Soil Science Society of Belgium presents

THE YOUNG SOIL SCIENTISTS DAY

Challenges for soil scientists

Book of Abstracts

March 31st 2022 | 9H30-16H30
Royal Academy, Hertogstraat 1, Brussels

Program

8.30 onwards	**Doors Open**
8.45 - 9.00	**Registration**
9.00 - 9.15	**Welkom** Prof. Karen Vancampenhout (KU Leuven) – President of SSSB
9.15 - 10.30	**Oral Presentations** - 9.15 – 9.30: Marie Dincher - *Importance of particles in the input-output budget of major elements in humus of a beech forest* - 9.30 – 9.45: Lin Wang - *Effects of treated wastewater irrigation on soil quality* - 9:45 – 10:00: Klara Dvorakova - *Improving soil organic carbon predictions from Sentinel 2 soil composites by assessing surface conditions and uncertainties* - 10:00 – 10.15: Florence Tan - *Evaluating the large-scale applicability of hillslope sediment connectivity models* - 10.15 – 10.30: Mekonnen Getahun - *Soils and vegetation of the Afro-Alpine vegetation belts of East African rift valley system: a literature review*
10.30 - 11.15	**Coffee Break + Posters (incl. poster tour)**
11.15 - 12.15	**Oral Presentations** - 11.15 – 11.30: Philippe Roux - *Influence of warming on ecosystem elemental budget, an Ecotron experiment* - 11.30 – 11.45: Haichao Li - *Soil textural control on moisture distribution at the microscale and its effect on organic matter mineralization* - 11.45 – 12.00: Ine Rosier - *Modelling the effects of vegetated landscape elements on the rainfall-runoff behaviour of agricultural catchments* - 12.00 – 12.15: Jacques Kilela - *Effect of organic amendment on the physicochemical characteristics of tailing and root development of tree species, fifteen years after planting*
12.15 - 13.15	**Lunch Break + Posters (incl. poster tour)**
13.15 - 13.45	**Keynote Presentation** - Prof. Jean Thomas Cornelis (University of British Columbia) – Former president of SSSB *Pedology, a key discipline if we are to harness all the complexity of soil-root-plant interactions to build resilient ecosystems*
13.45 - 15.00	**Oral Presentations** - 13.45 – 14.00: Ioanna Panagea - *Can we reverse the negative effects on topsoil structure and organic carbon caused by inversion tillage? Analysis of long-term experiments in Europe* - 14.00 – 14.15: Junwei Hu - *Do belowground herbivorous and bacterivorous microfauna influence plant growth independently?* - 14.15 – 14.30: Lin Lin - *Visual assessment of soil structural quality across soil textures and compaction levels – examination of profile walls vs. intact soil cores* - 14.30 – 14.45: Zimmin Li - *Aggregation reduces the release of bioavailable silicon from allophane and phytolith* - 14.45 – 15.00: Florian Lauryssen - *Estimation of the natural background of phosphate in a lowland river using tidal marsh sediment cores*
15.00 - 15.30	**Coffee Break + Posters**
15.30 - 16.30	**Workshop: Mental Health** - Merel Ackx - Career Development Advisor KU Leuven
16.30 – 17.00	Closing & Drink

Abstracts

of

oral presentations

Importance of particles in the input-output budget of major elements in humus of a beech forest

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This study presents a complete budget of the input/output fluxes of major elements in the humus layer by considering dust inputs and, for the first time, particle output. Indeed, in a context where forest ecosystems usually develop on poor and unfertilised soils, nutrient cycles and input/output balances are key to determine the sustainability of forests. This is especially true for the humus compartment.

In this study, we studied mulls in beech ecosystems considering two contrasting soil types. Over a timespan of 7 years the inputs and outputs of elements, i.e., both particles (dust inputs and particles in the outgoing solution) and solutions, have been quantified.

The concentrations of the elements in the particles output were 3 or 16 times higher than those in dust, because some particles were produced in the humus. The input/output balances were in equilibrium for K, Na and S in both soils and for P, Si and Mg in one soil. These elements were transported in the humus mainly as a solution or in soluble form in plant tissues. The inputs were higher than the outputs for Ca and Mn in both soils and for P, Si and Mg in one soil, which are the elements found in biominerals. This indicates that other outputs were not taken into account in this budget, such as biomineral sedimentation or uptake by fungi. In conclusion this study highlights the importance of the humus particles in element cycles.

Dincher, M., 2020. Major element residence times in humus from a beech forest: The role of element forms and recycling. Soil Biol. Biochem. 12.

Dincher, M., Calvaruso, C., Turpault, M.-P., 2020. Particles in humus leaching solution influence the input–output budget of the major elements in a beech forest. Biogeochemistry. https://doi.org/10.1007/s10533-020-00702-6

Improving soil organic carbon predictions from Sentinel-2 soil composites by assessing surface conditions and uncertainties

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Soil organic carbon (SOC) prediction from remote sensing is often hindered by disturbing factors at the soil surface, such as photosynthetic active and non-photosynthetic active vegetation, variation in soil moisture or surface roughness. With the increasing amount of freely available satellite data, recent studies have focused on stabilizing the soil reflectance by building reflectance composites using time series of images. Even if SOC predictions from composite images are promising, it is still not well established if the resulting composite spectra mirror the reflectance fingerprint of the optimal conditions to predict topsoil properties (i.e., a smooth, dry and bare soil).

We have collected 303 photos of soil surfaces in the Belgian loam belt where five main classes of surface conditions were distinguished: smooth seeded soils, soil crusts, partial cover by a rowing crop, moist soils and crop residue cover. Reflectance spectra were then extracted from the Sentinel-2 images coinciding with the date of the photos. After the growing crop was removed by a NDVI < 0.25, the Normalized Burn Ratio (NBR2) was calculated to characterize the soil surface, and a threshold of NBR2 < 0.05 was found to be able to separate wet soils and soils covered by crop residues from dry bare soils. Additionally, we found that normalizing the spectra (i.e., dividing the reflectance of each band by the mean reflectance of all spectral bands) allows for cancelling the albedo shift between soil crusts and smooth soils in seed-bed conditions. We then built the exposed soil composite from Sentinel-2 imagery (covering the spring periods of 2016-2021) and used the mean spectra per pixel to predict SOC content by means of a Partial Least Square Regression Model (PLSR) with 10-fold cross-validation. The uncertainty of the models, based on the 5 and 95% quantiles was assessed via bootstrapping, where each model was repeated 100 times with a slightly different calibration dataset. The cross validation of the model gave satisfactory results ($R^2 = 0.49 \pm 0.10$, RMSE = 3.4 ± 0.6 g C kg^{-1} and RPD = 1.4 ± 0.2). The resulting SOC prediction maps show that (1) the uncertainty of prediction decreases when the number of scenes per pixel increases, and reaches a minimum when more than six scenes per pixel are used (median uncertainty of all pixels is 28% of predicted SOC value) and (2) the uncertainty of prediction is lower for the prediction of the mean SOC per field (median uncertainty of fields is 22% of predicted value). The results of a validation against an independent data set showed a median difference of 0.5 g C kg^{-1} ± 2.8 g C kg^{-1} SOC between the measured and predicted SOC contents at field scale. Overall, this compositing method shows both realistic SOC patterns at the field scale and regional patterns corresponding to the ones reported in the literature.

Soils and vegetation of the afro-alpine vegetation belts of East African Rift Valley system: A literature review

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The tropical afro-alpine belt along with the East African Rift Valley system, consists of geographically separated ‘sky islands. The diverse soils of the afro-alpine belt are the basis of various ecosystem services. Mountains are the source of perennial water springs and take a prominent role in hydrology. Moreover, their soils have often high organic carbon content, representing large carbon stocks, and are therefore important in the context of mitigation of climate change. The purpose of this review is to take stock of what is known on the soils of the afro-alpine belts, in terms of soil hydraulic properties, soil organic carbon stock, and soil classification and to investigate how variation in these properties relate to the vegetation along with the East African Rift Valley system.

Using google scholar and Scopus databases, we searched for publications of any year in peer-reviewed journals, scientific reports, maps, and dissertations on soil surveys and vegetation in the English language. Over 150 publications were retrieved, of which only 50 publications were retained for reporting empirical results on the soils and the vegetation of afro-alpine belts. Important materials critically reviewed are 1:5000000 Soil Maps of the World, The Harmonized World Soil Database (Dewitte et al., 2013), Soil Atlas of Africa (Jones et al., 2013), the vegetation of Africa (White, 1983). All available documents were organized as follows: First, available afro-alpine mountain datasets and research documents were collected; categorized into local published Journals and SCI Journals and summarized and overall documents were reviewed and available information was organized.

Histosols, Cryosols, Leptosols, Gleysols, Podzols, Andosols, Cambisols, and Regosols are the most common RSGs reported occurring in the afro-alpine belt. Mountain soils provide a diversity of ecosystem services. However, there is limited information and research on soil hydraulic properties and soil organic carbon stocks due to inaccessibility and harsh conditions. Soils of the afro-alpine belt received little attention as conventional soil surveys focused on agricultural land. However, the vegetation of the afro-alpine belt is rather well studied and consists of adequate information.

Specific knowledge gap mentions some peculiar soil properties like andic properties of mountain soils. Notably, andic soils have unique morphological, physical, and chemical properties that persuade significant soil fertility and resilience to land degradation processes for example erosion and landslides. Another problem is the lack of consistent, detailed, and comparable data on soil resources across mountains, lack of medium-scale soil map coverage, moreover, existing data are old, have little coherence, and have limited applicability for contemporary needs. Therefore, in the future, soil hydraulic properties, soil organic carbon, and climate models research on the highest mountain areas should be given and needs special attention.

Do belowground herbivorous and bacterivorous microfauna influence plant growth independently?

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Understanding the interactions between the microorganisms involved in plant-soil system is crucial for improving nutrient management in agricultural ecosystems. Both herbivorous and bacterivorous microfauna has been proven strongly influence the soil nutrient mineralization and plant growth, however, their interactions is poorly known as our knowledge is mainly based on isolated investigations of single organism groups. This study investigated how herbivorous nematodes (*Pratylenchus zeae*), bacterivorous protists (*Acanthamoeba castellanii*), bacterivorous nematodes (*Rhabditis oxycera*), separately and in combination, affect soil N mineralization and plant growth, with Italian ryegrass (*Lolium multiflorum*) cultivated in individual specially designed sterile plant-soil-air microcosms. Bacterivorous nematodes increased while herbivorous nematodes decreased total plant biomass, and a significant negative interaction between herbivorous and bacterivorous nematodes was detected. Bacterivorous nematodes increased soil N mineralization, but bacterivorous protists and related interactions showed negligible effect on both plant growth and soil N mineralization, which might be due to unsuccessful colonization. Plant N uptake and herbivorous nematodes together explained 78.8% of the plant biomass variance. Plant with herbivorous nematodes infection showed a more conservative root traits with higher average diameter and lower root surface area and specific root length. In addition, herbivorous nematodes resulted in lower root biomass, soil dissolved C and soil dehydrogenase activity, which reduced soil N mineralization caused by bacterivorous nematodes. In sum, this study shows the negative multitrophic interactions between belowground herbivorous and bacterivorous microfauna on plant growth.

Effect of organic amendment on the physicochemical characteristics of tailing and root development of tree species, fifteen years after planting

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Among mine wastes, tailings are known to have the largest environmental impact, as they have the high concentrations of trace elements and are susceptible to wind dispersal and water erosion. A tree plantation trial was installed at Kipushi tailing (Democratic Republic of the Congo) in order to mitigate the contaminant dispersal on the surrounding areas. Fifteen years later, the present study was conducted on the purpose of investigating the macronutrient and trace metal concentrations in amended holes and assessing the development of tree species through root behavior in the tailing (in soil profiles at the base of tree).

Results show elevated available P, K, Ca and Mg concentration in the surface and amended layers which is higher than the unpolluted soil of the miombo woodland. Cu and Co concentration trended to increase in the rich OM layers (L1 and L3 amended), but Zn, Cd, Pb and As remained higher in tailings. Compared to the tailing layer, roots developed well in the amended layers (very abundant, all sizes and regular distribution), but few roots ranging from very fine to big from all the surviving species were able to go beyond the amended layers indicating the possibility of tree survival on the tailing over many years. *Acacia polyacantha* and *Psidium guajava* showed an abundant root development in the unamended tailing layers compared to other 8 tree species.

Therefore, species that are less sensitive to metal toxicity and soil compactness challenges need to be promoted for the phytostabilisation of tailings with fewer amendments and the top soil from the uncontaminated areas should be mixed with the organic amendments for the rehabilitation of larger areas.

Estimation of the natural background of phosphate in a lowland river using tidal marsh sediment cores

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Elevated phosphate (PO_4) concentrations can harm the ecological status in water by eutrophication. In the majority of surface waters in lowland regions such as Flanders (Belgium), the local PO_4 levels exceed the limits defined by environmental policy and fail to decrease, despite decreasing total phosphorus (P) emissions. In order to underpin the definition of currents limits, this study was set up to identify the pre-industrial background PO_4 concentration in surface water of the Scheldt river, a tidal river in Flanders.

We used the sedimentary records preserved in tidal marsh sediment cores as an archive for reconstructing historical changes in surface water PO_4. For sediment samples at sequential depths below the sediment surface, we dated the time of sediment deposition and analysed the extractable sediment-P. The resulting time series of sediment-P was linked to the time series of measured surface water-PO_4 concentrations (data 1967-present). By combining those datasets, the sorption characteristics of the sediment could be described using a Langmuir type sorption model. The calibrated sorption model allowed us to estimate a pre-industrial background surface water PO_4 levels, based on deeper sediment-P that stabilised at concentrations smaller than the modern.

In three out of the four cores, the sediment-P peaked around 1980, coinciding with the surface water PO_4. The estimated pre-industrial (~1800) background PO_4-concentration in the Scheldt river water was 62 [57; 66 (95%CI)] µg PO_4-P L^{-1}. That concentration exceeds the previously estimated natural background values in Flanders (15-35 µg TP L^{-1}) and is about half of the prevailing limit in the Scheldt river (120 µg PO_4-P L^{-1}). In the 1930s, river water concentrations were estimated at 140 [128; 148] µg PO_4-P L^{-1}, already exceeding the current limit. The method developed here proved useful for reconstructing historical, background PO_4 concentrations of a lowland tidal river. A similar approach can apply to other lowland tidal rivers to provide a scientific basis for local, catchment specific PO_4 backgrounds.

Soil textural control on moisture distribution at the microscale and its effect on organic matter mineralization

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Soil texture determines microbial activity and organic matter (OM) decomposition in several ways. Next to direct physicochemical stabilization of OM, the location of moisture in the soil matrix also depends on soil texture. At lower moisture content, the contact between soil moisture and OM might be critical for OM decomposition, because such areas of contact could function as a ‘bridge’ for transport of moisture, substrates and microorganisms. Additionally, water absorption by porous OM itself likely also depends on soil texture and this may thus bring about another indirect textural control on OM mineralization. However, the relevance of such indirect soil textural controls on OM mineralization has not been investigated. We therefore compared the mineralization of ^{13}C-labeled maize particles (C_{maize}-min) in a loamy sand and silt loam soil at three levels of water-filled pore space (20, 40 and 60%WFPS). The distribution of maize particles and moist soil volume was assessed at the microscale using X-ray µCT and contrast-enhancing agents. We hypothesized that a lower contact between OM and soil in the loamy sand soil would lead to a reduced OM decomposition compared with the silt loam soil. On the other hand, we expected that OM itself could attract more moisture from the surrounding loamy sand soil due to a higher water potential than in the silt loam soil at equal WFPS level. Contrary to our expectation, we found a lower contact between zones of moist soil and the added OM in the silt loam soil. But as expected, OM was able to attract more water from the loamy sand soil, and it preserved a moist state even when soil was at a low moisture content, which may explain the surprisingly limited inhibition of C_{maize}-min in drier loamy sand soil. This finding suggests that such a ‘sponge-effect’ of OM may be a relevant yet largely overlooked element in studying the relationship between soil moisture and OM decomposition. Contrary to our expectation, C_{maize}-min was higher in the silt loam soil texture across all three moisture levels ($P<0.05$). At low moisture content particularly, fungal and actinomycetes biomarker abundances were elevated in the silt loam soil. A shift towards a fungi-oriented microbial community could explain the higher C_{maize}-min rates in the silt loam soil under dry than moist conditions. Overall, our results showed that mineralization of added OM was surprisingly independent of soil moisture, but explanatory pathways were probably very much soil texture dependent.

Aggregation reduces the release of bioavailable silicon from allophane and phytolith

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Phytoliths form in plant tissues as fine, silt-sized amorphous silica particles. Once deposited in soils by plant debris, they can dissolve and feed silicon (Si) fluxes to the biosphere and hydrosphere, enhancing the positive effects of Si on plant health and carbon fixation by marine diatoms. In soils, microaggregates (<250 µm) may entrap phytoliths and protect them from dissolution. Here we aimed at analyzing the role of aggregation in protecting phytoliths and delaying the release of bioavailable Si. Synthetic 32-days aged aggregates were composed of (g kg^{-1}): organic matter (50), aluminosilicate mineral (370), iron (Fe) oxide (60), quartz (500) and rice phytolith (20). Two models, amorphous (*Am*) and crystalline (*Cryst*), were tested. The aluminosilicate and Fe oxide were, respectively, allophane and ferrihydrite in the *Am* model, kaolinite and goethite in the *Cryst* one, other components remaining in identical proportions. Aggregates were visualized by Scanning and Transmission Electron Microscopy. They were compared to individual compounds and unaggregated mixtures through kinetic Na_2CO_3 and $CaCl_2$ extraction assessing the pools of phytoliths and bioavailable Si, respectively. Aluminum (Al) and germanium (Ge) concentrations, and pH were measured in the CaCl2 extracts. CaCl2 extractable Si decreased in the order (g kg^{-1}): *Am* mixture (3.72) > *Am* aggregate (0.95) > *Cryst* mixture (0.48) > *Cryst* aggregate (0.39). Aggregation thus reduced Si release by 3.9- and 1.2- fold in the amorphous and crystalline model, respectively. The Si/Al and Ge/Si atomic ratios showed that allophane and phytolith were the main sources of bioavailable Si in the amorphous and crystalline model, respectively. In contrast to the crystalline model (pH 5.0-7.8), the acidic medium in the amorphous model (pH 3.7-4.9) enhanced allophane dissolution. Aggregation thus protected both allophane and phytolith from dissolution, and reduced the release of bioavailable Si, the source of which depended on the component stability and pH.

Visual assessment of soil structural quality across soil textures and compaction levels – examination of profile walls vs. intact soil cores

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Since in modern agriculture, soil structure degradation becomes very common, it is essential to protect soil structure quality. Methods that enable its straightforward monitoring are therefore needed. Numerous visual soil evaluation techniques that serve this purpose exist, and are varying in objective, evaluation depth, number of criteria assessed and final scoring. In this study, we mainly focus on three VESS methods, two were employed in the field along a profile wall (SubVESS and DSVESS), and one in the laboratory on soil cores (CoreVESS). The main aim was to compare the different VESS methods in terms of their feasibility and repeatability in detecting soil structure degradation in the topsoil and subsoil. Sixteen cropped fields were chosen in Belgium covering six of seven major soil texture classes according to the Belgian soil textural triangle. SubVESS and DSVESS were performed in 80 cm deep pits and till 40 cm in the same pit, respectively, while soil cores for CoreVESS and for the determination of soil quality indicators (SQi) with conventional laboratory methods were taken from three layers, i.e., ploughed topsoil (TOP), compacted subsoil (CSUB) and deeper subsoil (SUB), totalling 96 horizons. While SubVESS and CoreVESS were originally developed to evaluate subsoil and topsoil, respectively, they were thus used here beyond those zones. Moreover, all sampling and field evaluation was done at two positions per field, i.e., the more compacted headland and the less compacted in-field zone. It was shown that the Soil quality Sq scores assigned to the cores with CoreVESS were not significantly influenced by operators with different backgrounds but all having received basic VESS training. When comparing field and laboratory results, positive relationships were shown between Sq scores of SubVESS, DSVESS and CoreVESS. All VESS methods were able to assign significantly better soil quality (lower scores) at in-field positions as compared to headland positions, and significantly lower quality (higher scores) to CSUB layers than the other two layers. Laboratory-derived SQi values presented a similar trend, with CSUB layers always indicating worse situations. There were good significant relationships between the SQi values and different VESS-based Sq scores as well, with DSVESS showing the best correlations among the three VESS methods. The study thus confirmed that the different VESS methods all have a potential for monitoring soil structure quality in a fast, cheap, intuitive and practical way, although they all have their own advantages and disadvantages. It also showed that methods employed at depths other than that for which they were developed perform well.

Can we reverse the negative effects on topsoil structure and organic carbon caused by inversion tillage? Analysis of long-term experiments in Europe

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Inversion tillage is a commonly applied soil cultivation practice in Europe, which has been blamed though, for deteriorating topsoil stability and organic carbon (OC) content. In this study, the potential to reverse these negative effects in the topsoil by alternative agricultural management practices are evaluated in five long-term experiments in Europe. Topsoil samples (0 –15 cm) were collected and analysed to evaluate the effects of conservation tillage (reduced and no-tillage) or increased organic inputs of different origin (farmyard manure, compost, crop residues) combined with inversion tillage on topsoil stability, soil aggregates and within these, OC distribution. Reduced and no-tillage practices, as well as the additions of manure or compost, increased the aggregates mean weight diameter (MWD) and topsoil OC, as well as the OC corresponding to the different aggregate size fractions. The incorporation of crop residues had a positive impact on the MWD but a less profound effect on OC content both on total OC and on OC associated with the different aggregates. A negative relationship between the mass and the OC content of the microaggregates (53 – 250 µm) was identified in all experiments. There was no effect on the mass of the macroaggregates and the occluded microaggregates (mM) within these, while the corresponding OC contents increased with less tillage and more organic inputs. Inversion tillage led to less particulate organic matter (POM) within the mM, whereas the different organic inputs did not affect it. In all experiment where the total POM increased, the total soil organic carbon (SOC) was also affected positively. We concluded that the negative effects of inversion tillage on topsoil can be mitigated by reducing the tillage intensity or by adding organic materials, optimally combined with non-inversion tillage methods.

Modelling the effects of vegetated landscape elements on the rainfall-runoff behaviour of agricultural catchments

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In Europe, river flooding is the most severe type of natural disaster and there is strong scientific evidence that extreme flood events might become even more frequent in the future. Besides the socio-economic impact, they are associated with severe macroeconomic consequences. Also in Flanders, flooding is a recurring problem, which was demonstrated again by the destructive flood events of July 2021. Climate-smart upstream land use systems are increasingly recognized as a way to mitigate downstream flood risk. Vegetated landscape elements (vLEs) such as hedges, and lines of trees are inherent components of such climate-smart land use systems. Their typical position along the edges of agricultural parcels creates networks of vLEs. Little quantitative evidence is available about the hydrological functioning of these networks of vLEs and how this is affected by their geometric and intrinsic characteristics.

We used Landlab, an open-source, landscape earth systems modelling environment, its Green-Ampt infiltration component and its overland flow component, based on a formulation of the shallow water equations for 2D flood modelling by Almeida et al. (2012) of to quantify the effect of various characteristics of vLEs in an agricultural landscape. At the current stage of our research, we studied a synthetic, simplified landscape subject to composite design storms. The artificial digital elevation model was created by adding a random roughness to a uniform sloping area with a surface area of 25 ha. The configurations of agricultural parcels within the catchment were selected to be representative of the agricultural parcel configurations in Flanders, Belgium. The density, manning's roughness coefficient of the vLSEs situated at a selection of the boundaries of the agricultural parcels in the catchment and the saturated hydraulic conductivity of the underlying soil as well as other soil hydraulic properties, were ranged based on values found in literature. A spatially uniform, composite design rainfall event with a return period of 50 years was modelled over the catchment and the magnitude and the timing of the peak discharge along with the total discharge volume of the catchment along with the timing of the peak discharge were assessed.

Early results demonstrate that the presence, position, geometrical features and hydrological properties of vLEs in a catchment affect runoff when a spatially uniform design rainfall event with a return period of 50 years is modelled over the catchment. A decrease in total discharge volume and peak discharge of up to 41 % and 44 % respectively is predicted in a landscape where vLEs are positioned along all parcel boundaries compared to a situation with no vLEs, while the lag time would increase by 2.5 minutes. Further, these effects are influenced by the initial soil properties and conditions. Our findings will be verified for real micro-catchments and soil conditions and can support decisions about the conservation and extension of vLE networks in agricultural landscapes.

Influence of warming on ecosystem elemental budget, an Ecotron experiment

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Current projections show that conventional climate change mitigation will not prevent the achievement of a 2°C warming limit as set by the Paris Agreement. The associated modification of the climate system strongly influences terrestrial carbon cycling through its controls on soil processes such decomposition of soil organic matter (CO_2 production) and chemical weathering of silicates (CO_2 consumption). Both of these processes are also key in other biogeochemical cycle with strong interplay with C but are yet to be taken into consideration in global climate models.

The aim of this experiment was to provide a mechanistic understanding of warming on the processes impacting cycling of elements in the water-soil-plant continuum and possible shifts in elemental budgets. To do so, we used a novel tool at ULiege designed to simulate climate conditions: the Ecotron facility at the TERRA teaching and research center in Gembloux Agro-Bio Tech. The experiment was based in 6 controlled macrocosm unit of 60 m². Each unit was composed of 9 cubic lysimeter of 0.125m³. 6 cubic lysimeters were filled with grassland soil and seeded with Lolium multiflorum, while the last 3 were only filled with soil collected from a grassland. The reference macrocosm (MU1) corresponded to a typical Belgian climate between March and September averaged over the last 30 years with a constant daily precipitation rate of 2.4mm. Each subsequent MU showed an incrementally hotter climate of 0.5°C (MU2), 0.9°C (MU3), 1.7°C (MU4), 3.2°C (MU5) and 6.0°C (MU6).

Temperature tends to increase aboveground biomass production in the first 8 weeks before decreasing it, probably due to unfavourable growing conditions. Root biomass is overall similar across macrocosms after 6 months. However, colder MU show a higher shallow root production (0-5cm) which is compensated by deeper root production in hotter MU (15-33cm). Elemental concentrations show very distinct trends depending on the considered element. Typical fertilizing elements NPK show an overall decrease with time, with the strongest drop between week 7 and week 16 and remaining stable onward. Si, on the other hand, appear extremely responsive to warming. Temporal evolution of Si is similar between MU with an increase in concentration from T0 followed by a decrease which happen more quickly with an increasing temperature. Si dynamics could therefore be the result of stress conditions. Overall, after 6 months, colder climate (MU1-3) mobilizes more elements than hotter ones, mostly because of soil drying occurring towards the end of Spring and across the summer months.

Evaluating the large-scale applicability of hillslope sediment connectivity models

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Large uncertainties exist in the estimated load of sediment being moved through the land surface system and ultimately reaching the world's oceans. The lack of reliable information on the amount of sediment in rivers limits our understanding of the impacts of sediment on fluvial ecosystems and the downstream environment. To account for the scarcity of sediment observations worldwide, many studies have attempted to develop global soil erosion and sediment transport models with the goal of refining sediment load estimates. While considerable progress has been made in the development of large-scale, spatially explicit soil detachment and fluvial sediment transport models, the transfer of sediment on land, before the material reaches the river network, has largely been overlooked during large-scale modelling efforts. Yet, the dynamics of sediment on slopes, known as hillslope sediment connectivity, provide the critical link relating plot-scale soil erosion rates to catchment-wide sediment yield in rivers.

Here, we investigate the large-scale applicability of three existing hillslope sediment connectivity modelling approaches, two of which were originally developed for small-scale applications (the IC-SDR and SEDEM approaches) and one developed globally using a coarse grid cell resolution of ~10 km (the Rouse Number approach). We assess their performance for high-resolution large-scale applications by applying them on a set of 46 African catchments using globally applicable data of 90 m resolution. Cursory applications of the three approaches reveal that using parameter configurations reported by studies conducted at smaller scales or coarser resolution produces predictions that highly underestimate observed sediment load in the receiving river. However, an in-depth application of the IC-SDR approach, in which the model is refined and calibrated, shows an improvement in RUSLE-produced sediment load estimates using a single, regional best-fit parameter configuration, indicating the strong potential of the IC-SDR approach for global applications.

Findings from this study can contribute to large sediment modelling efforts aiming to develop a harmonious global soil erosion model representing all erosion processes and sediment transfer dynamics, from the source point of soil detachment to the final delivery to the world's oceans.

Effects of treated wastewater irrigation on soil quality

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Available freshwater is a limited resource worldwide, especially under a growing population and climate change. Wastewater reuse for irrigation is increasing globally, because of its potential to contribute to sustainable agriculture and circular economy. The use of treated wastewater (TWW) can decrease the pressure on freshwater resources, and it adds nutrients to the soil which may be beneficial for crop growth. However, its use on agricultural land can lead to soil contamination, salinization and structure degradation. In Flanders, Belgium, there is a high risk of water scarcity during drought events, but TWW irrigation is hardly used. In Flanders salinity problems associated with TWW irrigation on soil structure and water infiltration have not been studied so far. This study, therefore, aims to investigate the effects of TWW irrigation on soil physical quality in Flanders, Belgium.

Five experimental objects were established in 2019 at Inagro (50° 91′ N, 3° 12′ E), Beitem, Belgium under a spinach-cauliflower-potato-spinach rotation. In rainout shelters, four plots were irrigated with rainwater, treated domestic wastewater (TWW household), treated wastewater from the frozen-vegetables processing industry (TWW vegetable), and treated wastewater from the potato processing industry (TWW potato). The fifth plot was an open-air field and received precipitation directly. The total irrigation water volume in each rainout shelter object was almost equal to the precipitation of the rainfed object.

Using TWW potato and TWW vegetable irrigation for three years tended to increase soil salinity and sodicity. Soil electrical conductivity and sodium adsorption ratio under TWW vegetable and potato irrigation was significantly increased from that under rainwater irrigation at soil depths of 0-20, 20-40 and 40-60 cm. Preliminary data show hydraulic conductivity of treatments under TWW potato irrigation was significantly lower than other irrigation treatments at different matric tensions. The 2021 spinach yield under TWW potato and TWW vegetable treatments were significantly lower than that under rainwater and rainfed treatments.

Abstracts of posters

Rare earth elements: relevant tracers for understanding transfer in the soil-plant system?

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Transfer of trace elements from soil to plant is a corner stone for risk assessment. Rare earth elements (REE) are frequently used as geochemical tracers for element transfer to plant. In this study, we evaluated biogeochemical behaviours of trace elements and REE in the soil–plant continuum to assess to what extend the REE monitoring allows identifying preferential pathway from soil to plant. We quantified 11 trace elements and 14 REE in soil, root, shoot, soil solution, and soil water-extract samples of an intercropping cover crop. Evaluation of the element mobility was performed using both soil extractability and transfer factors. Results showed distinct soil–plant transfer of trace elements according to their biological roles or substitution potential. Soil, root, and shoot REE patterns were similar, indicating a large influence of soil REE composition on plant one. Compared to light REE (LREE), heavy REE (HREE) were more extractable and thus transferred to plants. We also observed differences in Ce and Eu behaviour concerning soil extractability and transfer from root to shoot. Soil solution and soil water-extract samples are not chemically representative of the fraction that can be uptaken by plants. However, LREE/HREE and Ce/Eu ratios in soil solution and soil water-extract samples can be used as indicators of environmental conditions.

The effect of deficit irrigation and Soil Fertility Management on Wheat Production and water productivity in the Upper Blue Nile Basin, Ethiopia

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In the Ethiopian Upper Blue Nile Basin, like in other regions in the world, agricultural productivity is declining due to water scarcity owing to longer dry seasons coupled with soil acidity-induced fertility problems. Reducing these problems might be essential to increase productivity. This study explores the effect of deficit irrigation (DI) combined with lime, manure and inorganic fertilizer on wheat production and water productivity (WP) in the Koga irrigation scheme, Ethiopia. Four levels of DI strategies (100% ETc or 0% water deficit as a control, 80%, 60% and 50% ETc) were applied for two irrigated seasons. Five levels of soil fertility management were applied for four consecutive cropping seasons: (i) 0.86 t ha^{-1} lime combined with 3 t ha^{-1} manure and full-dose urea and NPS-B (hereafter referred to as inorganic fertilizer) (L3); (ii) 1.15 t ha^{-1} lime combined with 3 t ha^{-1} manure and full-dose inorganic fertilizer (L2); (iii) 1.43 t ha^{-1} lime combined with 3 t ha^{-1} manure and full-dose inorganic fertilizer (L1); (iv) 3 t ha-1 manure combined with full-dose inorganic fertilizer (M); and (v) full-dose inorganic fertilizer alone (C). The grain yield and biomass data were collected at harvest from a sample area of 2 m × 3 m from each plot with three replicates. The effect of DI and liming, as well as manuring on grain yield and biomass, were highly significant. Under all irrigation scenarios, higher grain yield and biomass were found at L1, L2, L3 and M, compared with C. The highest WP was obtained at 50% ETc at L1, L2, L3 and M, respectively, compared with 100%, 80% and 60% ETc. Yet, the lowest WP was found at C under all irrigation scenarios compared with L1, L2, L3 and M. The WP increased when the amount of water supply decreased and liming doses increased. The application of full dose lime and manure combined with 50% ETc resulted in comparable grain yield, biomass and WP compared with 100% ETc at L3 and M. Under all irrigation scenarios, applying full dose liming is more profitable but at 60% and 50% ETc, manuring is more profitable than applying manure with 60% of lime requirement. It could be concluded that liming and manuring could be used to mitigate the yield penalty effect of DI in the study area.

Influence of glyphosate and AMPA on the extractability of trace elements in uncontaminated and contaminated soils

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Glyphosate is among the most broadly used herbicides around the world and has become controversial due to human health risks. In addition to its well-known herbicidal function, glyphosate has the capacity to chelate trace elements. Yet, agricultural soils may be contaminated by trace elements to various degrees raising the question of a possible enhancement of their mobility because of glyphosate and his major degradation product aminomethylphosphonic acid (AMPA). The potentially enhanced extractability of trace elements with glyphosate and AMPA has been studied by batch experiments where the trace elements are extracted from the soil (transferred from soil to solution) using an extracting solution containing an active substance. In our study, four agricultural soils have been selected: one soil is uncontaminated, two soils are anthropogenically contaminated, and the last one is naturally contaminated. While glyphosate enhanced the extractability of many elements (Cu, As, Zn, Cd…), AMPA mainly enhanced the extractability of As and decreased the mobility of other elements (Ba, Zn, Sn). Results depend on the considered soil and active substance concentration. Results also show that the commercial glyphosate-based pesticide is leading to a higher extractability of the trace elements than glyphosate alone in all soils except the uncontaminated one. Thus, glyphosate can be considered as a possible cause of the increase of trace element mobility, especially in the top layers where pesticide concentrations can be relatively high.

Impacts of soil conductivity loss on plant transpiration regulation under drought

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Between 60 and 90% of terrestrial precipitations go back to the atmosphere through plant transpiration stream and this huge flux is controlled by plant stomata. Yet, stomatal functioning is not yet fully understood and there is no consensus on a universal model for stomatal regulation. Recent studies have hypothesized that there is an intimate relationship between the hydraulics of the soil-plant continuum and the stomatal response to drought. It has been shown in silico that it is the drop in rhizosphere hydraulic conductance that is the main driver of leaf water potential decrease that leads to stomatal closure to protect the plant against cavitation. The soil conductance would be one of the first factors limiting the transfer of water to the plant under conditions of water deficit. On the other hand, physiologists have demonstrated that the stomatal regulation could differ between plant species and genotypes due to different sensitivities of stomata to chemical or hydraulic signals and have classified plant stomatal regulation into iso- or anisohydric regulation classes. In this project, we hypothesize that the degree of anisohydricity will be a function of the environment.

The objective of this research is to elucidate the impact of soil hydraulics on plant transpiration regulation under drought. Two main experiments will be conducted on two genotypes of Zea mays L. with contrasted stomatal behavior. First, we will use small pressure ecotrons to characterize the relationship between leaf potential, soil potential and transpiration from different combinations of vapor pressure deficit and soil hydric status (without any stomatal control). Then, we will perform a series of pot experiments with similar combinations of VPD and soil conditions to characterize the stomatal control and link it with the shape of the soil-plant conductance obtained from pressure ecotron. Finally, we will aim to validate our hypothesis that the degree of iso/anisohydricity is a function of the environment. The second experiment will be performed in a rhizotron in order to decipher how soil water potential spatial distribution will affect the stomatal regulation under drought. The last step will consist in comparing the collected data to ones obtained from larger scales and/or modelling approaches.

A first experiment with sunflower (i.e., an anisohydric plant) already showed that transpiration regulation is influenced by the substrate. It also questions the anisohydricity of the sunflower as the observed stomatal behavior was dependent on the environmental conditions.

Systemic solutions for upscaling of urgent ecosystem restoration for forest related biodiversity and ecosystem services (SUPERB)

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Imagine you were a bird flying over Europe. You would encounter damaged forest areas, burned down by the fire, or destroyed by bark beetles; and tree leaves affected by air pollution and herbivorous pests, or turning yellow and brown from a drought. From the air, you would also see people working in these damaged forests, planting, or seeding new trees, or protecting the naturally regenerating forest against grazing.

Due to ongoing climate change and short-term human interventions, forests are degrading and being disturbed. While it is recognized that restoration is extremely important, much more action on the ground is needed to develop and obtain forests in the long term. To improve and secure the health, lifecycle and productivity of forests, and reverse patterns of ecological degradation, restoration and adaptation is needed. The soil is an important component of a forest ecosystem. It represents one of the largest carbon pools on earth with a much larger amount of C than found in the aboveground biomass. Carbon sequestration helps restore degraded soils and mitigate the greenhouse effect. Therefore soil carbon and soil biota are the most important measurements in this study.

This research “SUPERB” will be carried out in 12 large-scale demonstration areas within Europe. These demos reflect the different stress situations faced by forests in Europe, the different biogeographical forest areas, ecological diversity and biodiversity, management practices and socio-economic conditions. Soil carbon and soil biota will be sampled to compare the reference with the degraded and restored stands. Soil samples are taken to a depth of 40 cm with fixed depth classes in order to analyze microbial biomass, functional catabolic diversity, fine root biomass, pH, carbon concentration, and bulk density. The data obtained from the analyses, will enable us to assess the situation of the restoration measures.

The aim of the project is to provide the best-practice guidelines for effective implementation and monitoring of forest restoration.

Quantification of intra-plot variability of vine water status using Sentinel-2: case study of two Belgian vineyards

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For decades, vines have been grown in dry regions, as the plant has to grow under water deficit to produce quality wines. Due in part to climate change, vine cultivation is developing in historically cooler and more humid regions. In addition to climate, soil and plant material are the terroir factors that most influence the water status of the vine, and conditions can be different within the same vineyard plot, implying heterogeneous vineyard management to achieve optimal wine quality.

The objective of this study is to explore the potential of Sentinel-2 to characterize the intra-plot variability of vine water status and its evolution through time.
Two Belgian vineyards, with high soil water availability intra-plot variation and different grape varieties, were selected. Both vineyards have grass in the inter-row and the spatial distributions of soil depth and soil water holding capacity (WHC) were measured. A cumulative drought index (DI_{cum}) was also estimated for each plot.

Four years (2018, 2019, 2020 and 2021) of Sentinel-2 images of these two Belgian vineyards were analyzed. Several spectral indices, based on the blue, red, NIR and SWIR bands on a 10 x 10 m² grid, were calculated and compared to quantify the evolution of the water status of the vine, as a function of the weather conditions (DI_{cum}), the grape variety and the WHC. Predawn leaf water potential (Ψ_{pd}) measurements were collected *in situ* at different dates during dry periods in order to compare them with the remote sensing indices.

We observed that spectral indices and the WHC were better correlated when the water conditions were the most constraining for the vine (e.g. $R^2 = 0.72$ on 16/08/18 for NDWI/EVI), i.e. when DI_{cum} is lowest. Edaphic heterogeneity is therefore better captured by spectral indices when conditions are dry for the vine. The spectral indices have a low value when the WHC is low, and vice versa. The spectral index NDWI/EVI quantifies the water status of the vine better than the NDWI, when comparing linear regressions between the two spectral indices and the Ψ_{pd} measured in the field ($R^2 = 0.67$ for NDWI/EVI; $R^2 = 0.64$ for NDWI).

In conclusion, the NDWI/EVI spectral index, measured from the Sentinel-2 bands, is promising for quantifying the spatial distribution of vine water status on a regular basis at the plot scale.

The major element forms and recycling impact their residence times in humus from a beech forest (Northeastern France)

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In forest ecosystems with generally low element inputs, one of the main nutrient sources entering the soil results from the degradation of litter. Although the processes and the release speed of elements, such as C, N and P, are well determined during litter degradation, knowledge is very limited regarding other elements, such as Fe, Al, Mg, Mn, Si, Ca, K, Na, some of which are essential for tree nutrition. The objective of this study was to determine the average residence time of these elements in 3 mull-type humus for 3 different soils, i.e., Dystric Cambisol (S1), Eutric Cambisol (S2) and Rendzic Leptosol (S3), in the same beech grove of the northeast of France and to identify the main mechanisms controlling them.

To achieve this goal, the following approach was used: 1) scanning electron microscope observation of the evolution and recycling of elements during litter degradation; 2) quantification of total inputs and their form (soluble/insoluble) in the litterfall and the contribution of exploitation residues; 3) quantification and evolution of litter stocks; and 4) calculation and comparison of the residence time of the elements according to their form.

In the Montiers beech forest, the stocks of elements were constant between 2010 and 2018 for all elements (C, Ca, N, Si, Fe, Mn, K, Mg, S, Al and Na). During 4 years (2012 to 2015) the inputs were relatively constant for the elements. The calculation of the mean residence time for C was fast (1.6 years) and was in accordance with the literature for a mull type humus in a beech forest. The other mean residence times were between 58.4 and 13.1 years for Fe and Al, between 3.3 and 1.6 years for Si, N, S and Ca, between 2.2 and 1.2 years for Mn, Mg, Na, P and C, and between 0.6 and 0.8 years for K. By comparing this mean residence time with the mean residence time of the insoluble fraction, it appears that the form and the location of the element in the inputs determine their release speed. The soluble forms of the elements seemed to be released instantly (K, Na) while the insoluble forms in biominerals (Si, Ca) and in the more resistant MO tissues like veins hade higher residence times. Scanning Electron Microscopy observations highlighted in the litter, the presence of testate amoebae, bacteria and the crystallization of biominerals around fungal hyphae. It was also observed abiotic precipitations of Si. These different observations illustrate the recycling mechanisms in the litter of Ca, Si, P, Mn, K, and Mg.

These different recycling mechanisms and the forms of the elements allow us to have an overview of the degradation of the litter and to conclude that litter is an important source of nutrients that is readily available, especially for K (0.6 years).

Agricultural drought: Will capillary rise from groundwater be among pertinent drivers of heterotrophic activity and carbon cycling in our soils?

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Large parts of the world have been subjected to altering weather conditions as a result of climate change. For Europe and more specifically Flanders this includes a more frequent occurrence of droughts. The latter leads to low soil moisture levels, which in turn can have an inhibiting effect on soil biogeochemical processes like mineralization of soil organic matter. However, aside from precipitation, soil moisture can also be supplied from groundwater through the action of capillary rise. Therefore, the question arises if (and to what extent) this capillary rise contributes to a minimal moisture content required for activity of heterotrophs to proceed largely unimpeded.

To assess this, we monitored soil water dynamics in ten sloping fields spanning a gradient in soil texture, a well-known determinant of capillary rise height field. Two microplots within each sloping field (at hilltop and foot slope) were established to evaluate the effect of contrasting groundwater table level, and thus drainage condition, on moisture supply in the topsoil (moisture tension and volumetric moisture content). In each of the 20 microplots, mesocosms filled with soil and ^{13}C-isotope-labeled ryegrass were buried into the topsoil to determine carbon (C) decomposition rates in summer of 2021. Accordingly, we hypothesized the following: higher moisture availability and thus faster C decomposition occurs in case of shallower capillary fringe heights and vice versa. At this stage soil fractionation and IRMS-analyses are ongoing to infer ryegrass-C decomposition and temporary transfer to the fine particle size soil fraction.

Invasive woody plants: a way to protect the soil?

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Agriculture is currently facing a number of challenges such as climate change, soil degradation and loss of soil fertility, and high food demand. Added to this scenario is the increase in areas invaded by plants in some regions of the tropics, as a consequence of growing anthropogenic and climatic pressure. Efforts to completely eradicate these species have been unsuccessful in most, if not all, cases, and have given rise to new ways of dealing with invasions, especially in underdeveloped tropical countries, focusing on harnessing the potential benefits that these species can offer. In this regard, the impact of invasive woody species on soil properties is unclear. We explore here the most prominent potential benefits of invasive woody species for soil. Invasive woody species increase soil carbon sequestration and nitrogen and phosphorus availability depending on the density of the invader in the ecosystem, the capacity to fix nitrogen, the quantity and quality of the litter and its interaction with the soil physical environment, and the direct interactions between the roots of these species and the microbial community. These results suggest that the restoration of some soil properties and thus their protection depend on the resource use efficiency and ecophysiological traits of the invasive species.

The SOPHIE initiative – The first interlaboratory comparison of the wet end of the soil water retention curve

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Soil water retention curves (SWRCs) are key inputs to feed Richards's equation-based hydrological models. Knowing that these models play a role in a wide range of societal issues, they must be based on reliable data. SWRCs are usually obtained in laboratory on soil samples using one/some of the available methods. Although some studies show that different non-harmonized elements of the procedures for the determination of SWRCs in laboratories can significantly influence the measurement of retention properties, to date, these procedures are not harmonized. The impact of these non-harmonized procedures on the legacy SWRCs data and on the hydrological models they feed remains to be investigated.

The challenge was to carry out an interlaboratory comparison using an artificial constructed reference sample set with controlled retention properties that can be transferred safely between laboratories.

The reference sample was composed by a mix of glass beads and cement. The inter-laboratory comparison involved 14 European laboratories with 3 successive rounds of measurements of four retention points (10, 50, 100 & 300 hPa) on 84 reference samples. The samples followed specific inter-laboratory exchange schemes designed to assess both the intra-/inter-laboratory variability and the effect of sample transfer. The random effect related to the laboratories, samples and transport between laboratories on the SWRCs were determined based on a Bayesian linear mixed model programmed in the "Stan" language.

Random effects related to different laboratories and different samples together explain about one third of the variability of the SWRCs. The effect of the transfer of the samples between laboratories seems to be quite negligible. A simple bulk density analysis showed that the reference samples were not uniform, with bulk densities ranged from 1.575 to 1.835 g/cm^3. Nevertheless, the linear mixed model shows that the random effect related to different laboratories is more important than the random effect related to the intrinsic differences between samples. This underlines the fact that differences in SWRC measurements, on a same sample, from one laboratory to another can be substantial.

These results raise several hypotheses that are worth investigating. We hypothesize that the laboratory induced variability of SWRC measurements, may have an impact on the output of water balance simulations. We also hypothesize that non-harmonized procedures are, in part, responsible for the variability of SWRC measurement between laboratories. Quantifying the impact of these key procedural aspects on the overall variability of these data may help accelerate measurement harmonization efforts. Our results may also pave the way for better harmonization of data in some existing databases that contain metadata related to the same procedures/methods used in the interlaboratory comparison.

Impact of soil variability on dielectric soil moisture sensor measurements

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The past two decades have seen a growing interest in real-time soil moisture sensors and their relevance in irrigation scheduling. The application and use of this sensor data, however, remains a challenge, as sensor measurements can be biased and uncertain, mainly due to soil variability and local interferences. Dielectric sensors determine the soil water content (SWC) based on the bulk permittivity, which heavily depends on the SWC but also on other factors such as bulk density, salinity and clay content. This study assesses the impact of soil characteristics, i.e., bulk density and soil texture on dielectric soil moisture sensor measurements to gather insight on these sensor measurement errors.

Sets of three dielectric sensors (TEROS 10, METER Group) were installed in the root zone (15 cm depth) of 30 vegetable cultivation fields spread over Flanders, with different soil textures varying from sandy to loamy soils and different bulk densities (1.2 – 1.7 g/cm³). In addition to the sensor measurements, manual soil moisture samples were taken from the upper 30 cm layer to determine sensor measurement bias. The inherent sensor accuracy and precision were primarily validated in a soil column experiment using five different soil textures.

The findings show that the bulk density level within a soil textural class has a significant impact on sensor measurement bias and hence suggest a field specific calibration, while soil texture was not proven significant – keeping in mind no clay soils were included in this study. An approach is provided to deal with a variety of bulk densities (1.2 – 1.7 g/cm³) embedded in soil textural classes. Firstly, a correction for bulk density based on the dielectric mixing model needs to be applied when converting measured permittivity to SWC (m³/m³), although this does not entirely explain measurement bias. Secondly, a calibration method is provided, recognising both sample and sensor measurement error, while taking into account the bulk density. Finally, local changes around the sensor needles can have an impact as well, resulting in an unknown additional measurement error. Knowledge on soil characteristics and their impact on measurement bias and uncertainty is vital for sensor data interpretation in the application of irrigation scheduling. Further research is needed, however, to provide a foundation for measurement error modelling, more specifically in light of measurement error correlations.

A tool for monitoring and sharing experimental cropping systems

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In large agricultural projects, different partners from several countries run simultaneously similar experiments towards common research objectives. In the past, a large consortium had problems to guarantee consistency and comparability in experimentation, as well as timely separate reporting by each partner was a challenge. For the SoilCare Horizon 2020 project, a data management system was developed to collect, store, and share information about experimental cropping systems using common coding and terminology, required by the interdisciplinary involvement in agricultural research nowadays. Information, data, and metadata about the cropping systems' elements were grouped in five pools: 1. basic information, 2. field information, 3. experimental setup, 4. agricultural management data and 5. measured data/results. These information pools included the details required for monitoring and analysing agricultural processes and relations, as well as details required for unified documentation. Permitted users can browse, query and download data through the SoilCare Explorer web application and everybody can use the database scheme and templates deposited in Zenodo. At the end of the project, a unified analysis and a homogeneous report of all the experiments were produced using information from the SoilCare - database.

The effect of nature management residues as soil improvers on soil chemistry, plant growth and disease suppression

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In many European regions, legislation limits the amount of phosphorus that can be applied onto a field. As a majority of agricultural soils in Flanders (Belgium) has P levels that exceed the acceptable limits, the use of farmyard manure as a soil improver is limited because it can lead to excessive P amounts in the soil. In order to be able to increase soil carbon levels without exceeding the legal P limits, there is a need for alternative soil improvers with a high C/P ratio. Nature management residues, such as soft rush and chopped heath, may be interesting alternatives as they have relatively high C/P ratios and may also have additional benefits such as increased disease suppression.

The effect of nature management residues on soil chemistry and plant growth and disease suppression was studied in two field trials in two consecutive years with *Acer campestre*. Two types of management residues (soft rush and chopped heath) were applied and farmyard manure was used as a reference. The application rate of the three materials was adapted to apply the same dose of organic matter.

After two years, no differences were found in the nutritional soil status. No significant differences were found in the growth of the plants and the severity of an infection with *Erysiphe* over the two years. Although not significant, a trend of decreased fallout due to an infection with *Verticillium* was observed for the two management residues after one year. Based on these results, we can conclude that management residues are suitable alternatives for farmyard manure and would be especially valuable on fields where P application is limited.

Rainfall - Soil moisture response in relation to land use in steep tropical enviroments: field-based research in NW-Rwanda

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The steep sloped environments of the Northern-western provinces of Rwanda are often affected by severe cases of rainfall-triggered shallow landslides. Recent studies in the region revealed that these landslides mostly occur towards the end of the wet season when the soil moisture contents seem to be the most favourable. The high demographic pressure of this area is associated with significant land use/cover changes (e.g., deforestation) and land management practices (e.g., agricultural terraces). Recent studies in the region have demonstrated that deforestation can significantly increase landslide susceptibility over a period of several years. Our field observations also show that agricultural terraces seem to play a role in the occurrence of landslides. Nonetheless, not only for Rwanda, but also in general, our insights on the impacts of land use/cover changes and land management practices on the soil moisture conditions that lead to rainfall-triggered landslides remain very poorly quantified. This is especially true in the tropics. The goal of our research is to better quantify and understand the relation between rainfall and soil moisture and how it is influenced by weather patterns, soil characteristics, land use/management and topography. More specifically, we work at the level of six experimental hillslope transects with contrasting soil types (i.e., clayey or sandy soils). For each soil type, three hillslopes with different land uses and land management practices are investigated: cultivated hillslope, terraced hillslope, and forest hillslope. In total, we installed sixty access tubes, eighteen sensors, five rain gauges and six piezometers to monitor/measure the spatial-temporal variation of soil moisture content, rainfall and groundwater fluctuations. Both automatic and manual measurements are carried out, bringing accurate daily to sub-daily data for all the sites. The acquisition of the data

was initiated during the wet season that started at the end of 2021. Preliminary results show important contrasts in the patterns of rainfall-soil moisture conditions. These data from the field measurements will be used to better analyse the variation of rainfall-soil moisture response of potentially landslides susceptible slopes. In the long run, these data will contribute to the development of better landslide early warning systems and other disaster risk reduction strategies.