significantly higher than in the playground soils. No distinct relationship was found between the age of the parks, and concentrations of trace elements in the surface soil. The playground soils clearly showed signs of anthropogenic influence, as they contained an important amount of artefacts. The park soils were characterized by a significantly higher organic carbon content than the playground soils, and by a lower amount of artefacts. The pH of the playground soils was slightly alkaline (pH = 8.2 ± 0.6), while park soils showed a neutral pH (7.1 ± 0.3). Linear regression analysis showed that, based on pH, organic content, and the concentrations of Al, Fe, Mn, Ca, K, Na and Mg it is possible to make a good estimate of the concentrations of heavy metals in the playground and park soils.

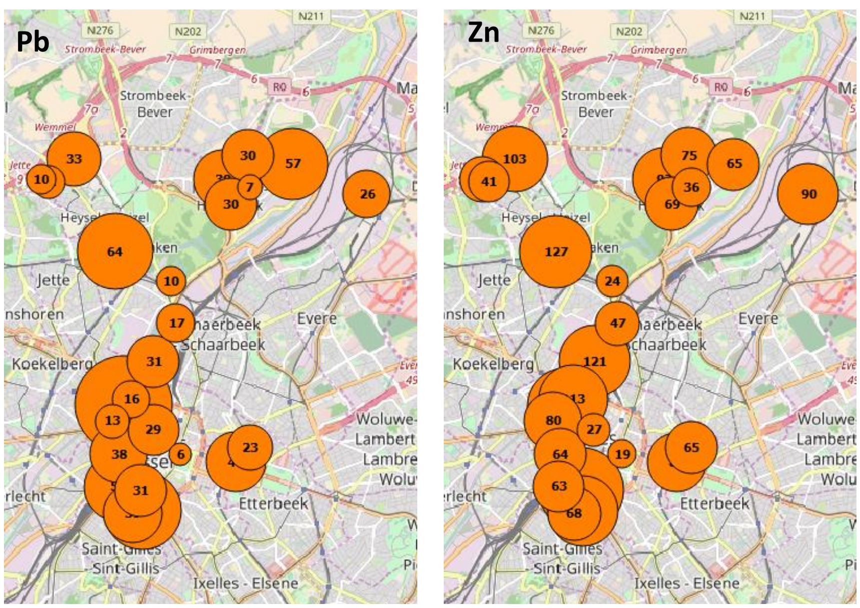

Figure 1: Distribution of Zn and Pb (in mg/kg) in playground soils in Brussels

The geochemical data obtained in this study will be further used for risk characterization of children exposed to these urban playground and park soils.

Soil Organic Carbon mapping in croplands by airborne APEX images using LUCAS topsoil database

Fabio Castaldi[1], Bas van Wesemael[1], Sabine Chabrillat[2]

[1]*Georges Lemaître Centre for Earth and Climate Research, Earth and Life Institute, Universite Catholique de Louvain, Belgium.*

[2]*Helmholtz-Zentrum Potsdam - Deutsches GeoForschungsZentrum GFZ. Germany*

(bas.vanwesemael@uclouvain.be)

The quantitative prediction of soil properties using the first generation of hyperspectral satellite sensors is hampered by the very low signal to noise ratio (SNR) in the short wave infrared (SWIR) region for Hyperion imagers on board of the NASA EO-1 platform or by the restricted spectral range (415–1050 nm) for the Compact High Resolution Imaging Spectrometer (CHRIS) on the European Space Agency's PROBA platform. In the near future at least five satellites equipped with hyperspectral imagers are due to be launched. A calibration/validation protocol is necessary to investigate the potential of these forthcoming hyperspectral imagers. Therefore, we are developing a standardized multivariate calibration approach valid for large areas and that requires minimal user inputs. For these purposes, LUCAS topsoil database was used to calibrate robust multivariate prediction models for the prediction of the OC content of 146 topsoil samples collected in croplands in Central Belgium and Gutland-Oesling region (Grand Duchy of Luxembourg). The predicted OC values at the sampling points were joined with hyperspectral remote data in order to predict OC over all bare soils of the two study areas.

A subset from LUCAS database was created selecting only the samples collected on croplands (LUCAS_agri). This subset was spilt into 7 classes, for this purpose, a matrix composed of all the soil variables of the LUCAS_agri database was clustered using the k-means algorithm and the optimal number of clusters was chosen through the 'gap' method. In order to make possible the comparison between the spectra acquired according with LUCAS protocol and those acquired with a new protocol 5Belgium and Luxembourg), we scanned again 153 samples of the LUCAS_agri dataset, transforming the LUCAS spectra into "new protocol" spectra by means of the External Parameter Orthogonalization (EPO) method.

The classified soil spectra of the LUCAS_agri were used as training data to classify soil spectra of the samples collected in Belgium and Luxembourg using an artificial neural network (ANN). After the class assignment, a partial least square regression (PLSR) model was carried out for each class of the LUCAS_agri dataset, which was used to predict OC content of the samples of the two study areas belonging to the same class. The predicted OC values obtained by the LUCAS_agri models were joined with airborne APEX hyperspectral data to obtain the OC maps of 90 fields. The APEX sensor was used as the new generation of hyperspectral satellites are not yet launched.

Theme 3: From legacy maps to useful updated GIS layers

Keynote 2: Past soil survey experiences as a source of inspiration for future soil research.

J.Bouma

Em.prof soil science, Wageningen University, the Netherlands

(johan.bouma@planet.nl)

The soil science discipline is challenged with exceptional opportunities now that 195 countries have agreed in September 2015 to support seventeen UN Sustainable Development Goals (SDGs), including an obligation to periodically report progress until the target date of 2030. Even though soil is not mentioned as such in the SDGs, several SDGs have an important soil component: food security, water quality, climate mitigation, biodiversity and terrestrial ecosystems protection. It is hard to see how these SDGs could be reached without substantial input by soil scientists. But soil scientists can't do it alone as the SDGs call not only for inter- but also transdisciplinary approaches, the latter because of their societal focus. A key question is therefore what soil data will be delivered to interdisciplinary teams, including soil scientists, trying to formulate scenarios leading to reaching certain SDGs. There is a risk that data on basic soil characteristics, such as texture, %C and bulk density will be inserted in pedotransferfunctions, allowing prediction of dynamic soil processes using widely available soil-water-plant-atmosphere simulation models, creating the false impression that soil aspects have been taken care of. Not so, because soils are complex and dynamic living bodies in a landscape context and soil surveys, always in the past including soil classification and land evaluation, have expressed this well, be it in often descriptive, qualitative terms by experts. The development during the last few decades of new techniques, methods and procedures, facilitated by the explosive development of ICT, has strongly improved the capability of soil scientists, allowing more quantitative expressions. While the link between soil survey and soil classification has remained, the link with land evaluation appears to have disappeared and this needs to be re-established for soil science to be more effective in contributing to achieving SDGs. In addition, the need for innovative communication in our "post-truth", "fact-free"and "alternative facts" society of today, requires intensive and serious contact with stakeholders. Here, we can learn from the pioneers of soil science, men like Dukochaev, who for the first time saw "soils", that had been overlooked before and who "walked the fields" interacting with land users. Taking a fresh look at soils and their potential, applying a wealth of modern techniques considering living soils in a landscape context, will be the best future way for soil science to contribute to the SDGs.

Drainage class maps: update needs and legacy value

Peter Finke(1), Geert Baert(2), Johan Van de wauw(3), Martine Swerts(4) (Peter.Finke@UGent.be)

Drainage class maps: update needs and legacy value

Department of Soil Management, UGent; (2) Faculteit Bio-ingenieurswetenschappen Vakgroep Toegepaste biowetenschappen, UGent; (3) ; (4) Aanspreekpunt Bodem DEPARTEMENT OMGEVING. Afdeling Vlaams Planbureau voor Omgeving

The drainage class is an entry to the legend of the Soil map of Belgium, 1:20,000. Though mapped in the field using morphological criteria, mostly in the 1950's and 1960's, it has been used mostly in a qualitative and quantitative hydrological context. These applications are associated with uncertainty due to factors such as (i) errors and impurities in the original map; (ii) errors in translating morphological observations to hydrological regimes; (iii) changes in the hydrological regime since the time of mapping. Nevertheless, the drainage class maps are, at the least, highly useful documents for applications that need a geographic overview of the hydrological regime during the mapping period. Examples are calibration and testing of hydrological models, regional soilscape reconstructions, etc.

A few years ago, the question was raised, by the then Department LNE in Flanders, if the drainage class maps need updating from the perspective of current applications. If so, what would be suitable methods to update efficiently? Would such update be a drainage class map or something else? We will summarize the results of this study. Finally, to ponder over roadmaps for updated hydro-regime maps, we will need (i) to evaluate the value of recent technical developments in digital soil mapping methods and modelling approaches, and (ii) to identify funding platforms and smart collaborations of research groups.

Potential of using LiDAR-data for updating the drainage class of the soil map of Flanders

Roelens, J.[1]; Dondeyne, S.[1]; Van Orshoven, J.[2]; Diels, J.[1]

[1] Department of Earth and Environmental Sciences, Division Soil and Water Management, KU Leuven, Leuven, Belgium
[2] Department of Earth and Environmental Sciences, Division of Forest, Nature and Landscape, KU Leuven, Leuven, Belgium

(jennifer.roelens@kuleuven.be)

In the last decade, great advances have been made in the field of digital soil mapping and modelling (DSMM) as new mapping tools and high-resolution covariate data provide new opportunities to predict soil patterns and properties. Spatial soil patterns are complex and are becoming even more heterogeneous when they have been or are modified for anthropogenic needs. This is especially the case in areas with a low variation in relief and with a high anthropogenic impact, as is the case for an important share of the Flemish region in Belgium.

An aerial Light Detection and Ranging (LiDAR) database encompassing at least 16 points per square meter accompanied by simultaneously collected digital RGB imagery is available for Flanders. For every segment of the water course network as available in the digital Flemish Hydrological Atlas (VHA), relevant LiDAR point data can be extracted from the LiDAR database by means of a buffer and topological point-in-polygon extraction. To further extract points for determination of the water course's cross section at predefined locations along its course, another buffer zone is defined around a predefined cross-section. This can be done assuming that the cross-section of a segment is invariable over that distance. The buffer distance was determined based on a sensitivity analysis. Piecewise linear and cubic spline functions were fitted through the projected points on the cross-sectional plane by least squares optimization to materialise the cross section.

The potential of electromagnetic induction surveying for detailed soil mapping

Timothy Saey, Marc Van Meirvenne
Ghent University, Department of Soil Management, Research Group Soil Spatial Inventory Techniques, Ghent, Belgium

(Timothy.Saey@ugent.be)

Recently, the measurement of apparent soil electrical conductivity (EC) with EMI has become an invaluable tool for establishing the spatial variation of the soil composition for a wide variety of applications e.g. precision agriculture, quaternary geomorphology, archaeology, vadose zone hydrology... The advantage of measuring EC is the ability to operate with non-invasive proximal soil sensors, which integrate the response of a soil volume down to an effective depth. Multi-signal instruments increase the possibilities to infer depth variations in soil properties because of their simultaneous measurement of the EC from different soil volumes. The integration of these multiple signals allows for a more thorough identification of both lateral and vertical soil variations, improving the delineation of deviating soil units and features. Furthermore, this infers a more targeted and efficient soil sampling and/or excavation, which results in a more effective characterization and interpretation of the soil variability. This methodology was evaluated extensively within sedimentary landscapes, where different depositional layers occur at a different depth within the soil profile. A compilation of results from the last 10 years illustrate the importance of integrating EMI data within the comprehensive mapping of soil units.

Theme 4: Soil mapping in global perspective

The impact of soil mapping on soil moisture and radiance modeling

Authors: **Bechtold, M**.(1), De Lannoy(1), G.J.M., Koster(2), R.D., Reichle(2), R.H., Mahanama, S.P.(2), Liu, Q.(2)

(1) KU Leuven, Department of Earth and Environmental Sciences
(2) NASA Goddard Space Flight Center, Global Modeling and Assimilation Office

(michel.bechtold@kuleuven.be)

The advent of new data sets describing soil texture and associated soil properties offers the promise of improved land surface simulations and enhanced satellite data interpretation. Here we describe the composition of a new soil texture data set and its implementation into a specific land surface modeling system, namely, the Catchment land surface model (LSM) of the NASA Goddard Earth Observing System version 5 (GEOS-5) modeling and assimilation framework. First, global soil texture composites are generated using data from the Harmonized World Soil Database version 1.21 (HWSD1.21) and the State Soil Geographic (STATSGO2) project, with explicit consideration of different levels of organic material. Then, the LSM's soil parameters are upgraded using the new texture data, with hydraulic parameters derived for the more extensive set of texture classes using pedotransfer functions. Other changes to the LSM parameters are included to further support simulations at increasingly fine resolutions. A suite of simulations with the original and new parameter versions shows modest yet significant improvements in the Catchment LSM's simulation of soil moisture and surface hydrological fluxes. The revised LSM parameters are used in the newest Soil Moisture Active Passive (SMAP) soil moisture assimilation product. In the second part of the presentation we narrow the focus on organic-rich soils, which are characterized by high soil moisture contents and hydrological dynamics that differ greatly from those in biomes on mineral soils. In these shallow-groundwater systems, soil moisture of the unsaturated zone is closely coupled to water table depth, which is thus a key variable that must be adequately modeled. We discuss the structural model changes that are necessary to better mimic the characteristic hydrological dynamics and we highlight how soil information in organic-rich areas can be used to improve hydrological and radiance modeling.

The Belgian contribution to the Global Soil Organic Carbon Stock map

Caroline Chartin[1], Suzanna Lettens[2], Pieter Verschelde[2], Sabine Buyle[3], Katrien Oorts[3], Patrick Engels[4], Bruno De Vos[2], Bas van Wesemael[1]

[1]Georges Lemaître Centre for Earth and Climate Research, Earth and Life Institute, Université Catholique de Louvain, 1348 Louvain-la-Neuve
[2] Environment and Climate unit, Research Institute for Nature and Forest, 1070 Brussels, Belgium
[3] Departement Omgeving, Vlaamse Overheid, 1000 Brussel[4] Service Public de Wallonie, Direction Générale de l'Agriculture, des Ressources Naturelles et de l'Environnement (DGO3), 5100 Namur

(bas.vanwesemael@uclouvain.be)

The Intergovernmental Technical Panel on Soils of the Global Soil Partnership (GSP) launched an initiative to compile the global soil organic carbon stock map in December 2016. This map will consist of national soil organic carbon (SOC) stock maps developed as 1 km soil grids covering the 0-30 cm topsoil. A generic guideline has been developed providing definitions and methodological options. The Belgian contribution has been submitted at the end of September 2017. Given the regional context, separate SOC maps for agricultural land and forest had to be compiled. The maps are based on digital soil mapping approaches whereby empirical models are calibrated to predict the SOC stock using covariates that are available at a sufficient resolution at the regional scale. All maps are strongly dependent on the Belgian Soil Map (texture and drainage parameters). Most maps were constructed at a finer resolution (10x10 to 40x40 m² grid cells) and were first joined and finally scaled up to the required 1 by 1 km grid cells. Given the different nature of the individual maps, the uncertainty of each map varies. For instance a map of the 90% confidence interval of the SOC stocks was produced for agricultural soils in Wallonia based on a Monte Carlo Approach taking into account both the measurement and the model uncertainties. For Flemish forest soils, spatial and analytical uncertainties were taken into account using bootstrapping techniques. For Flemish agricultural soils, the uncertainty reported is the model uncertainty on point estimates for each data point, in which the estimated model parameters are simulated 1000 times as being independent normal distributed variables using their model estimation and standard error as distribution parameters. No additional uncertainty is taken into account for the conversion functions that use the stochastic variables "bulk density" and the conversion from 0.3 to 1m. The SOC stock map is the first comprehensive map for Belgium integrating grasslands, croplands and forest and can serve as a reference layer. The metadata are available and allow assessing the uncertainties of the stock estimates in the different component maps.

Harmonisation of a soil map at the continental scale: the map of the Soil Atlas of Africa

Olivier Dewitte

Royal Museum for Central Africa, Department of Earth Sciences, Tervuren, Belgium
Olivier Dewitte

(Olivier.Dewitte@africamuseum.be)

Problem statement and aim: The protection and the sustainable management of soil resources in Africa are of paramount importance, especially in the context of major global environmental challenges such as food security, climate change, fresh water scarcity and biodiversity loss. To raise the awareness of the general public, stakeholders, policy makers and the science community to the importance of soil in Africa, the Soil Atlas of Africa was published in 2013 by the Joint Research Centre of the European Commission (Jones et al., 2013). To that end, a new harmonised soil map at the continental scale has been produced (Dewitte et al., 2013). Here we present the steps of the construction of this area-class map. **Methods:** We show that the basic information is derived from the Harmonized World Soil Database (HWSD) and that the original data was updated and modified according to the World Reference Base for Soil Resources classification system. The corrections concerned boundary issues, areas with no information, soil patterns, river and drainage networks, and dynamic features such as sand dunes, water bodies and coastlines. **Results and discussion:** In comparison to the initial map derived from HWSD, the new map represents a correction of 13% of the soil data for the continent. When the map was published in 2013 and made available for free downloading, it was anticipated that this new product would have the potential to enhance global studies on climate change, food production and land degradation for example. It was also anticipated that explanation of the decisions that were made to produce the map would be useful to others who are attempting to harmonise legacy soil data sources to provide a usable information base. Through a literature analysis, the way the map has been cited and used by the scientific community is discussed with regard to these expectations and also the use of other soil information products that recently were made available at the continental scale.

References:

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Posters

Title: ‘Spatial analysis of an urban fill through electromagnetic soil sensing’

Christin Bobe, Ellen Van De Vijver, Marc Van Meirvenne

Research Group Soil Spatial Inventory Techniques,
Department of Soil Management,
Ghent University,
Coupure Links 653
9000 Gent, Belgium

Estimating the spatial distribution of urban soil from land cover data: the case of Flanders

Van de Vijver, E., **Delbecque N**., Verdoodt, A., Van Meirvenne, M. & Seuntjens, P.

Department of Soil Management, Ghent University, Campus Coupure, block B, Coupure Links 653, B-9000 Gent, Belgium

Historical as well as recent urban and industrial expansion has left us with a vast territory of urban soil. On traditional soil maps, many of which still the first tool at hand for soil investigation today, urban and industrial areas remain blind (unsurveyed) spots. Furthermore, because of rapid urban sprawl in recent decades, even only "middle-aged" soil maps are likely to be already out-of-date. This research aims to evaluate the use of land cover data to bridge the urban soil information gap, considering the highly urbanized region of Flanders (Belgium) as a case study. The current extent and spatial distribution of urban soil is 1) estimated from recently acquired land cover data, and 2) compared with the urban soil territory as derived from the legacy soil map of Belgium, as this still is one of the most commonly used reference documents for soil-related studies in Flanders. We intend to illustrate how the occurrence of urban soil on a regional scale can be estimated based on a simple reclassification of land cover data, a procedure which can easily be transposed to other exhaustive sources of land information.

Quantifying the long-term impact of agriculture on soil profiles and sediment redistribution – the case of Lauwerdal (N. France)

Nick Krekelbergh1, Stefaan Dondeyne2, Amaury Frankl1

1 Department of Geography, Ghent University
2 Department of Earth and Environmental Sciences, KU Leuven
Corresponding author: Nick.Krekelbergh@UGent.be

This research considers the quantification of sediment redistribution in agricultural land and the effect on soil profiles in the European loess belt. As a case study, two small agricultural catchments in Lauwerdal were selected, located in the municipalities of Acquin-Westbécourt and Quelmes on the plateau of Artois. By means of soil mapping (soil profiles and augering) we investigated which soil types and soil catenas are occurring within the study area. Based on these results the effects of erosion and sedimentation on soil development (truncation, buried profiles) will be measured and long-term sediment redistribution will be quantified in the catchments. Using series of stereoscopic aerial photographs, an assessment will be made of the impact of erosion since the middle of the twentieth century, as no detailed soil maps from this period that cover the area of research exist. The WaTEM/SEDEM erosion model will be used to simulate the redistribution patterns of the sediment over the landscape. An attempt will be made to establish a dating framework for these processes as the colluvial deposits in the soil profiles are being sampled for carbon-14 dating. Preliminary results show a strong predominance of soils developed on clay-with-flints with an important impact of tillage erosion as stony colluvial deposits accumulate in the lower landscape positions. In the thalweg of the basins deep gullies have been incised through water erosion, which have subsequently been filled up with colluvial material and stone debris.

How do soil patterns influence crop growth?
Preliminary geophysics & remote sensing data combination for precision fertigation in potato fields.

DUMONT Gaël[1*], VON HEBEL Chris[2], PICCARD Isabelle[3], REYNAERT Sophie[4], JANSSENS Pieter[4], VAN DER KRUK Jan[2], GARRE Sarah[1]

[1]Liège University (ULiège), Gembloux Agro-Bio Tech, TERRA Research and Teaching Center

[2]Forschungszentrum Jülich, Institute of Bio- and Geoscience, Agrosphere (IBG-3)
[3]VITO Remote Sensing
[4]Soil Service of Belgium (BDB)
* Corresponding author: gdumont@uliege.be

Due its shallow root system, a high water demand and a high drought sensitivity, the growth of potato plants is particularly influenced by the heterogeneous field properties. The POTENTIAL project aims to explore and demonstrate innovative sensing techniques, which reveal spatio-temporal variation in potato fields in order to adapt agricultural management to these heterogeneities. The combined used of multiple sensing methods (satellite & drone imagery, electromagnetic induction mapping and profiling

(EMI), electrical resistivity tomography (ERT) and punctual soil sensors) offers different investigation scale and frequency.

We used satellite and drone images were used to derive multiple observation indexes (the LAI (leaf area index), fAPAR (fraction of photo-synthetically active radiation absorbed by the canopy) and fCover (vegetation cover fraction)). The indices were used to monitor the crop development throughout the growing season. We also acquired EMI maps on the bare soil prior to the growing season and calibrated them using direct current resistivity methods. The obtained maps reveal electrical conductivity patterns in the soil that correlate with indexes derived from aerial images. This indicates that the initial soil conditions (soil texture, water content and water salinity) strongly influence the overall crop performance. In addition, we obtained timelapse 2D ERT tomograms. Once the setup installed, the acquisition can easily be repeated throughout the growing season. The 2D sections are used to estimate the weekly soil water content dynamics. We installed various temperature, water content and soil electrical conductivity sensors at 4 depths (20, 40, 60 and 80 cm depth) as validation for the geophysical data. Finally, repeated soil and plant sampling was conducted to monitor the soil conditions (soil water and nitrogen content), crop growth (stomatal conductance) and final yield. The preliminary results containing data from point over transect up till field scale at different moments in time will now help us to investigate the decisive factors for crop performance and the potential of the different data sources to be integrated in decision-making systems for precision irrigation and fertilisation of potato.

The 'DOV-verkenner': the web portal to information of the (sub)soil of Flanders

Katrien Oorts[1,*], Sabine. Buyle[1], Marleen Van Damme[1], Linsey Vanthounout[1], Veerle Vanwesenbeeck[1], and Martien Swerts[1]

[1] Vlaams Planbureau voor Omgeving, Departement Omgeving, Vlaamse Overheid, 1000 Brussel

*Corresponding author: katrien.oorts@vlaanderen.be

Ever since 1996, three departments within the government of Flanders cooperate to build the '**Databank Ondergrond Vlaanderen (DOV)'** offering INSPIRE-compliant open data free of charge and available for re-use. These data cover the themes soil, geology, geotechnics, groundwater and geothermics. The importance of DOV can't be underestimated as the users of DOV can be found among a variety of organisations such as governmental institutions, universities, consultancy firms, private sector, citizens, etc.

The **soil** part of DOV consists of soil data, soil maps and thematical maps about erosion, landslides and pedological heritage.

The dataset '**Bodemprofielen**' shows soil profile data of the DOV soil database (Figure 1). The descriptions and analytical results of the 7020 soil profiles and surface samples from the historical Aardewerk-Vlaanderen-2010 database are part of the **datasets 'Bodemprofielen kartering Belgische bodemkaart'** and **'Oppervlaktemonsters kartering Belgische bodemkaart'**.

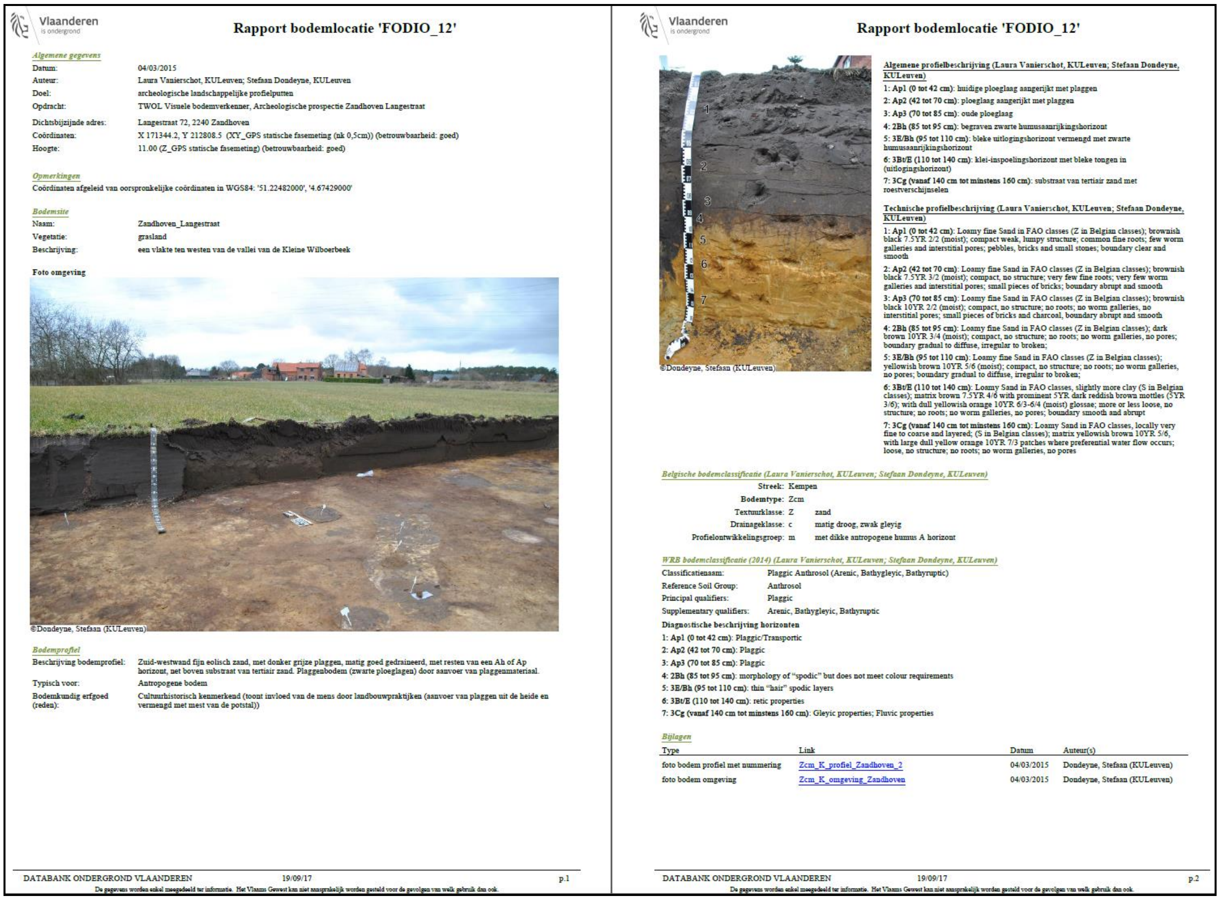
The **'Bodemkaart (1:20.000) van België' (soil map (1:20.000) of Belgium)** shows all the information associated with the soil map of Belgium for the Flemish part. First of all, the different components and the general characteristics of each soil type are explained. If available, a photograph and a soil profile description, representative of the soil type of the selected soil map polygon, are given. Whenever more than one representative soil profile is available for a specific soil type, the variability of soil profiles for that soil type is shown. Finally, for each location the scan of the original soil map sheet (scale 1:20.000), the information booklet of the map sheet and the basic maps at scale 1:5.000 can be downloaded. The **'Bodemkaart van België volgens World Reference Base (WRB)'** is a translation of the soil map of Belgium into the WRB soil classification system.

The 'Potentiële bodemerosiekaart per perceel (2016)' gives an indication of the potential **erosion** for each agricultural parcel in Flanders. Additionally, maps with proposed and implemented on-site erosion measures can be consulted and preferentially run-off lines can be shown.

The risk for **landslides** can be consulted on the map layers 'Gevoeligheidskaart voor grondverschuivingen' (susceptibility to landslides) and 'Gekarteerde grondverschuivingen' (mapped landslides).

Most soil and subsoil data can be consulted in the **online 'DOV-verkenner'** (DOV-viewer). The soil data in this application can easily be accessed via the user friendly '**DOV-bodemloketten**' (soil portals): https://dov.vlaanderen.be/dovweb/html/bodemloketten.html. These 'bodemloketten' provide a brief description of the available soil information for each soil theme and a direct link to the specific online data in the DOV-verkenner: with a single mouse-click you are directed to the optimal combination of thematic maps of a specific soil theme in the DOV-verkenner.

The DOV data can, as mentioned before, be consulted by employing the online DOV applications, but the use of the DOV **services** is also strongly promoted. These web services are designed according to the open standards and can be integrated in any geographical information system. Users can combine their own data with data collected from web services or downloaded files, thus creating their own tailor-made geographical environment.



Vlaanderen is ondergrond

Rapport bodemlocatie 'FODIO_12'

Algemene gegevens

Datum:	04/03/2015
Auteur:	Laura Vanierschot, KULeuven; Stefaan Dondeyne, KULeuven
Doel:	archeologische landschappelijke profielputten
Opdracht:	TWOL Visuele bodemverkenner, Archeologische prospectie Zandhoven Langestraat
Dichtsbijzijnde adres:	Langestraat 72, 2240 Zandhoven
Coördinaten:	X 171344.2, Y 212808.5 (XY_GPS statische fasemeting (nk 0,5cm)) (betrouwbaarheid: goed)
Hoogte:	11.00 (Z_GPS statische fasemeting) (betrouwbaarheid: goed)

Opmerkingen

Coördinaten afgeleid van oorspronkelijke coördinaten in WGS84: '51.22482000', '4.67429000'

Bodemsite

Naam:	Zandhoven_Langestraat
Vegetatie:	grasland
Beschrijving:	een vlakte ten westen van de vallei van de Kleine Wilboerbeek

Foto omgeving

©Dondeyne, Stefaan (KULeuven)

Bodemprofiel

Beschrijving bodemprofiel:	Zuid-westwand fijn eolisch zand, met donker grijze plaggen, matig goed gedraineerd, met resten van een Ah of Ap horizont, net boven substraat van tertiair zand. Plaggenbodem (zwarte ploeglagen) door aanvoer van plaggenmateriaal.
Typisch voor:	Antropogene bodem
Bodemkundig erfgoed (reden):	Cultuurhistorisch kenmerkend (toont invloed van de mens door landbouwpraktijken (aanvoer van plaggen uit de heide en vermengd met mest van de potstal))

DATABANK ONDERGROND VLAANDEREN 19/09/17 p.1

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Vlaanderen is ondergrond

Rapport bodemlocatie 'FODIO_12'

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Algemene profielbeschrijving (Laura Vanierschot, KULeuven; Stefaan Dondeyne, KULeuven)

1: Ap1 (0 tot 42 cm): huidige ploeglaag aangerijkt met plaggen

2: Ap2 (42 tot 70 cm): ploeglaag aangerijkt met plaggen

3: Ap3 (70 tot 85 cm): oude ploeglaag

4: 2Bh (85 tot 95 cm): begraven zwarte humusaanrijkingshorizont

5: 3E/Bh (95 tot 110 cm): bleke uitlogingshorizont vermengd met zwarte humusaanrijkingshorizont

6: 3Bt/E (110 tot 140 cm): klei-inspoelingshorizont met bleke tongen in (uitlogingshorizont)

7: 3Cg (vanaf 140 cm tot minstens 160 cm): substraat van tertiair zand met roestverschijnselen

Technische profielbeschrijving (Laura Vanierschot, KULeuven; Stefaan Dondeyne, KULeuven)

1: Ap1 (0 tot 42 cm): Loamy fine Sand in FAO classes (Z in Belgian classes); brownish black 7.5YR 2/2 (moist); compact weak, lumpy structure; common fine roots; few worm galleries and interstitial pores; pebbles, bricks and small stones; boundary clear and smooth

2: Ap2 (42 tot 70 cm): Loamy fine Sand in FAO classes (Z in Belgian classes); brownish black 7.5YR 3/2 (moist); compact, no structure; very few fine roots; very few worm galleries and interstitial pores; small pieces of bricks; boundary abrupt and smooth

3: Ap3 (70 tot 85 cm): Loamy fine Sand in FAO classes (Z in Belgian classes); brownish black 10YR 2/2 (moist); compact, no structure; no roots; no worm galleries, no interstitial pores; small pieces of bricks and charcoal, boundary abrupt and smooth

4: 2Bh (85 tot 95 cm): Loamy fine Sand in FAO classes (Z in Belgian classes); dark brown 10YR 3/4 (moist); compact, no structure; no roots; no worm galleries, no pores; boundary gradual to diffuse, irregular to broken;

5: 3E/Bh (95 tot 110 cm): Loamy fine Sand in FAO classes (Z in Belgian classes); yellowish brown 10YR 5/6 (moist); compact, no structure; no roots; no worm galleries, no pores; boundary gradual to diffuse, irregular to broken;

6: 3Bt/E (110 tot 140 cm): Loamy Sand in FAO classes, slightly more clay (S in Belgian classes); matrix brown 7.5YR 4/6 with prominent 5YR dark reddish brown mottles (5YR 3/6); with dull yellowish orange 10YR 6/3-6/4 (moist) glossae; more or less loose, no structure; no roots; no worm galleries, no pores; boundary smooth and abrupt

7: 3Cg (vanaf 140 cm tot minstens 160 cm): Loamy Sand in FAO classes, locally very fine to coarse and layered; (S in Belgian classes); matrix yellowish brown 10YR 5/6, with large dull yellow orange 10YR 7/3 patches where preferential water flow occurs; loose, no structure; no roots; no worm galleries, no pores

Belgische bodemclassificatie (Laura Vanierschot, KULeuven; Stefaan Dondeyne, KULeuven)

Streek:	Kempen	
Bodemtype:	Zcm	
Textuurklasse:	Z	zand
Drainageklasse:	c	matig droog, zwak gleyig
Profielontwikkelingsgroep:	m	met dikke antropogene humus A horizont

WRB bodemclassificatie (2014) (Laura Vanierschot, KULeuven; Stefaan Dondeyne, KULeuven)

Classificatienaam:	Plaggic Anthrosol (Arenic, Bathygleyic, Bathyruptic)
Reference Soil Group:	Anthrosol
Principal qualifiers:	Plaggic
Supplementary qualifiers:	Arenic, Bathygleyic, Bathyruptic

Diagnostische beschrijving horizonten

1: Ap1 (0 tot 42 cm): Plaggic/Transportic

2: Ap2 (42 tot 70 cm): Plaggic

3: Ap3 (70 tot 85 cm): Plaggic

4: 2Bh (85 tot 95 cm): morphology of "spodic" but does not meet colour requirements

5: 3E/Bh (95 tot 110 cm): thin "hair" spodic layers

6: 3Bt/E (110 tot 140 cm): retic properties

7: 3Cg (vanaf 140 cm tot minstens 160 cm): Gleyic properties; Fluvic properties

Bijlagen

Type	Link	Datum	Auteur(s)
foto bodem profiel met nummering	Zcm_K_profiel_Zandhoven_2	04/03/2015	Dondeyne, Stefaan (KULeuven)
foto bodem omgeving	Zcm_K_omgeving_Zandhoven	04/03/2015	Dondeyne, Stefaan (KULeuven)

DATABANK ONDERGROND VLAANDEREN 19/09/17 p.2

De gegevens worden enkel meegedeeld ter informatie. Het Vlaams Gewest kan niet aansprakelijk worden gesteld voor de gevolgen van welk gebruik dan ook.

Figure 1: Example of a soil profile description report available in the dataset 'Bodemprofielen' of the DOV-verkenner.

Mapping soils from terrain features – the case of Nech Sar National Park southern Ethiopian Rift Valley

Shetie Gatew[1,2], Stefaan Dondeyne[2], Jennifer Roelens[2], Jan Nyssen[3], Karen Vancampenhout[4], Jozef Deckers[2]
[1]Faculty of Natural Sciences, Department of Biology, Arba Minch University, Ethiopia
[2]Department of Earth and Environmental Sciences, KU Leuven, Celestijnenlaan 200E, B- 3001 Leuven, Belgium
[3]Department of Geography, Ghent University, Krijgslaan 281 (S8), B-9000 Ghent, Belgium
[4]Cluster for Bio-engineering Technology, Department Microbial and Molecular Systems, KU Leuven Campus Geel, Kleinhoefstraat 4, B-2440 Geel, Belgium
E-mail address: Shetieg@yahoo.com (correspondence author*)*

Current soil maps of Ethiopia do not represent accurately the soils of Nech Sar National Park. In the framework of studies on the ecology of the park, we prepared a new soil map based on field observations and a digital terrain model derived from SRTM data with a 30-m resolution. The landscape comprises volcanic cones, lava and basalt outflows, undulating plains, horsts, alluvial plains and river deltas. SOTER-like terrain mapping units were identified. First, the DTM was classified into 128 terrain classes defined by slope gradient (4 classes), relief intensity (4 classes), potential drainage density (2 classes), and hypsometry (4 classes). A soil-landscape relation between the terrain mapping units and WRB soil units was established based on 34 soil profile pits. Based on this relation, the terrain mapping units were either merged or split to represent comprehensive soil and terrain map. The new soil map indicates that Leptosols (30 %), Cambisols (26 %), Andosols (21 %), Fluvisols (12 %), and Vertisols (9 %) are the most widespread Reference Soil Groups of the park. In contrast, the harmonized soil map of Africa derived from the FAO soil map of the world – indicates that Luvisols (70%), Vertisols (14%) and Fluvisols (16%) would be the most common Reference Soil Groups. However, these latter mapping units are not consistent with the topography. This case study shows that with the now freely available SRTM data, it is possible to improve current soil information layers with relatively limited resources, even in a complex terrain as Nech Sar National Park.
Keywords: Digital Elevation Model, SOTER, Luvisols, Andosols, Cambisols, Vertisols, Leptosols, Fluvisols, soil-landscape relationship