Program SSSB-DYSS2023

8.30 onwards	**Doors open**
8.40-9.00	**Registration**
9.00-9.10	**Welcome** Prof. Jeroen Meersmans (ULiège) – President of SSSB
9.10-10.30	**Oral presentations** – 9.10 – 9.30: Boito Lucilla – *Silicates rock! Steps towards application of silicate rocks to mitigate climate change* – 9.30 – 9.50: Arthur Vienne – *Insights from a basalt mesocosm experiment. Do earthworms stimulate carbon sequestration through enhanced weathering?* – 9:50 – 10.10: Nicolas Kovacs – *Converting grassland to a bamboo plantation affects soil organic carbon stock and dynamics* – 10:10 – 10.30: Kelly Wittemans – *Digital mapping of soil properties in Flanders using the DOV soil database*
10.30-11.30	**Coffee Break + Posters** (incl. poster tour start@10.40)
11.30-12.30	**Workshop "Research ethic and misconduct: a focus on scientific publication"**
12.30-13.30	**Lunch Break + Posters** (incl. poster tour start@12.45)
13.30-14.10	**Key Note Presentation** Prof. Karen Vancampenhout (KU Leuven) – Former president of SSSB *The ways of the dead - finding a nexus between biotic and abiotic drivers of soil carbon cycling*
14.10-14.30	**Oral presentations** – 14.10 – 14.30: Marie Dincher – *Major element residence times in humus from a beech forest: the role of element forms and recycling*
14.30-15.30	**Coffee Break + Posters** (incl. poster tour start@14.40)
15.30-16.30	**Oral presentations** – 15.30 – 15.50: Astrid Francoys – *Assessing capillary rise in a laboratory set-up: impact of contrasting groundwater depths on topsoil moisture and mineralization of added plant material* – 15.50 – 16.10: Florian Lauryssen – *Phosphorus reference conditions in lowland streams: survey in old forests and anaerobic sediment release* – 16.10 – 16.30: Yixian Chen – *Data-driven prediction of gully densities at the global scale*
16.30-17.00	**Closing and Drink**

Abstracts of oral presentations

Silicates rock! Steps towards application of silicate rocks to mitigate climate change

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Atmospheric Carbon Dioxide Removal strategies (CDRs) are necessary to mitigate anthropogenic climate change[1]. A promising CDR is enhanced silicate rock weathering (EW), deployed on croplands[2,3]. The principle of EW is the reaction of silicates with CO_2 and water to form bicarbonates, storing C for hundreds of years and longer[4]. However, several important challenges need to be addressed before applying EW as a CDR. In order to include it in the C market, we need to build a Monitoring, Reporting and Verification (MRV) framework for EW by 1) assessing its C sequestration potential, and 2) developing cheap and reliable proxies for this C sequestration in field settings. So far, most research focused on lab-based weathering and sequestration rates, but these may differ substantially in field settings.

Using a mesocosm experiment, we aim at bridging this gap. The mesocosm experiment consisted of soils applied with basalt and planted with corn. We measured i) CO_2 fluxes as well as CH_4 and N_2O emissions, in order to assess the full climate change mitigation effect of EW; ii) Soil Inorganic C (SIC), which together with leachate water chemistry allows us to determine the fate of sequestered C; iii) porewater and leachate water alkalinity, Dissolved Inorganic Carbon (DIC), pH and other elemental chemistry in order to determine weathering rates; and iv) Electrical Conductivity (EC), which has been proposed as a an easy-to-measure proxy for weathering rates[5]. Here, I will show preliminary results of the first growing season of this experiment.

1. Beerling, D.J., et al., *Potential for large-scale CO_2 removal via enhanced rock weathering with croplands.* Nature, 2020. **583**(7815): p. 242-+.
2. Gasser, T., et al., *Negative emissions physically needed to keep global warming below 2 degrees C.* Nature Communications, 2015. **6**.
3. IPCC, *An IPCC Special Report on the Impacts of Global Warming of 1.5° C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways*. 2019, IPCC.
4. Vicca, S., et al., *Is the climate change mitigation effect of enhanced silicate weathering governed by biological processes?* Global change biology, 2022. **28**(3): p. 711-726
5. Amann, T. and J. Hartmann, *Carbon accounting for enhanced weathering.* Frontiers in Climate, 2022: p. 54.

Data-driven prediction of gully densities at the global scale

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Gully erosion has been recognized as a major contributor to soil erosion and land degradation. While studies have focused on understanding gully erosion at local scales, its patterns and controlling factors on a global scale remain less understood. Overall, gully erosion remains difficult to predict mainly due to the complex and threshold-dependent nature of gully formation, which increase the complexity of potential models and their data requirements. Here we help addressing this problem by developing a machine learning model capable of predicting gully head densities (GHD) at a global scale with feasible data requirements.

For this purpose, we developed a database of mapped GHD for over 18,000 sites worldwide, using an efficient grid-based scoring method to assess the GHD based on Google Earth imagery. Next, we collected and processed global layers of environmental factors that may be relevant in explaining contrasts in GHD (e.g. topography, soil characteristics, land cover, rainfall). Using these data, we trained and cross-validated an ensemble of random forest models, capable of estimating global patterns of GHD at a 1 km² resolution as well as the associated uncertainty.

Our first analyses show that global gully occurrences strongly depend on vegetation cover and topography (mainly local relief), but also soil characteristics (mainly coarse fragment content) and rainfall (mainly annual average rainfall). Combined, they allow for predictions of GHD with an average validation model efficiency of around 0.4. Overall, our work presents the first attempt to quantitatively predict gully densities at a global scale. Likewise, we present the global gully density map at 1km^2 resolution. This not only opens promising perspectives for further research, but also offers a valuable tool to better understand and address land degradation at larger scales.

Major element residence times in humus from a beech forest: the role of element forms and recycling

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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 in the same beech forest of the northeast of France and to identify the main mechanisms controlling them. In the Montiers beech forest, the stocks of elements were constant between 2010 and 2018 for 11 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.

Assessing capillary rise in a laboratory set-up: impact of contrasting groundwater depths on topsoil moisture and mineralization of added plant material

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Capillary forces in soil allow counter-gravity moisture transport from groundwater to unsaturated layers. This matric suction driven process is often disregarded in biogeochemical studies because the impact on topsoil is largely unknown (capillary rise is not included in soil C models & difficult if not impossible to control in empirical research). As climate change is expected to intensify the occurrence and severity of droughts, the control of groundwater depth and capillary rise on topsoil heterotrophic activity requires better understanding. In this study, a laboratory set-up is employed to (1) examine topsoil moisture supply by capillary rise and (2) consequently the effect on mineralization of added plant material. Undisturbed two-meter-long soil columns of three different textures (loamy sand, (sandy) loam and silt loam) were subjected to two artificial groundwater table depths (–115 cm and –165 cm) while moisture transport was followed by volumetric water sensors. Additionally, carbon mineralization of added plant material was monitored over a period of ten weeks. We observed an upward moisture flux of capillary rise towards the topsoil for all textures and both groundwater depths. However, higher moisture contents were observed for the shallow groundwater level treatment (–115 cm) as a result of more rapid fluxes, with the largest effect for silt loam soils. Contrary to our expectations, this had no effect on the mineralization of added plant material. In summary, capillary rise succeeded to reach topsoil at groundwater depths to –165 cm for all textures, but no differences were found in mineralization of added plant material when groundwater increased by 50 cm. Field studies with native soil C instead of a plant-biomass substrate are ongoing.

Converting grassland to a bamboo plantation affects soil organic carbon stock and dynamics

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Soil may play a key role in regulating the global climate through carbon storage following changes in land use or agro-management. In this respect, the plantation of bamboo forests seems to have great potential to help fight climate change. However, bamboo's exact soil carbon sequestration potential needs to be better quantified. Therefore, in the present research, the soil organic carbon (SOC) dynamics of three bamboo species (i.e. *Phyllostachys nigra*, *Phyllostachys aurea* and *Phyllostachys aureosulcata*) planted 12 years ago in the Belgian Kempen have been studied in detail. Besides the SOC stock changes, the C-inputs in and C-outputs from the soil have been assessed by measuring the litter fall and root systems versus CO_2 respiration rates, respectively.

We took soil samples in 10cm depth increments up to 40cm. Twelve years after converting the permanent grassland into bamboo plots, *P. aurea* and *P. aureosulcata* showed a significantly higher SOC stock between 30 and 40cm in depth. When looking at the total stock in the top 40cm, a general trend showed an increase in SOC across all bamboo sites. However, only *P. aureosulcata* had a significantly higher stock than the initial permanent grassland.

The bamboo root system, particularly that of *P. aureosulcata*, whose culms occupied the greatest soil occupancy rate, was remarkably better developed and distributed in depth than grassland. The soil CO_2 effluxes ($\mu molCO_2\ m^{-2}\ s^{-1}$) showed no significant overall difference between grassland and *P. aureosulcata*, indicating that the amount of carbon is not the limiting factor for respiration. However, the relative effluxes ($mgCO_2$-C gSOC h^{-1}) suggested that SOC from bamboo was more stable. In a nutshell, this study shows that converting permanent grassland into *Phyllostachys* bamboo plantation results in a net sequestration of C in the soil by increasing both C-inputs and stability. However, to assess its full climate change mitigation potential, future research should consider C-storage in the above-ground biomass and conduct an associated LCA when considering its usage in various products (e.g. timber, flooring).

Phosphorus reference conditions in lowland streams: survey in old forests and anaerobic sediment release

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The reference (pristine) concentrations of total dissolved phosphorus (TDP) in surface waters are difficult to define in lowland regions because of their high population density. Here, we estimated reference conditions of TDP from headwaters and their riverbed sediments (n=140) in old forests. Surface waters and sediments were collected in the lowland region of Belgium as transects starting in 20 different old forests (before 1775; pristine) to up to 1.5 km outside the forest edge (disturbed). Sediment P concentrations in disturbed samples readily increased with increasing distance from the borders of old forests. The P mobilized from the sediments to the overlying water was also measured in laboratory incubations to mimic P release during seasonal redox cycles. The sediment respiration was larger in disturbed than in the reference sediments.

Disturbed sediments released more P during anaerobic than aerobic incubations, while reference sediments did not show such a difference. The mean TDP in the reference surface water samples is 57 µg TDP L-1 [95% confidence interval 41; 72], very close to the pre-industrial background previously estimated for the Scheldt river. The 90th percentile of the reference water is 137 [110; 180] µg TDP L-1. That P90 is just under the prevailing TP limit of 140 µg P L-1, illustrating that this limit is very close to the upper baseline of reference conditions. The P75, often proposed as the threshold for high ecological status, was 84 [55; 122] µg P L-1. This study showed that soil or sediments in old forests might serve to identify reference conditions. The well-established summer peaks of TDP in lowland rivers are unlikely to occur in pristine areas.

Insights from a basalt mesocosm experiment. Do earthworms stimulate carbon sequestration through enhanced weathering?

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Virtually all scenarios that limit global warming to 1.5°C require large scale carbon dioxide removal (CDR). Enhanced Weathering (EW) is considered an attractive CDR technology because of the permanence of sequestered inorganic carbon and because of its scalability. Yet, a great challenge in EW research is quantification of weathering and C sequestration rates. In addition, soil (macro)biota such as earthworms were postulated to substantially stimulate silicate dissolution. However, quantitative data on how earthworms influence (in)organic C sequestration in enhanced weathering systems are lacking. To evaluate the effect of earthworms on EW, we set up a mesocosm experiment using soil (with basalt) and/or with earthworms.

In non-worm soils, addition of 100 ton basalt ha^{-1} decreased soil CO_2 emissions (SCE) approximately by 2 ton CO_2 ha^{-1} after 130 days. Simultaneously, basalt only increased dissolved inorganic carbon (DIC) export by about 40 kg CO_2 ha^{-1}. We observe that in a <1 year timescale, leached cations are negligible compared with cations retention in the columns' exchangeable (NH_4-acetate extractable) fraction. No significant SOC and SIC differences were detected in this short-term experiment, still a substantial minimal basalt weathering rate (mWr) (>10^{-12} mol alkalinity m^{-2} s^{-1}) was derived from the large increase in exchanged base cations.

Earthworms did not increase and even decreased DIC export. We did not observe an earthworm-induced increase in SIC and thus earthworm stimulated inorganic C sequestration. Earthworms were found to enlarge clay precipitation and base cation exchange, withholding dissolved cations in the soil system, increasing basalt mWr and presumably SOC stabilization. Within this short-term experiment however, SCE was promoted more through earthworm activity in basalt amended mesocosms, indicating that basalt stimulates earthworm microbiota. In conclusions, earthworms did not cause NET CDR within this short experimental timeframe, yet basalt dissolution was stimulated with expected benefits for SOC retention in the long run.

Digital mapping of soil properties in Flanders using the DOV soil database

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Accurate, area-wide soil information is crucial for evaluating the regional budget of carbon stocks, water and nutrient flows. However, soil profile collections are often too limited and heterogeneously distributed across the territory to assign at least one observation to each soil and land use type combination. To address these limitations, the Aardewerk-STAT method was developed as a spatial generalization approach in a previous study. With emerging computing power and new digital technologies, a new initiative was initiated by the Flemish government to look at additional, innovative methods.

In this project, 13 soil properties were estimated at five depth intervals (0-10, 10-30, 30-60, 60-100 and 100-150 cm) using digital soil mapping techniques. Based on an extensive literature review, an approach based on Random Forest models was selected. Applied to a collection of 6,891 profiles and 8,877 samples, we used 73 predictors or SCORPAN variables. The results include area-wide datasets at 10 m resolution for the different combinations of soil property and depth interval. The soil properties were only modeled for the so-called legacy time period (1945-1975), which made use of the soil profiles underpinning the soil map. The amount of more recent soil data (1975 – present) was found to be insufficient for modelling soil properties. In general, texture fractions proved to be most accurate with R^2 values ranging from 0.29 to 0.87. As expected, regional trends in soil properties are visible in the generated geodatasets. The various geodatasets will subsequently be integrated into the DOV environment and can be consulted via DOV's online explorer: http://dov.vlaanderen.be/verkenner.

Overall, the models optimally utilize the available soil data. Further improvements can focus on adding more recent and harmonized soil data, integrating new or updated predictors, making further use of the ever-increasing computing capacity, and further developing the web application to make soil information more accessible.

Abstracts
of
poster presentations

Turn on the lights! Illuminating plant material using different light sources. Examples from the DIVA-site (Antwerp, Belgium).

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Dark Earths, dark colored, humic and homogeneous layers, ubiquitous in urban contexts, are the result of different anthropogenic activities (domestic and/or economic). The site of DIVA (Antwerp, Belgium) constitutes a good example in this regard. Recent excavations uncovered between 1 and 2 meters thick Dark Earth, chronologically bracketed between the end of the Gallo-Roman empire and the 11th century.

In order to better understand the different activities that took part in the formation of the Dark Earth, micromorphological analyses have been conducted. These analyses were carried out by the description of the thin sections under different lights: PPL, XPL and auto-fluorescence (UV and Blue). Surprisingly, under blue and UV some preserved anatomical features within apparently amorphous decomposed organic matter appeared. These structures were invisible under PPL and XPL.

The aim of this poster is to emphasize the use of auto-fluorescence while describing thin sections, since it can provide important evidence that was invisible under PPL and XPL.

Fluoride adsorption in volcanic soils is controlled by solution pH, weathering degree and organic matter content

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Fluoride in volcanic regions occurs in gas emissions or in ash fallout from eruptive activity. Overexposure to fluoride poses a risk to humans, livestock and plants. Fluoride may also be released from volcanic rocks during water-rock interaction, which enhances aluminosilicate dissolution. However, the mobility of fluoride in the environment is considerably reduced due to its strong binding affinity for mineral surfaces such as ferrihydrite and short-range order aluminosilicates (allophanes) which typically occur in soils formed from volcanic materials. We measured the fluoride adsorption envelopes (pH 2.8–7) of five Icelandic volcanic soils, including two soils with contrasting weathering degrees (a slightly weathered Vitric Andosol (VA) and a well-developed Brown Andosol (BA)) and three soils with varying organic matter content (a Histic Andosol (HA) and two Histosols (HI1 and HI2)). We used a 1.3 mmol l^{-1} NaF solution and pH-stat titration. For the five soils, minimum and maximum adsorption occurs at pH 2.8 and ≥6, respectively. This is attributed to the combined effect of pH and soil anion exchange capacity (AEC) on fluoride adsorption. At pH <6, fluoride forms positively charged alumino-fluoride complexes ($AlF_x^{(3-x)}$). Because the AEC of allophanes (point of zero charge, PZC = 6) and ferrihydrite (PZC = 6.5) increases with decreasing pH, adsorption of $AlF_x^{(3-x)}$ is restricted. At higher pH, the fluoride ion (F^-) dominates in solution, but its adsorption becomes limited as AEC decreases. The order of increasing maximum fluoride adsorption capacity is VA < HI1 < HI2 ≈ BA ≈ HA. VA has a low allophanes+ferrihydrite content. HI2, BA and VA have significant amounts of these components, providing ample reactive surfaces for fluoride adsorption. The organic-rich HI1 soil contains less allophanes+ferrihydrite than VA but can adsorb more fluoride. This suggests that organo-aluminium/iron complexes in HI1 provide abundant surface sites (≡AlOH and ≡FeOH) for fluoride adsorption.

Chitin-enriched compost to increase the soil water retention and resilience to drought

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This study aims to increase the resilience of the soil against prolonged droughts that are predicted under future climate. Increasing the soil water holding capacity might be a solution to this threat, but the impact of compost addition on this property varies among different sources. Furthermore, the functioning of compost might be improved by adding soil amendments. This study investigates chitin, a natural product present in the exoskeleton of insects.

The influence of chitin-enriched compost on soil physical properties was tested in a pot experiment encompassing 78 treatments in three replicates. All possible combinations of the following parameters were investigated under two water regimes: three doses of chitin (0, 1 and 2 g/kg), three compost types (green compost (GC), fruit, vegetable and yard compost (FVYC) and spent mushroom compost (SMC)), which were incorporated or mulched, and applied at a dose of 110 or 265 ton/ha. Pots without compost (WC), but chitin-enriched, were also investigated. In the dry water regime (DWR) 18 mm of water was added every two weeks, while the wet water regime (WWR) included 7 mm every three days. Lettuce was cultivated in every pot. Undisturbed soil samples were analyzed to obtain the plant available water capacity (PAWC).

The addition of chitin-enriched compost significantly affected the soil water retention. An increase in chitin dose from 1 g/kg to 2 g/kg resulted in an enhanced PAWC in the WWR by, on average, 66% and 75% respectively. This trend was only present for 1 g/kg in the DWR. The addition of 1 g/kg to 110 ton/ha SMC resulted in an 85% increase in PAWC, while for an identical chitin-enrichment of GC, FVYC and WC this was 71%, 77% and 35% respectively. The functioning of the compost enhanced with rising dose, and was higher for the incorporated treatments compared to mulching.

Use of soil pitting in maize to mitigate runoff, erosion, and pesticide losses

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Soils of the loess belt of Western Europe are intensively cropped and particularly prone to runoff and soil erosion, especially when planted with row crops with wide spacing between rows such as maize. In this context, microbasin tillage techniques could help mitigate these risks while being fairly easy to integrate into existing cropping systems. Soil pitting was therefore tested across 14 site-years of field trials in maize crops by an adapted seeding unit forming small depressions in-between the maize rows. Runoff and surface losses of sediments and pesticides were measured on soil pitted plots in central Belgium under natural rainfall, and compared with conventionally tilled plots. Seasonal runoff, erosion rates, and pesticide (flufenacet) surface losses were reduced on average by 69%, 83%, and 65% respectively, following soil pitting. Median curve number (CN) values calibrated on this dataset are 68 for the control, and 63 for the soil pitting treatment (using $\lambda = 0.05$). Unlike some reported observations in tied-ridging, analysis of individual rainfall event data reveals that this mitigation effect appears to be consistent throughout the season and for a wide range of intensities for natural rain events.

The mechanical behaviour of volcanic soils and its response to water content changes are constrained by mineralogy

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Volcanic soils are usually regarded as soils with excellent mechanical properties. However, there is increasing evidence that slopes covered with volcanic soils are susceptible to landslides when exposed to prolonged or intense rain events. Volcanic regions are often densely populated, and the rupture of volcanic soils in mountainous areas represents a significant but poorly understood hazard.

In order to improve our capacity to predict the stability of volcanic slopes subjected to rapidly changing water inputs, a better description of the hydraulic and mechanical properties, and their coupling, of volcanic soils is required.

In this study, we report water retention curve, hydraulic conductivity and shear strength measurements performed on volcanic soils varying in mineralogy and microstructure. We collected undisturbed volcanic soils in Tenerife, Spain, and characterized their mineralogy and microstructure. We used state-of-the-art techniques based on evaporation methods to estimate water retention and to infer hydraulic conductivity. The mechanical behaviour of the soils with variable water content was tested by performing triaxial tests.

Based on the clay-size fraction mineralogy, we distinguished soils rich in allophanes from those dominated by halloysite. The former soils have a large porosity (64%), excellent water retention (saturated gravimetric water content, θ_g, is about 150 %) and a saturated hydraulic conductivity, K_{sat}, of ~15mm/h. The halloysite-rich soils have a saturated θ_g nearly two times smaller, but a K_{sat} about ten times higher. The shear strength of the soils containing halloysite is greater, but comparatively more sensitive to soil moisture. Drying reduces shear strength in these soils significantly, whereas such effect is not observed for the allophanic soils.

Our results, which highlight the contrasting response of shear strength to variable water content in volcanic soils differing by their secondary mineralogy, have implications for improving our capacity to model accurately the stability of slopes covered with volcanic soils.

How to estimate Soil Extractable Water Capacity of forest soils in Wallonia : challenges related to rooting depth, stony content and bulk density

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In the context of climate change, an increase in the frequency and intensity of spring and summer droughts and heatwaves is observed. This impacts the health and mortality risk of our forest ecosystems and requires an adaptation of forest management, in particular for what concerns soil water balance and soil water stress occurrence. It is for instance important to be able to correctly assess the soil extractable water capacity (SEWC) of forest soils.

However, forest soils have a number of specific characteristics that complicate the estimation of SEWC: stoniness, bulk density, organic matter content, root profiles and turnovers, soil depth etc. The ultimate objective of this research is to make progress on the quality of the prediction of SEWC down to 2m deep in Walloon forest soils from the Ardennes, by taking better account of fine earth and stoniness properties, from field and laboratory measurements (development of pedotransfer functions, for example) and modelling.

Assessing urban gully initiation at the scale of Africa

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The rapid and typically uncontrolled growth of many African cities leads to a plethora of problems and challenges. One of these is the formation and expansion of large urban gullies (UGs) in many (sub)tropical cities. UGs typically lead to the destruction of houses and other infrastructures, displace large numbers of people and often claim casualties. As the formation of such gullies is strongly linked to land use and rainfall intensity, the problems associated with UGs are likely to aggravate in the near future as a result of continued urban expansion and climate change. However, this newly emerging geo-hydrological hazard hitherto received very little research attention. Several studies report on the occurrence and impacts of UGs. Yet, they remain limited to specific local case studies. A clear understanding of the patterns, impacts and driving factors of UGs at larger scales is currently lacking. To address this gap, we aim to better understand the spatial patterns and UG occurrence at the scale of Africa.

In order to achieve this, we are documenting cases of UG occurrence across Africa through the visual analysis of very high spatial resolution satellite imagery. This mapping already allowed us to identify more than 3,500 UGs in 11 countries (mainly across D.R. Congo, Angola, Republic of the Congo, Nigeria and Mozambique). Using on this database, we develop a logistic regression model that accurately simulates the likelihood that UGs occur within (peri-)urban areas across Africa. Our preliminary results show that a combination of rainfall characteristics, topography, soil type and variables describing the land use/urban context can already robustly explain why certain cities are extremely susceptible to the problem and others not. Overall, our dataset and model are first crucial steps to better understand the current and future risks of UGs across Africa.

Biochemical quality of vermicompost as a function of the type of substrate ingested and earthworm species during vermicomposting

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Recently, vermicomposting has emerged as an established recycling technology for upgrading organic materials into a high-value product called vermicompost that can be used for soil improvement. However, the potential of earthworm species to produce high quality vermicompost during vermicomposting of available agricultural wastes must first be evaluated. Thus, we conducted a vermicomposting experiment using local (*Eudrilus eugeniae*) and exotic (*Eisenia fetida* and *Eisenia andrei*) earthworm species fed on mixed agricultural wastes from two types of animal manure (cow and donkey) mixed with three mixtures of crop residue (maize with soybean, maize with banana and soybean with banana residues) on production of high-quality vermicompost. The bio-chemical characteristics of the final vermicompost/non-composted control was quantified at 90 days (end) of the experiment. Earthworms decreased total organic C and C:N ratio compared with uninoculated control by the end of the experiment. While the nutrient concentrations such as total N, P and S found increased in vermicomposts. Moreover, the microbial biomass C, β-glucosidase and dehydrogenase activity in vermicomposts were greater than that in the uninoculated control especially substrates consisted of donkey manure. Compared with exotic earthworm species, the indigenous earthworm (*E. eugeniae*) fed substrates of cow manure mixed with soybean and banana residues greatly increased nutrient concentrations and microbial activity, which is important for improving soil fertility. Our results highlight the potential of indigenous and exotic earthworm species to differ in nutrient stabilization and microbial activity enhancement during the vermicomposting process depending on the type of mixed agricultural residues.

Crushed basalt application to a tropical soil alters its properties: a modelling study using Crunchflow

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Applied to cropland soils at the regional scale, enhanced silicate weathering (ESW) has increasingly been proposed as a technique that could sequestrate significant quantities of atmospheric CO_2 while providing ancillary benefits to soil fertility and crop growth. However, its effectiveness to remove atmospheric CO_2 still faces uncertainties. Furthermore, the long-term impact of silicate additions on soil properties and functioning is not well understood. To address these concerns, we used the reactive transport model CrunchFlow to investigate ESW in a tropical environment. We simulated five annual additions of 50 tha^{-1} of a basaltic rock powder of known mineralogy in the topmost 20 cm of a highly weathered Oxisol. According to our results, basalt weathering can reduce soil acidity, with the initial solution pH increasing from 5.6 to 10.7 after five applications. This process also supplies Ca, Mg and K and remineralizes the Oxisol, potentially improving its chemical fertility. Our estimation indicates that instantaneous CO_2 sequestration rates significantly increase from 0.081 $tha^{-1}yr^{-1}$ after the initial basalt addition to 8.75 $tha^{-1}yr^{-1}$ after five. Additionally, we highlight the likely precipitation of allophanes (up to 1.5 wt.% mostly in the 0-20 cm soil layer) upon dissolution of the rock's glassy component and plagioclases. As inferred for volcanic soils, allophanes have a large capacity for organic carbon stabilisation. However, this variable-charge mineral provides a large reactive surface for irreversible binding of phosphate, possibly limiting its bioavailability. Calcite formation is also expected due to the alkaline pH developed and release of Ca from basalt weathering, although in minor amounts (~0.1 wt.%). Overall, we have demonstrated that the deliberate application of basalt to a tropical soil leads to significant changes in its properties but the resulting effects on its functioning remain unknown. We will discuss the limitations of our model and improvements needed to increase its accuracy.

Understanding the impact of rainfall variability, land-use/land-cover change and geomorphology on hydrologic connectivity in the Lake Tana Basin (Ethiopia)

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Geomorphological and soil factors play a crucial role in the hydrological connectivity of a landscape. Rainfall variability and land-use/land cover change can affect the degree to which water can flow through and between different areas of a landscape. However, the hydrological connectivity of a landscape is also influenced by geomorphological and soil factors. In this study, we focused on the impact of land-use/land cover change and rainfall variability on hydrological connectivity of the Ribb and Gumera sub-catchments in the Lake Tana basin in Ethiopia, with particular attention on the role of geomorphology and soil characteristics.

To analyze land-use/land cover change, we used the ESA CCI land cover maps for the years 1995, 2005, and 2015, and assessed the impact of land cover change on surface runoff using the Soil and Water Assessment Tool (SWAT+), with an emphasis on geomorphology and soil characteristics. The model was validated by comparing simulated actual evapotranspiration (ETa) with ETa values extracted from remote sensing data. The hydrological behaviour of the sub-catchments was analyzed based on model performance and flow component separation. Additionally, the Topographic Wetness Index (TWI) was used to compare structural connectivity between the sub-catchments to assess the impact of the geomorphology.

Our land-use/land cover change analysis revealed that between 1995 and 2015, shrubland was converted to broadleaved deciduous forests, urban areas increased, and cropland persisted. However, we found that the impact of land-use/land cover change on surface runoff was not significant, indicating the dominance of geomorphological and soil factors. On the other hand, we observed a decline in surface runoff due to rainfall variability in the period 2005-2009. The hydrological contrast between the sub-catchments was attributed to their different topographical characteristics, which can be explained in the context of hydrological connectivity.

Recovery of bacterial community composition in two soils with soil powder inoculum following gamma irradiation

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Gamma (γ) irradiation at a dose of 6kGy is often used for partial sterilization of soil to selectively eliminate target organisms (e.g., nematode community), but the effects of partial sterilization on the non- target organisms (bacteria and archaea) and their recovery are not known yet. We investigated the recovery of bacterial community composition of two types of soils (i.e., silt loam and loamy sand) 1 and 12 weeks after γ-irradiation (6kGy) by means of 16S rRNA gene amplicon sequencing. We further investigated whether inoculation of soil powder (SP) from the same soils would stimulate bacterial recovery. In both soils, alpha-diversity indices (richness, evenness, and Shannon) were not significantly affected by treatments, but the Bray-Curtis dissimilarity index assessed by non-metric dimensional scaling (NMDS) showed significant effects on the beta diversity. Genus *Nitrolancea*, a novel nitrite-oxidizing bacteria (belonging to phylum *Chloroflexi*), was present only in the SP- reinoculated treatment of loamy sand soils. The family *Nitrososphaeraceae* (members of ammonia- oxidizing archaea) was one of the dominant families in silt loam soil both with and without SP reinoculation. In both soils, the community composition of SP-reinoculated soils remained similar between week1 and week12, indicating the quick re-establishment of the prokaryotic community by SP inoculum. These results suggest that prokaryote recovery after γ-irradiation can be enhanced by SP inoculation, and the re- established community by SP inoculation is strongly dependent on soil type. The recovery of microbial activity should be considered carefully in studies where selective sterilization is inevitable, in order to avoid over- or underestimations of the ecological contribution of soil organisms.

What are the hydrological controls on soil processes controlling carbon- and nutrient-efflux in the Critical Zone at the landscape scale?

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The Critical Zone (CZ) provides many ecosystem services that are endangered by both climate change and human activities. It is subject to multiple processes in interaction at the interface of the atmosphere, biosphere, hydrosphere, and lithosphere, which complicate its integrative study. This project will develop a truly interdisciplinary CZ research allowing to understand more precisely some key CZ processes and their interactions. The use of advanced sensing technologies will also provide a framework for future CZ research. This project focuses on the spatio-temporal variations of soil hydrology and its control on carbon and nutrient fluxes in hillslope systems.

This project will start by studying the long-term patterns of the Critical Zone (subsurface structure, soil characterization, topography, vegetation characterization, *etc*.) known to influence the shorter-term (sub)surface processes. Soil moisture and temperature will then be monitored using in-situ sensors and UAVs equipped with Ground-Penetrating Radar and thermal infrared camera. Their control on soil respiration, soil nutrients and dissolved organic carbon fluxes will be studied. These processes will then be used for smart modelling. First, a 3-D physical-based model will be developed to characterize water and heat dynamics. Then, using a deep neural network, additional data will be integrated to predict water, nutrient and carbon fluxes at the landscape scale.

Despite the fact that peatlands play an important role in climate regulation, biodiversity support, water regulation, carbon storage, they are still understudied. Hence, this methodology will be first developed in a peatland landscape characterized by a clear topographic gradient in the Belgian High Fens. Then, it will be applied on a frozen peatland located in Alaska (USA), presenting a natural permafrost degradation gradient.

Soil nematode community increased N_2O emission but insufficiently explained by enhanced mineral N availability

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Soil nematodes are one of the most important soil fauna in agricultural land, as they have a great impact on soil N mineralization, thereby likely influencing soil N_2O production. However, research on the effect of soil nematodes on N_2O emissions is limited and mostly based on single species of nematodes under artificial soil conditions, which may result in inaccurate estimations. In this study, we used representative soil nematode community and conducted an incubation experiment under realistic conditions with respect to soil microflora and nutrients to investigate their contribution to N_2O emissions. Our results show that N2O emission rates and cumulative emissions increased by nematodes, and their contribution varied in different soils (loamy sand 748%, loam 55.8%, and silt loam 21.3%), in line with nematode abundance in these soils. Net N mineralization was increased by 6.9%, 8.3%, and 5.9% in loamy sand, loam, and silt loam soil, respectively, during the 74-day incubation period. Coupled with N mineralization, soil nematodes also enhanced C mineralization by 3.4%, 3.5%, and 5.5% in loamy sand, loam, and silt loam soil, respectively. The concentration of NO_3^--N was positively correlated with N_2O emission rate after controlling for other soil properties in loam and silt loam soil. However, the increase of mineral N availability due to nematodes were relatively small compared to that of N_2O emission caused by nematodes. We conclude that soil nematodes could increase soil N mineralization and soil N_2O production, while the contribution of soil nematodes on N_2O emission is insufficiently explained by increased mineral N availability. Further studies are still needed on the underlying mechanisms of the control of nematodes on N_2O emissions, e.g. the change in community composition and function of soil bacteria and fungi influenced by the activities of nematodes.

Can rewetting restoration fully recover molecular compositions of peat to their own selves?

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Peatland is a waterlogged nature that has invaluable properties and makes themselves the most pivotal terrestrial ecosystems especially for carbon sequestration. However, many of peatlands have been affected by drainage, which subsequently decomposes soil organic matter and halts peat carbon accumulation. In this regards, rewetting has been proposed as a measure to recover peatland functionalities and sequester carbon in peat. With growing awareness of their functional importance, peatland stability remains enigmatic after rewetting restoration. The molecular composition of peat may be aligned with their stability, which eventually demonstrates key processes. To evaluate their vulnerability, we examined 13 fen peatlands across a longitudinal transect of Europe, in which we compare molecular compositions between drained, undrained, and rewetting sites by using mid-infrared spectroscopy. In this research, we aim to address several questions : 1) are there differences in molecular composition across the three hydrological regimes 2) are molecular compositions differently affected by depth increment? 3) lastly, do natural states influence molecular composition? These outcomes may further discern peat decomposition processes under intensified pressure of climate change.

Disentangling the effects of tree community characteristics on litter decomposition processes and carbon storage in forests of the northern hemisphere using a synthetic community approach

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In terrestrial ecosystems, most of the plant net primary production ends to the soil as litter. Litter decomposition is one of the key functions in the forest ecosystem as the various processes allow nutrients to become available and therefore regulating the carbon and nutrient cycles. It is argued that tree species mixture and assisted migration can be an effective management practice in terms of climate change adaptation. Therefore, there is an urgent need of better understanding the effects of non-native species and mixtures on the litter decomposition processes and soils in our forests.

Litter decomposition has been the subject of a considerable amount of research. However, it stays a complicated topic as most driving factors are mutual interacting. The different processes are mainly influenced by three factors: the "physicochemical environment", the "litter quality" and the present (soil) organisms (micro-macro detritivores). We want to investigate the complex linkages between the aboveground tree biodiversity and decomposition by using a unique common garden, the geographical arboretum of Tervuren. We will analyse a broad range of tree species (traits) and their effects on litter decomposition under similar site conditions to avoid confounding factors as much as possible and including non-linear relationships in the modelling.

The research consists of taking an inventory and characterizing the local tree environments of the 120 selected plots, monitoring annual litter fall, monitoring local microclimates, sampling forest floor and upper soil layers, analysing carbon fractions, determine decomposer community and executing three types of decomposition experiments: a tea bag experiment, community litter bags and a reciprocal transplant experiment.

At this stage of the research mostly practical work and preliminary results are available. Consequently, the poster will illustrate the concepts and giving preliminary results mainly.

50 shades of dark. The micromorphological study of the DIVA site in the historical centre of Antwerp (Belgium)

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During archaeological excavations at the DIVA-site in the historical center of Antwerp, several metres thick, dark, homogeneous deposits were unearthed. They contain finds dating from Late Antiquity to the Late Middle Ages. The upper part of the sequence shows an excellent preservation of organic remains, witnessing the progressive wettening of the area. Micromorphology not only permits to distinguish sub-layers within the seemingly homogeneous dark earth, but also to come to a better understanding of site taphonomy, and to reconstruct part of the site biography. As such, agricultural activities, followed by activities close to a settlement, walked surfaces within a settlement and stabling in the more recent periods were identified.

The poster is intended to provide an overview of these diverse site formation parameters and different anthropogenic Dark Earths.

Grassroots: Data-driven management solutions for carbon sequestration in grasslands

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Grasslands cover 20% of Flanders and have the potential to store over 100 tons of carbon per hectare in the soil, making them priority habitats for carbon capture and storage. However, the efficacy of grasslands in mitigating greenhouse gas emissions depends on their context and management.

The high costs of carbon monitoring have left it largely unknown how much carbon is stored in grasslands in Flanders, and which grasslands function as a carbon sink or source, thus hindering their potential for climate-change mitigation. While sensors can offer a cost-effective means of data collection, issues of practicality in real-world scenarios and integrating sensor data into existing soil carbon dynamics models have impeded their implementation in soil carbon monitoring.

To address this, my research aims to integrate sensor data with existing soil data layers into new Soil Organic Carbon (SOC) digital soil maps through data fusion and machine learning. Specifically, I aim to (1) evaluate if grasslands in Flanders are currently carbon sources or sinks, (2) optimize methods for assessing carbon sequestration in real-world scenarios and (3) evaluate two common management strategies for grasslands and their potential to maximize stable carbon sequestration in order to combat climate change.

Changes in soil structure and hydraulic properties under treated wastewater irrigation: A meta-analysis

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Treated wastewater (TWW) is frequently utilized as a resource for agricultural irrigation systems, but its higher salt content compared to freshwater can have detrimental effects on soil salinization, resulting in structure and hydraulic properties issues. Comparing and extrapolating results from different studies on the use of TWW in agricultural irrigation is challenging due to the heterogeneity between experiments in terms of TWW quality, experimental conditions, and soil properties. To investigate the impact of TWW irrigation on soil structural and hydraulic properties from a soil salinity perspective, a statistical analysis was conducted based on literature published between 2000 and 2021. The study quantified the effects of TWW irrigation on nine soil variables, including aggregate stability (AS), bulk density (BD), saturated hydraulic conductivity (Ks), soil organic carbon (SOC), soil pH, unsaturated hydraulic conductivity (HC), exchangeable sodium percentage (ESP), cation exchange capacity (CEC), and electrical conductivity (EC). Overall, TWW irrigation led to significant soil salinization. Additionally, TWW irrigation had the potential to both improve and harm selected soil structural and hydraulic properties, depending on the classification of TWW and the type of soil. This study elucidated a reference and potential research directions for investigating the impact of TWW irrigation on soil salinity accumulation and degradation.

Long-term manuring facilitates glomalin accumulation by chemical composition shifts and macro-aggregation

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Glomalin-related soil proteins (GRSP) accumulation contributes to soil quality and carbon (C) sequestration. Arbuscular mycorrhizal fungi (AMF) directly regulate the quantity and quality of GRSP, while soil aggregates protect GRSP from decomposition. However, the process mechanism via fertilization-induced AMF properties and soil aggregate stability regulation of GRSP production and stabilization remains unclear. Here, a 29-year fertilization experiment (no fertilization (CK), mineral fertilization (NPK), manuring (M, NPKM, NPKMR), straw returning (NPKS), and Fallow treatments) was selected to investigate soil abiotic (pH, nutrients, mean weight diameter (MWD), GRSP chemical composition) and biotic (AMF biomass and diversity) properties, and to assess the accumulation of GRSP in bulk soil and across different aggregates. Results showed that GRSP content increased over time in fertilization and Fallow treatments. Compared with no fertilization, long-term manuring (M, NPKM, NPKMR) and straw returning (NPKS) significantly increased GRSP content in bulk soil by 100 %, 80% and in macroaggregates (GRSP>0.25mm) by 74 %, 65%, respectively. Manuring and straw returning also altered GRSP's chemical composition by increasing the proportion of recalcitrant (aromatic) C in GRSP by 73%, 21%. Specifically, manuring increased biomass and diversity of AMF, maybe enhancing the quality and quantity of GRSP. Meanwhile, manuring facilitated aggregate stability (MWD) and the mass percentage of macro-aggregates, maybe increasing GRSP>0.25mm content. Straw returning only significantly increased AMF diversity, but had a weak effect on AMF biomass and aggregate stability. Statistics analysis indicated that GRSP accumulation is mainly controlled by AMF-regulated GRSP self-recalcitrance, followed by macroaggregates protection. This study contributes to the understanding of the various fertilization effects on GRSP accumulation and provides a feasible way forward for soil C sequestration in sustainable agriculture.