Remote Sensing for Soils Seminar.

UCLouvain, 11/01/2023.

We organized this seminar at the occasion of the PhD defense of Klara Dvorakova benefitting from the presence of the jury members, all renowned scientists in the domain of remote sensing for predicting soil properties.

When we started with remote sensing for soils at the UCLouvain in 2003, we had to rely on airborne hyperspectral campaigns organized every two years by the Belgian Science policy STEREO programme. Since then, the availability and quality of optical satellite remote sensing such as the Sentinel 2 multispectral instrument have dramatically changed the paradigm for soil mapping and monitoring. Remote sensing of soil organic carbon (SOC) becomes feasible covering the vast majority of the croplands at regional scales and continental scales within the framework of the Worldsoils project financed by the European Space Agency. A new generation of space-based hyperspectral missions is under implementation and there is no doubt that this will enhance the performance of soil property mapping and monitoring still further.

The speakers illustrate the need for remote sensing in the framework of the EU Soil Mission, the challenges for acquiring a full coverage of the croplands, the exciting potential of the new generation of hyperspectral satellites, the challenges of selecting the optimal conditions for soil property prediction and last but not least the potential for remote sensing in the framework of regenerative agriculture and carbon farming.

Arwyn Jones, European Commission Joint Research Centre, introduces the need for soil monitoring within the policy framework of the European Green Deal. He underlines that the EU Soil strategy aims to reap the benefits of healthy soils for people, food, nature and climate. However, one of the challenges remains to determine the set of parameters and descriptors for a healthy soil. Remote sensing is a key component of an integrated EU soil monitoring system to track the progress towards soil health. In the near future the evidence of such a system will converge in an EUSO Soil Health Dashboard. However, there are still several issues to resolve related to e.g., consistent methodology, visibility of the soil surface, integration of different earth observation flows and policy maker awareness to be overcome. Finding competitive procedures to estimate such parameters of soil health condition will be key for consolidating the EU soil health law objectives by 2050.

Figure 1 EU Soil Strategy context. COM(2021)699 final.

Uta Heiden, German Aerospace Center (DLR), addresses the challenges of observing soils from optical satellite platforms. She introduces the technique of soil composite mapping (SCMaP) that creates a reflectance signal for each bare soil pixel based on a time series of images. The advantage of such system is that the coverage of cropland area is much larger than for single images and that the signal is more stable for each pixel as a result of averaging. She addresses the challenges of defining thresholds for spectral indices allowing to create an optimal bare soil mask and demonstrates the SCMaP product suite. These products can be used for soil property

algorithms but also for indicators of management practices such as bare soil frequency and seasonality.

Sabine Chabrillat, German Research Center for Geosciences (GFZ) and Leibniz University Hannover (LUH), stresses the contributions of soil spectroscopy and remote sensing to fulfilling the need for accurate, up-to-date and spatially referenced soil information. She explains the principles of spectroscopy and hyperspectral remote sensing in determining selected soil properties such as SOC and clay content and explains how these soil constituents can be determined from bare soil pixels. She then presents the characteristics of the current (PRISMA and EnMAP) and future (SBG, CHIME) hyperspectral satellite missions. She presents the advances in soil property mapping by the EnMAP Science program i.e. account for disturbing factors, use of large-scale soil spectral libraries to develop robust multivariate calibration methods and contribute to the development of harmonized soil spectral libraries for calibration /validation. She demonstrates some preliminary results for soil property mapping based on EnMAP in the Thessaloniki area (Greece) and discusses the influence of disturbing factors and future developments for soil property prediction algorithms for the CHIME mission.

Figure 2 German satellite EnMAP launch on April 1, 2022.

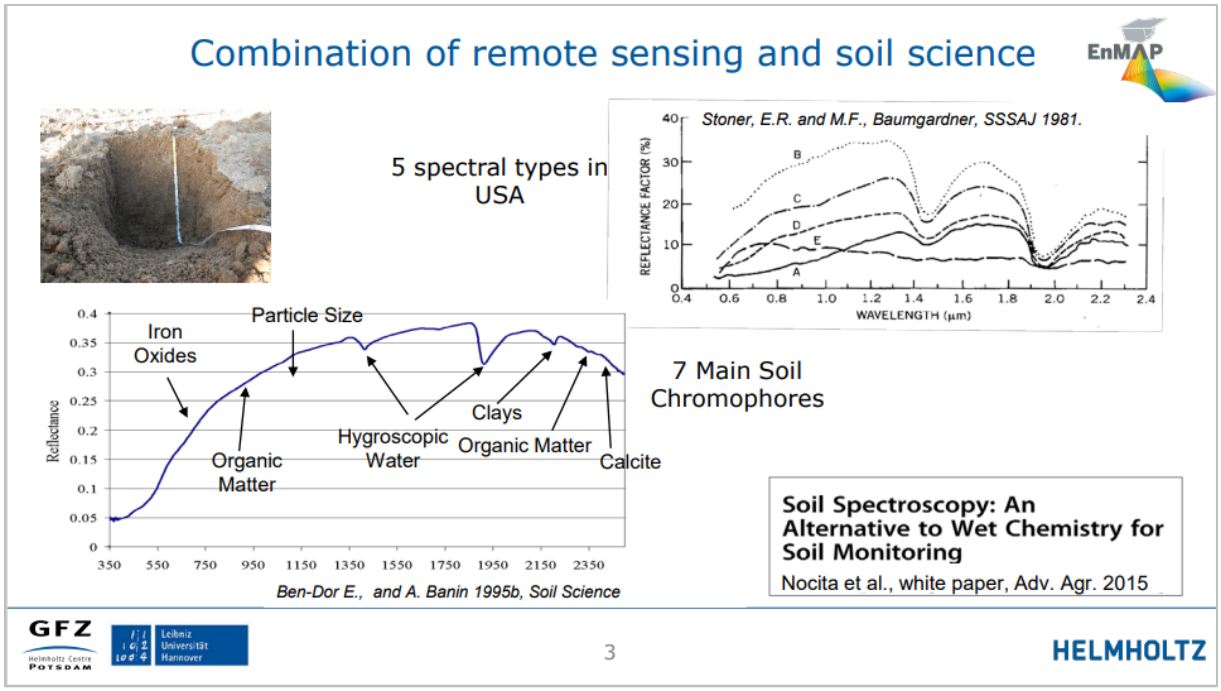

Figure 3 References to combined remote sensing and soil science.

Fabio Castaldi, National Research Council of Italy, gives an overview of the experiences from the STEROPES-EJP Soil project. He focuses on the surface conditions required for the correct prediction of soil properties from remote sensing with special attention for disturbing factors such as green vegetation, dry vegetation and soil moisture. First, he explains the disturbances that can influence the signal when moving from lab to satellite spectra. Then he gives a practical example of

the increased coverage of temporal series of satellite imagery. He then demonstrates the impacts of green vegetation, dry vegetation and soil moisture on soil property mapping. He demonstrates the use of spectral indices to search for the optimal conditions in a multispectral time series applied to the case of soil moisture disturbance. Finally, he offers his perspective on the challenges of the increase in vegetation and residue coverage as a result of regenerative agriculture.

Jelle van Wesemael, Soil Capital, starts by presenting Soil Capital, and its mission mission in supporting farmers to transition to more profitable and regenerative agriculture with their programme for carbon farming. Currently, 600 farmers have signed up to Soil capital's carbon farming programme covering 160,000 ha and 29,000 carbon certificates have been issued. He explains the way in which the App 'MySoilCapital' calculates the carbon credits over a period of 1-5, 6-10 and 10-15 years. He then addresses the contribution of remote sensing in a carbon certification programme by simplifying data entries, adding value for farmers, allowing monitoring of practices and ensuring scientific credibility. He concludes by advocating to bridge the gap between science and practice and stresses that besides the aforementioned needs, Soil Capital contributes their agronomic knowhow and detailed datasets on regenerative agriculture.

Figure 4 In-situ soil measurements

The series of presentations started off with the need for monitoring of soil properties in the framework of the EU Soil strategy and a vision on the integration of soil monitoring networks and remote sensing products in a soil dashboard. The next three speakers discussed the current challenges for determining soil properties from earth observation. On the one hand temporal soil reflectance composites increase the extent of bare soil that can be mapped and on the other hand the latest techniques for dealing with disturbing factors that hinder the detection of bare soils were presented. The developments in remote sensing are rapid and already the performance of the next generation of hyperspectral satellite is tested in the PRISMA and EnMAP programme. Hyperspectral satellites such as SBG and CHIME with frequent overpass and regular global coverage comparable to the current multispectral Sentinel 2 are in preparation. No doubt that exploring the capabilities of remote sensing for up-to-date soil properties as well as soil management practices will continue and will benefit regenerative agriculture and soil carbon crediting systems such as the ones pioneered by Soil Capital. The speakers of the seminar will continue working together towards monitoring of healthy soils in the Worldsoils project and for carbon farming in the Horizon Europe project MRV4SOC that will be launched this spring. Moreover, a new PhD studentship will start for monitoring SOC over the entire Walloon Region financed by the Plan de Relance de la Wallonie. With these bright perspectives we invite you to watch the presentations through the link below.

If you want to get involved as a WORLDSOILS Stakeholder, please visit and contact us at https://www.world-soils.com/stakeholders/