Young Soil Scientists Day
Brussels - March 15, 2024

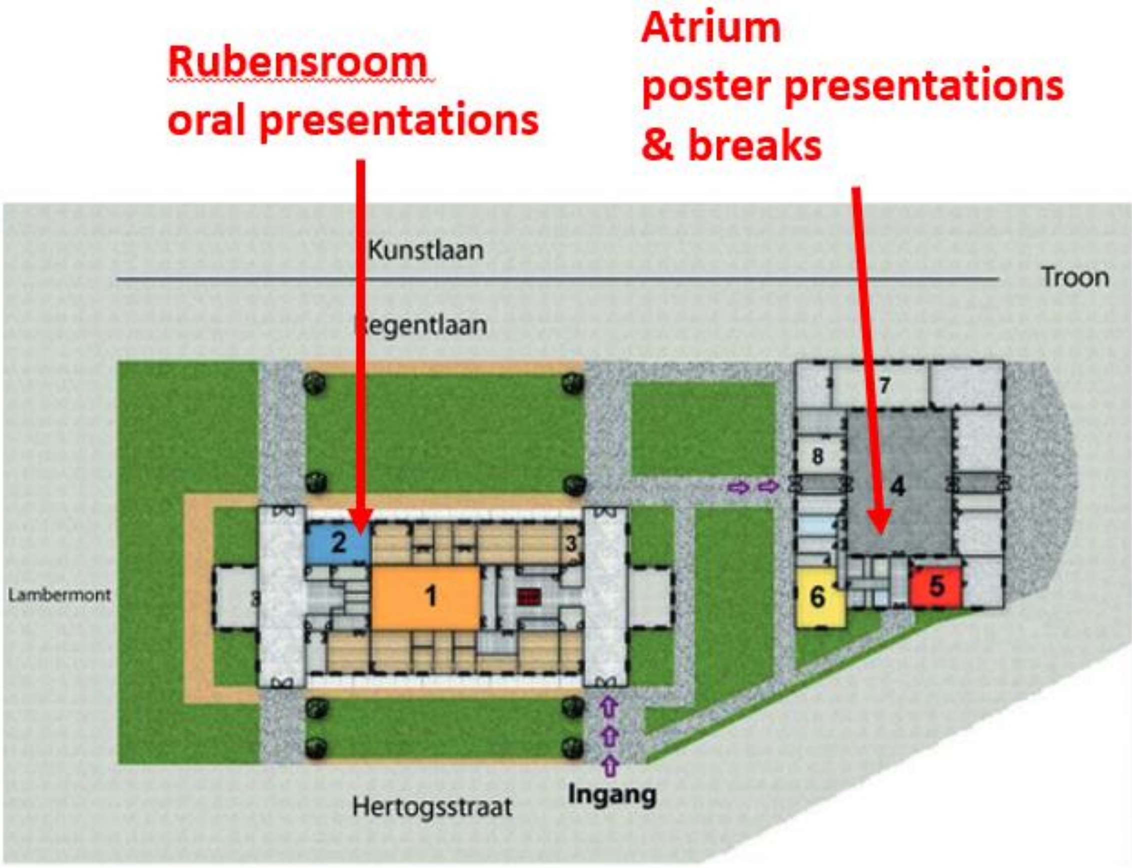
Abstract proceedings

Venue

Royal Academy, Hertogstraat 1, Brussels

Registration, poster presentations & breaks: Atrium – Throne Building

Welcome & oral presentations: Rubens Auditorium – Palace (ground floor)



Program

Program morning session

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	Lotte Baert (UGent) – *The influence of long-term compost application on soil nitrous oxide emissions*
	9.30 – 9.50	Outéndé Toundou (UGent) – *Enhancing soil resilience to climate change and sweet potato (Solanum tuberosum) crop production using the HYDRUS-2D model and compost*
	9:50 – 10.10	Sibylle Comeliau (ULiège) – *What solutions to reduce trace elements uptake by vegetables in market gardens? Lessons from a three-year pot experiment*
	10:10 – 10.30	Jie Xue (UCLouvain) – *Mapping soil organic carbon in croplands all over China using continuous multitemporal Sentinel-2 remote sensing*
10.30-11.30	**Coffee Break + Posters** (incl. poster tour start@10.40)	
11.30-12.30	**Workshop** Ramos Pamplona Marilou (ULiège) - *Networking for young researchers: The Whys and the Hows*	
12.30-13.30	**Lunch Break + Posters** (incl. poster tour start@12.40)	

Program afternoon session

13.30-14.50	**Oral presentations**	
	13:30 – 13.50	Yue Zhou (UCLouvain) – *A framework for mapping conservation agricultural fields using time-series optical and radar imagery*
	13:50 – 14.10	Zixuan Han (ULiège) – *Conservation tillage and residue incorporation enhance the sequestration and iron-mediated stabilization of aggregate-associated organic carbon in Mollisols*
	14.10 – 14.30	Rémy Willemet (ILVO) – *How can organic mulch affect crop emergence and development?*
	14.30 – 14.50	Timothée Clement (UCLouvain) - *Effectiveness of conservation tillage at mitigating runoff and soil erosion under Western European conditions: a meta-analysis*
14.50-15.50	**Coffee Break + Posters** (incl. poster tour start@15.00)	
15.50-17.10	**Oral presentations**	
	15.50 – 16.10	Victor Van de Velde (UGent) – *Resilience of gross soil phosphorus fluxes after slash-and-burn on highly weathered Ferralsols*
	16.10 – 16.30	Junwei Hu (UGent) – *Does root phenotypic plasticity mediate the effects of bacterivorous and herbivorous nematodes on rhizosphere bacterial communities?*
	16.30 – 16.50	Xin Li (ULiège) – *Cooperative-dominated organic agriculture improves soil health*
	16.50 – 17.10	Alex James (KULeuven) – *Modelling floodplain peatland development during the Holocene*
17.10-18.00	**Closing – announcing DYSS award winners 2024 – Drink**	

Abstracts
of
oral presentations

The influence of long-term compost application on soil nitrous oxide emissions

[1*]Baert, L., [2]Maenhout, P., [1]Sleutel, S. & [1]Cornelis, W.

*lead presenter – Lotte.Baert@UGent.be

[1]Ghent University, Department of Environment, Belgium

[2]Plant Sciences Unit, Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), Merelbeke, Belgium

The application of compost is generally seen as practice benefitting multiple soil properties including soil carbon storage, soil fertility and soil biological parameters. However, compost application may stimulate soil nitrous oxide (N_2O) emissions, a potent greenhouse gas. Therefore, this study investigates the impact of long-term application of compost on soil nitrous oxide emissions.

In the BOPACT field trial, a long-term experiment by ILVO, compost has been applied since 2010 and N2O emissions were monitored on a weekly basis since May 2023. Potato was grown as main crop during the summer of 2023. Since this crop is cultivated on ridges, separate gas samples were collected from the ridge and furrow parts of the field. Afterwards, yellow mustard was sown as a cover crop. The soil moisture content was monitored continuously using soil moisture sensors.

Instantly after planting the main crop, a significantly higher emission was observed from the furrow parts of the field, but this effect declines rapidly and by the end of the growing season a larger emission was measured from the ridges. A significant amount of greenhouse gas emission was measured in Autumn when the cover crop was on the field. This stresses the importance of measuring outside the growing period of the main crop. In general, large peaks in N_2O emissions corresponded to field management practices including ploughing and application of compost, mineral fertilizer and cattle slurry. Given the extended dataset, a variety of field conditions were met during the observation period. Soil moisture- and temperature data allowed to interpret N_2O emission patterns during the monitoring campaign.

Finally, the cumulative N_2O emissions from May 2023 until January 2024 were similar for the treatments with and without compost. This encouraging result further supports the potential of compost as soil amendment.

Effectiveness of conservation tillage at mitigating runoff and soil erosion under Western European conditions: a meta-analysis

[1*]Clement, T., [1]Bielders, C.L., & [2]Degré, A.

*lead presenter - timothee.clement@uclouvain.be

[1]UCLouvain, Earth and Life Institute, Belgium

[2]ULiège, Gembloux Agro-Bio Tech, Belgium

Conservation farming practices are known for their capacity to mitigate runoff and erosion, but the magnitude of their effectiveness is highly variable across studies. In order to better understand the contribution of environmental and management factors to their effectiveness, up to 21 studies reporting 178 individual trials were collated for a quantitative review regarding conservation (non-inversion) tillage, at the plot scale and in a Western European context.

Two different methods suitable for hierarchically structured datasets were used for the meta-analysis - hierarchical nonparametric bootstrapping and linear random effects models -, yielding nearly identical average outcomes but differing in terms of confidence intervals. We found that, on average, conservation tillage techniques alleviate cumulative seasonal overland flow by 27% and associated sediments losses by 66%, but strong evidence of publication bias was detected, probably leading to an overestimation of its effectiveness. These mitigation effects are shown to be much greater for spring crops than for winter crops, and to increase with time since ploughing was stopped. The type of conservation tillage scheme also strongly affects the ability to attenuate surface flows. Intensive non-inversion tillage systems relying on repeated use of (powered) tillage operations appear to be the least effective for reducing both water and sediment losses. The best performing scheme against runoff would be a deep (non-inversion) tillage (-61%), while against erosion it would be a no-till system (-82%).

Although several explanatory factors were identified, there remains a high (unexplained) variability between trials effect sizes, thus not attributable to pure sampling variability. Meanwhile, this review provides farm advisors or policy makers with guidance on the contexts in which implementation of such conservation practices should be supported so as to maximize expected benefits.

What solutions to reduce trace elements uptake by vegetables in market gardens? Lessons from a three-year pot experiment

[1*]Comeliau, S., [1]Bergen, J-C., [1]Paquet, C., [1]Marit, E., [1]Biron, P., [1]Houtart, A. & [1]Colinet, G.

*lead presenter - sibylle.comeliau@uliege.be

[1]University of Liège (Gembloux Agro-Bio Tech), Belgium

Food safety has become a major concern in Belgium since excessive levels of Cd and Pb were measured in vegetables grown in private and market gardens, even in areas with slight soil contaminations. Addition of amendments has been reported in the literature as a cost-effective remediation approach to mitigate Cd uptake by vegetables.

A three-year pot trial was conducted with Swiss chard on acidic soil with moderate total Cd concentrations (pH $CaCl_2$ = 5.6 – Cd = 1.4 $\mathrm{mg.kg^{-1}}$). Each year, soil was amended with biochar and green waste compost, applied alone or in combination with lime. Effects on soil pH, extractible metals and uptake by the plants were studied. In parallel, the experiment was repeated with Swiss chard and lettuce in a market garden with similar soil Cd concentration.

The results showed that multiple compost additions significantly increased the soil pH in pots (mean pH $CaCl_2$ = 6.5) and hence decreased the $CaCl_2$ Cd concentration. Lime addition in respect of agricultural recommendations also contributed to pH increase but in a lesser extent than compost. Large variability of vegetable Cd content was observed. Compost results in the lowest cadmium levels in Swiss chard but these still exceed the European threshold.

Results were compared to field experiment. Soil pH and cadmium content could not fully explain measured plant concentrations. Climatic conditions slowed down the degradation of soil amendments, especially lime. This highlighted the need to repeat field trials on the same plots in longer term (3 to 5 years).

The importance of soil pH in controlling trace elements uptake by plants is widely recognized. However, despite neutral soil in some gardens, the vegetables still did not comply with EU legislation. Therefore, further studies are needed to identify the other factors to consider for controlling the bioavailability of Cd, especially in the field.

Conservation tillage and residue incorporation enhance the sequestration and iron-mediated stabilization of aggregate-associated organic carbon in Mollisols

[1,2]Han, Z., [1,*]Wu, X., [3]Liang, A., [1]Li, S., [1]Gao, H., [1]Song, X., [1]Jia, A., [2,*]Degré, A.

*lead presenter - Zixuan.Han@student.uliege.be

[1]Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 100081, PR China

[2]University de Liège, GxABT, Terra Research Center, Gembloux 5030, Belgium

[3]Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Changchun, 130102, PR China

Conservation tillage practices, here defined as minimal or no soil disturbance with crop residue retention, is effective in preserving soil organic carbon (SOC). However, the mechanisms underlying the minerals-mediated chemical and physical stabilization of SOC remain unclear.

We conducted a 9-year field experiment to investigate the effects of tillage managements on iron oxides, OC chemical composition and aggregate stability in Mollisols. The three tillage practices consist in conventional tillage (CT) without crop residue, ridge tillage (RT) and no tillage (NT) with straw mulching. Compared to CT, 9-years of RT and NT significantly increased SOC content by 13.6% and 17.9% in the 0–20 cm soil layer due to an increase in the aromatic compound content. Furthermore, NT and RT increased the proportion of macroaggregates and mean weight diameter (MWD) by 10.7%–17.7% compared to CT, indicating increased aggregate stability. The contents of amorphous iron oxides (Feo) and complex iron oxides (Fep) were strongly positively correlated with SOC content and MWD ($p < 0.001$), which promote the SOC physical protection. NT and RT significantly increased the Feo and Fep contents of by 10.6–14.4% and 12.7–41.1%, respectively, in bulk soil and silt + clay fractions within macroaggregates compared to CT. Moreover, the aromatic-C content and aromatic-C/aliphatic-C ratio under NT and RT not only enhanced by 13.6%–24.6% and 16.5%–38.9% compared to CT, but also showed positive relationship with macroaggregate-associated OC. The aromatic-C/aliphatic-C ratio increased with increasing Feo plus Fep contents ($p < 0.01$), which stands for an increased in the recalcitrant-C proportion, and this shift was beneficial for the accumulation of mineral-associated OC.

These results indicate that conservation tillage with residue incorporation can enhance the accessibility of Fe for binding C possibly by forming organo-Fe complexes, which in turn improve soil aggregation, and thus promoted the long-term SOC sequestration in Mollisols.

Does root phenotypic plasticity mediate the effects of bacterivorous and herbivorous nematodes on rhizosphere bacterial communities?

[1]*Hu, J., [2,3]Méndez, S.G., [1]Hassi, U., [4]De Tender, C., [5]Radisras, N., [6]Tsegaye Gebremikael, M., [1]Sleutel, S., [2,3]Goormachtig, S., [1]De Neve, S.

*lead presenter - junwei.hu@ugent.be

[1]Department of Environment, Ghent University, Gent, Belgium

[2]Department of Plant Biotechnology and Bioinformatics, Ghent University, Gent, Belgium

[3]Center for Plant Systems Biology, Vlaams Instituut voor Biotechnologie (VIB), Gent, Belgium

[4]Department of Biochemistry and Microbiology, Ghent University, Gent, Belgium

[5]Department of Plants and Crops, Ghent University, Gent, Belgium

[6]Department of Food Science, Aarhus University, Aarhus, Denmark

The rhizosphere bacterial community is mainly dependent on the plant species and soil types. t is also known that nematodes, the most abundant fauna in the rhizosphere, may impact rhizosphere bacteria either via top-down (bacterivores) or bottom-up (herbivores and bacterivores) regulation. However, the complex trophic control of herbivorous and bacterivorous nematodes on the rhizosphere bacterial community remains largely unexplored. Here, we investigated the separate and combined influence of bacterivorous and herbivorous nematodes (*Poikilolaimus oxycercus* and *Pratylenchus zeae*) on the abundance, diversity and activity of the rhizosphere bacterial community of Italian ryegrass (*Lolium multiflorum*), and whether root traits mediated these effects. Our results show that both bacterivorous and herbivorous nematodes changed root traits, particularly root mass density and root C:N ratio, which in turn mediated their effect on rhizosphere chemistry (e.g. pH and DOC), thus affecting bacterial abundance, alpha diversity and activity. Bacterivorous nematodes had both a direct effect, which reduced bacterial abundance, and an indirect effect, which increased bacterial abundance via increase in root mass density and root C:N ratio, resulting in a negative overall effect. The presence of bacterivorous nematodes, either alone or in combination with herbivorous nematodes, led to different compositions of the rhizosphere bacterial community. Both root traits and rhizosphere chemistry contributed to explaining variations in community composition, with rhizosphere chemistry accounting for a larger portion of the variation, though the majority remained unexplained.. We conclude that mass density and C:N ratio of the root system are key factors mediating the trophic control of bacterivorous and herbivorous nematodes on rhizosphere bacterial community. Given the high variation of bacterial community composition and the heterogenous nature of root systems, our results suggest the need for investigations at finer scales to understand the effects of root traits on rhizosphere bacteria community and trophic interactions mediated by root plasticity.

Modelling floodplain peatland development during the Holocene

[1*]James, A., [1]Swinnen, W., [1]Verstraeten, G.

[1]KU Leuven, Division of Geography and Tourism, Department of Earth and Environmental Sciences, Leuven, Belgium (ward.swinnen@kuleuven.be)

Understanding peatland dynamics at longer timescales is crucial for effective management practices that preserve and enrich their significant carbon stocks. However, current models of soil carbon dynamics concentrate on fluxes of 'young' carbon and assume a geomorphically stable setting, which is ill-suited for the extended development period and dynamic characteristics of floodplains. Consequently, modelling such environments requires a different approach that accounts for the protracted timeframe of soil profile development, the intricacies of fen-type peatland dynamics, and the intertwined influence of river dynamics on peatland ecosystems.

To address this gap, we developed a new peatland model specifically tailored for floodplains by coupling a modified version of an existing peatland model (DigiBog 1D) with a water balance model (STREAM). This integrated tool, combined with pollen-based land cover and climate reconstructions, enables detailed simulations of peatland dynamics from the basal age of the profile (12,000 years BP). We applied this model to a Flemish peatland (Zwarte Beek), which has been the focus of extensive remediation efforts principally from an ecological point of view, to assess their impact on the soil profile carbon content in a changing climate.

Our results show the ability of the model to simulate soil profile development over the Holocene, the effects of past drainage and indicate the magnitude of historic peat removals. Variations in river discharge resulting from climatic and land cover changes have a limited effect on alluvial peat growth. The differences in discharge primarily influence the magnitude of peak events which do not affect peatland dynamics as long as thresholds are not exceeded. In contrast, the configuration of the local river, or drainage network, including the number of channels and their position relative to the peat surface, strongly influences peat thickness and therefore soil carbon content.

These findings suggest that management strategies focusing on river network configuration, such as reducing the number of channels or raising the river bed, can be effective in promoting long-term alluvial peat growth. By integrating river dynamics into peatland models, we enhance our understanding of the complex interactions between river systems and peatland ecosystems, providing valuable insights for sustainable management practices in floodplain environments.

Cooperative-dominated organic agriculture improves soil health

[1, 2]*Li. X., [1]Wu. D., [1]Huang, Y., [3]Yang. X., [2]Colinet. G., [2]De Clerck. C., Zhang. W. & [3] Meersmans, J.

*lead presenter - lixin06@caas.cn

[1]Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 10081, China

[2]Teaching and Research Centre, Gembloux AgroBio Tech, University of Liège, 5030 Gembloux, Belgium

[3]Institute of Soil and Water Conservation, Northwest A&F University, Yangling, Shaanxi 712100, China

The expansion of farm scale has been promoted to achieve more rational and efficient utilization of arable land resources in recent years. Farmer cooperatives have emerged as an effective system to expand the agricultural management scale. However, further evaluation is needed to determine whether organic agriculture dominated by cooperatives can effectively improve soil health.

Farmlands under the organic management system of cooperatives were compared with the conventional management system of smallholders in southeastern China to investigate the effects of different management modes on soil health. The cooperative-dominated organic management system showed higher stability of aggregates, soil organic matter (SOM), available nutrients, and microbial biomass. It also significantly altered the structure of microbial communities. The soil fertility index and biological index were respectively 36.5% and 24.2% higher under the organic management system as compared to the conventional management system. However, there was no significant difference in soil environmental indices between the two management modes. Bulk density, penetration resistance, mean weight diameter, SOM, dissolved organic carbon, earthworm biomass, gram-negative bacteria, and bacteria were identified by network analysis as key indicators of soil health assessment. The cooperative management system significantly enhanced soil health by 23.38% by improving soil structural stability, total and active organic carbon, and quantities of soil faunas and microorganisms.

Overall, the organic agriculture system, which was dominated by cooperatives, could enhance soil health by ameliorating soil physical, chemical, and biological properties. Our findings aimed to unravel the significant contribution of organic farming under cooperatives to enhance soil health in intensive agricultural systems.

Enhancing soil resilience to climate change and sweet potato (*Solanum tuberosum*) crop production using the HYDRUS-2D model and compost

[1*]Toundou, O., [2]Baert, L., [3]Mawussi, G. & [2]Cornelis, W.

*lead presenter - Outende.Toundou@ugent.be

[1]Department of Environment, Ghent University, Belgium

[2]Université de Lomé, Togo

Droughts at unexpected times are one of climate change effects reducing significantly global food production. Simulations help to understand future conditions in order to develop preventive resilience strategies. The aim of this study is to validate the Hydrus-2D simulations with field trial measurements. The study site is BOPACT experiment, a long-term compost field trial of potato grown in furrows in Merebelke.

Soil water content was measured hourly three months (June to August) using soil moisture sensors installed at 15 cm, 45 cm, and 75 cm on the ridges, as well as 10 cm in the furrows. In addition, soil samples were taken to obtain the soil moisture retention curve. Hydrus-2D version 5.03 was used to simulate water content within the soil profile. The simulation was performed in a 2D general environment, with the initial water contents of the profiles serving as the initial conditions. The top of the profile was subjected to atmospheric boundary conditions, while the remains and bottom received varying pressure head and free drainage conditions.

The results indicate that the saturated water content (ϴs) and parameter n in the soil water retention function are slightly higher for compost plot profiles. Water content variations (between measured and simulated values) are more noticeable in surface layers (-15 cm and -45 cm) than in deeper layer (-75 cm). The RMSE values are less than 0.3 for all horizons, except at -45 cm of compost plot (RMSE=0.52). The profiles that received compost show a positive linear regression with a low slope except at -45 cm without slope (r=0). The next step in this research will be the optimization of the model for use in the predictive resilience of agrosystems to climate change.

Resilience of gross soil phosphorus fluxes after slash-and-burn on highly weathered Ferralsols

[1*]Van de Velde, V., [2]Makelele, I., [3]Fuchslueger, L., [4]Magala, A.-J., [5]Mande, J., [6]Doetterl, S., [1]Bodé, S., [3]Richter, A., [1]Bauters, M. & [1]Boeckx, P.

* Lead presenter, viktor.vandevelde@ugent.be

[1] Ghent University, Belgium

[2] Official University of Bukavu, D.R. Congo

[3] Vienna University, Austria

[4] Félix Houphouët-Boigny University, Ivory Coast

[5] University of Kisangani, D.R. Congo

[6] ETH Zürich, Switzerland

Tropical secondary forests are rapidly gaining importance as the extent of undisturbed forests is rapidly declining through conversions to agricultural fields or plantations. Particularly in the Congo Basin, forest disturbances are dominated by land clearing for slash-and-burn agriculture. The recovery of aboveground biomass after agricultural abandonment in this region takes more than 100 years. However, the recovery of nutrient cycling remains poorly constrained.

The elementary ecosystem supply of phosphorus (P), a key nutrient in ecosystem functioning, originates from mineral weathering. However, ecosystems regrowing on the central Congo Basin's highly weathered and nutrient-poor Ferralsols critically rely on atmospheric inputs and nutrient recycling to sustain biomass accrual. The availability of inorganic P (Pi) for plants in soils is part of a dynamic system governed by a balance of processes releasing Pi into the soil solution (mineralization and abiotic desorption) and processes removing Pi from the soil solution (microbial immobilization and abiotic adsorption).

In this study, we quantified these gross fluxes through an ex-situ isotope pool dilution approach using the $^{33}PO_4^{3-}$ radiotracer. Surface soil samples were collected in two secondary forest chronosequences in the region around Kisangani, DRC, encompassing forest plots of 1 – 60 years since disturbance with old-growth forest references. The fluxes were inferred between two time points, using 0.5 M $NaHCO_3$ as the extractant and measure for the plant-available Pi pool. The average gross in- and efflux rates, respectively 0.24 and 0.19 µg Pi-P g^{-1} DW day^{-1}, corresponded to 57% of the available Pi pool per day. The magnitude of both fluxes was mainly explained by the size of the available Pi pool, but no significant trends were found along secondary succession. Additionally, soil texture explained most of the observed variability, pointing toward soil physical parameters dominating the gross P fluxes and the available Pi turnover being resilient during the recovery from slash-and-burn.

How can organic mulch affect crop emergence and development?

[1*]Willemet, R., [2]De Boever, M. & [3]Cornelis, W.M.

[1] remy.willemet@ilvo.vlaanderen.be, Flanders Research Institute for Agriculture, Fisheries and Food, Belgium

[2] maarten.deboever@ilvo.vlaanderen.be, Flanders Research Institute for Agriculture, Fisheries and Food, Belgium

[3] wim.cornelis@ugent.be, Department of Environment – Soil Physics Unit, Ghent University, Belgium

In Belgium, drought and heat stress are two primary environmental factors affecting arable crop growth and yield. In the future, an increase in the frequency and intensity of hot extremes will intensify variability in Belgian agronomic production and decrease yield for some drought-sensitive crops, including maize and potato. One challenge Flemish agriculture will face with climate change is preserving the soil water balance. Covering the soil with organic residues is an effective way to conserve water and reduce heat impact. This practice can affect the agroecosystem in multiple ways, e.g., (i) shifts in both hydrological and heat flows, (ii) improvements in soil fertility, and (iii) enhancements in microbial soil community size and composition.

In this study, we investigated the efficacy of grass-clover mulching in mitigating the adverse effects of drought and heat stress on potato cultivation (*Solanum tuberosum* L.) in the Flemish region of Belgium. A field experiment was conducted in 2023 to evaluate the influence of two grass-clover mulch thicknesses of 6 cm and 12 cm (31 t/ha and 64 t/ha) on soil water content, soil temperature and nitrogen dynamics,, plant growth, and soil microbial activity. Hourly monitoring of soil temperature, water content and tension at three soil depths provides insights into the impact of mulching on soil processes.

The effect of mulch on crop emergence and development was different depending on the soil moisture regime. Under dry field conditions, plant emergence was higher and development improved with increasing mulch thickness. However, in wetter conditions, plant development and emergence were enhanced by a 6 cm mulch thickness but negatively impacted by a 12 cm mulch thickness.

These findings emphasize the potential of mulching as a viable strategy for enhancing agricultural resilience by considering environmental conditions and plant physiology requirements, particularly during the sensitive crop stages.

Mapping soil organic carbon in croplands overall China using continuous multitemporal Sentinel-2 remote sensing

[1, 2]*Xue, J.,[3]Zhang, X., [4]Chen, S., [2]van Wesemael, B. & [4]Shi, Z.

*lead presenter - xj2019@zju.edu.cn

[1]Department of Land Management, Zhejiang University, Hangzhou 310058, China

[2]Earth and Life Institute, Université catholique de Louvain, Louvain-la-Neuve 1348, Belgium

[3]UMR ECOSYS, AgroParisTech, INRAE, Université Paris-Saclay, Palaiseau 91120, France

[4]Institute of Applied Remote Sensing and Information Technology, College of Environmental and Resource Sciences, Zhejiang University, Hangzhou 310058, China

Precise soil organic carbon (SOC) monitoring is an urgent need for solving worldwide issues, such as food security, water regulation, land degradation, and climate change, especially in agricultural region. Remote sensing technology has evolved as a potent tool for capturing variations in SOC across small-scale areas. However, its application on a nationwide scale remains limited, particularly in countries like China with extensive and diverse soil landscapes.

To fill the knowledge gap, this study aimed to map the spatial distribution of cropland SOC at 10-m spatial resolution across China by combing the digital soil mapping framework and remote sensing techniques. Firstly, we applied the Two-Dimensional Bare Soil Separation algorithm to extract and synthesize the continuous spectral reflectance of soil surface, leveraging multi-temporal Sentinel-2 imagery spanning from 2018 to 2022. Baes on the bare soil mosaics, we calculated a serious of remote sensing indexes, which include 10 single bands reflectance, 9 new constructed SOC indexes, and 15 existed indexes. Secondly, eight combinations of the remote sensing indexes were used to develop random forest model via 20 bootstrapped validations. Notedly, the combinations include the different collocations of three remote sensing indexes modes, and all these remote sensing indexes with environmental covariates before and after forward recursive feature selection (FRFS).

The results showed that the predicted model using remote sensing indexes with environment covariates selected by FRFS method performed the best in SOC prediction, with R^2 of 0.62, RMSE of 4.84 g kg^{-1}, and the uncertainty represented by PIR of 17.88 g kg^{-1}. The SOC content was predicted to be highest in the eastern Qinghai-Tibet Plateau and Northeast China. The framework of this study was an effective way for a high-resolution, high-accuracy and large-area prediction of SOC. The generated SOC map holds great significance for further land management and precision agriculture policymaking.

A framework for mapping conservation agricultural fields using time-series optical and radar imagery

[1]*Zhou, Y., [1] Ferdinand, M.S., [2]van Wesemael, J., [1]Dvorakova, K., [1]Baret P. V., [1]Van Oost, K. & [1]van Wesemael, B.

*lead presenter –

[1]Earth and Life Institute, Université catholique de Louvain, Louvain-la-Neuve 1348, Belgium

The importance of conservation agriculture is undeniable, both for improving soil health and offering a viable path towards carbon neutrality. However, to date, survey statistics on the extent of conservation agriculture were based on farmer declarations or field inspections. This is a major impediment to the promotion or monitoring of conservation agriculture. Here, we collected the management practices of a total of 247 fields under conservation agriculture in the Walloon region of Belgium in 2020-2021, with the aim of developing a classification model for the prediction of conservation agriculture by combining remotely sensed data with census data.

The input variables of the model are based on the three main pillars of conservation agriculture (crop diversification, maximum soil cover and minimum mechanical soil disturbance). The number of crops and cereals in the rotation was estimated from the agricultural census. For the extent of soil cover, the Google Earth Engine platform was used to obtain time series of optical remote sensing images (2015-2020, Sentinel-2, Landsat-7, Landsat-8) and precipitation data. We then analyzed the variation of spectral indices such as the NDVI and the Normalized Burn Ratio (NBR2) and constructed indicators to distinguish between bare soil and cover crop. For mechanical soil disturbance, radar data (Sentinel-1) were also obtained from the GEE platform to establish a tillage practice model. Subsequently, Random Forest (RF) classification method was used to construct a classification model distinguishing fields under conservation from those under conventional practices. The results of a ten-fold cross-validation showed a good overall accuracy of 92%. The model was utilized to classify the farming systems in all croplands of the Hesbaye region of Belgium. The results show that 15.5% (2,875 fields) of 18,516 croplands can be classified as conservation agriculture. These fields tend to adopt non-inversion tillage and have diverse crop rotations.

Abstracts
of
poster presentations

The role of nematodes in N_2O emissions from agricultural soils with different N fertilization

[1*]Andrade M. M., [1]Hu J., [1]Mahabbah M. H., [1]De Neve S.

*Lead presenter- MalaikaMariana.AndradeHernandez@UGent.be

[1]Ghent University, Department of Environment, Belgium

In the recent years, there has been growing concern about nitrous oxide emissions (N2O), given their potent greenhouse gas effect and critical role in the depletion of stratospheric ozone. More than 50% of N2O emissions come from microbial activities within soils, which was stimulated by the use of inorganic and organic nitrogen fertilizers. Soil nematodes, through the interaction with soil microbes, regulate soil N cycling and have recently been reported to affect soil N2O emissions, particularly in light textured soils. However, it is unknown when and where soil nematodes might show effect on N2O emissions in agricultural soils with different N fertilization. An incubation experiment was designed to explore the role of soil nematodes by manipulating their presence and absence, in N2O emissions across different N fertilization types, namely, no external nitrogen addition (CK), chemical nitrogen fertilizer (N), manure slurry (M), and crop residue (R). Conducted on two soil textures—loamy sand and sandy loam—the experiment included eight treatments with four replicates each, totalling 64 experimental units. Soil will be gamma irradiated to remove all soil fauna, and soil nematode community will be inoculated in the nematode present treatments. The effect of soil nematodes will be estimated as the difference between nematode present and absent soils. The soil cores will be incubated for two months with periodic gas chromatography measurements of N2O and CO2 emissions. Also, the ^{15}N and ^{18}O signature will be measured for identifying the pathways of N2O production, e.g., nitrification or denitrification, and bacterial or fungal denitrification. The study hypothesizes that soil nematodes play a larger role in N2O emissions in N fertilized soil, and particularly in organic material with low C/N ratio. This research aims to clarify the complex interplay between soil amendments, nematode activity, and greenhouse gas emissions, offering insights into mitigating N2O emissions through strategic soil management and enhancing our understanding of soil biological processes and their environmental impacts.

C-farms: cropping on industrial waste to create a carbon sink in agricultural soils

[1*]Cosgrove, M.J., [2]Roussard, J., [1]Vandecasteele, B., [1]De Boever, M. &[2]Vicca, S.

*Lead presenter - micaela.cosgove@ilvo.vlaanderen.be

[1]Flanders Institute for Agricultural, Fisheries and Food Research (ILVO), Belgium

[2]Antwerp University

Climate change mitigation has many tools and technologies, including net emission technologies (NETs), to achieve carbon sequestration. Low-tech and less expensive NETs, such as enhanced weathering, provide multiple benefits to society. Identifying the practicality and impact of said activities offers a hybrid industrial-agricultural process that could accelerate enhanced weathering, increase carbonisation and contribute to a circular economy.

Within the C-Farms Project, agro-experiments are being conducted to determine how silicate materials affect crop performance over three years. The treatments and combinations observed are silicates from steel slag production, construction and demolition waste and basalt. Organic amendments applied include biogas digestate, compost, and two biochars.

The experiment is being conducted in East Flanders and is divided into three phases: pre-treatment, treatment, and post-treatment. During the pre-treatment phase, soil samples were collected and analysed for their chemical composition. During the treatment phase, the silicate and treatment materials were applied to the soil, and the crops were watered according to their specific needs. During the post-treatment phase, the crops will be harvested seasonally, and their yield and quality will be analysed in conjunction with plant growth analyses'. As an extension of this experiment, a focus on the impact of enhanced weathering on drought tolerance will be conducted by influencing water availability. The crops of focus are dwarf maize and a series of cash crops in the primary experiment and soya in the drought experiment.

The findings of these experiments will contribute to understanding the enhanced weathering potential of silicate materials as a climate change NET. Moreover, insights into the effects of silicate materials on crop performance and drought tolerance could inform sustainable agricultural practices and contribute to the development of resilient cropping systems in the face of climate change.

NB: Results are unavailable as the experiment is in its 3rd month.

Distribution of pristine and aged polystyrene microplastics in soil aggregate fractions

[1]de León, C.M.F., [1]*Novita, P., [1]De Neve, S.

*lead presenter - Carmen.deLeon@UGent.be

[1]Ghent University, Belgium

Plastics are extensively used due to their versatility, affordability, and longevity, yet they contribute significantly to environmental waste. Their accumulation in soil can alter its biophysical properties and serve as carriers for harmful substances. Agricultural practices involving microplastics (MPs) contribute to soil contamination, potentially impacting various ecosystems including oceans. To understand their migration patterns to other environmental compartments, is important to assess the amounts of MPs that are associated in specific soil aggregate sizes. This study aims to investigate the redistribution of Polystyrene (PS) in both pristine and aged stages across soil aggregate fractions (macro-aggregates, micro-aggregates and within silt+clay fractions). Two soil types (loam and silt loam) were collected from the top 30 cm to ensure aggregate formation due to the higher microbial activity at the topsoil. The soil was treated with MPs of three different sizes (10, 25, and 48 µm) and organic matter to promote aggregation during a 2-month incubation period. Given the heterogeneity of soils and MPs, the extraction process involves several steps. Initially, physical fractionation separates the soil into aggregate types, followed by oxidation of organic matter to facilitate its removal. Subsequently, microplastics are extracted through density separation and filtration, enabling examination and estimation through microscopic analysis. What will be the influence of weathering process in the MPs behaviour? What will be the impact of MPs size in the redistribution patterns? Will the difference in texture lead to different MPs distribution pattern?

Assessing the influence of capillary moisture supply on carbon mineralization in topsoil of Flemish croplands during a dry summer

[1,2] *Françoys, A., [1]Hu, J., [3]Dewitte, K., [2]Boeckx, P., [1]Cornelis, W., [1]De Neve, S. & [1]Sleutel, S.

*lead presenter

[1] Department of Environment, Ghent University, Coupure Links 653, 9000 Ghent, Belgium

[2] Department of Green Chemistry and Technology, Ghent University, Coupure Links 653, 9000 Ghent, Belgium

[3] Department of Plants and Crops, Ghent University, Coupure Links 653, 9000 Ghent, Belgium

Droughts are projected to gain in frequency and severeness in the future and are likely to offset soil organic carbon (SOC) dynamics in European cropland. To predict this effect, it is essential that models properly account for relevant occurring hydrological processes. The influence of counter-gravity moisture transport through capillary action is often overlooked causing its impact on topsoil processes to remain largely unknown, although during drought, capillary rise may form a relevant input term of the topsoil moisture balance. In this experiment, we aimed to investigate to what extent a 1 to 2.5 m deep groundwater table supplies moisture to the topsoil (0 – 30 cm), and consequently affect SOC mineralization in six croplands of three common soil textures in Flanders, viz. loamy sand, (sandy) loam and silt loam soil. Repacked soil columns were *in situ* installed into the plough layers, with either a gravel layer at the bottom blocking upward capillary moisture transport ('gravel' treatment), or allowing bidirectional water movement ('non-gravel' treatment). We found that for the loamy sand and (sandy) loam croplands, groundwater tables ranging from 140 cm to > 230 cm and 134 cm to > 270 cm, respectively, were too deep to significantly impact topsoil moisture. Moreover, moisture contents were even significantly higher in the gravel treatment (0.135 $m^3\ m^{-3}$ and 0.172 $m^3\ m^{-3}$) compared to the non-gravel treatment (0.113 $m^3\ m^{-3}$ and 0.165 $m^3\ m^{-3}$ for the loamy sand and (sandy) loam soil, respectively), which we attribute to reduced downward suction induced by the gravel layer. In contrast, for the silt loam soils, we did find significantly higher moisture levels in the non-gravel treatment (0.227 $m^3\ m^{-3}$) compared to the gravel treatment (0.174 $m^3\ m^{-3}$), indicating that capillary rise significantly supplied moisture from the groundwater table, located between 100 cm and 255 cm depth, up to the topsoil in this finer-textured soil. Within treatments, SOC mineralization (measured as CO_2 emission) followed moisture level temporal trends. However, contrary to our expectation, treatment-induced moisture increases caused by capillary action, i.e. in case of the non-gravel treatment in silt loam soils, did not lead to enhanced SOC mineralization (51.2 mg CO_2-C $m^{-2}\ h^{-1}$) compared to the gravel treatment (51.9 mg CO_2-C $m^{-2}\ h^{-1}$).

Optimizing soil sample preparation and machine learning models for estimating soil total nitrogen with Vis-NIR spectroscopy

[1]Huai, S., [2]Colinet, G., [1]Yu, W., [1]Zhang, Q., [1]Jin, Y., [1]*Lu, C.

[1] Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing, China

[2] Gembloux Agro-Bio Tech, University of Liege, Liege, Belgium

Soil nitrogen is integral for preserving soil fertility and fostering crop growth. Enabling rapid and accurate estimation of soil nitrogen levels is beneficial for advancing the process of soil information management. This study focused on black soil from Northeast China and red soil from Southern China, acquiring spectroscopy and corresponding soil total nitrogen content information from three different sieving treatments (no sieving, sieved to 2mm, sieved to 0.25mm, and sieved to 0.15mm). After Savitzky-Golay smoothing of the spectroscopy, three types of differentiation transformations were applied to select characteristic nitrogen bands. Four modeling methods including Partial Least Squares Regression (PLSR), Support Vector Machine Regression (SVR), Generalized Regression Neural Network (GRNN), and Back Propagation Neural Network (BPNN) were utilized to establish the optimal estimation models for soil nitrogen content. The results revealed significant impacts of different sieving treatments on the predictive quality of models generated using Vis-NIR spectroscopy, with models built using samples sieved to 0.25mm and 0.15mm showing higher accuracy compared to other treatments. Specifically, within the sieved to 0.25mm treatment, the first-order differentiation (FD) combined with BPNN method yielded the highest accuracy for the total nitrogen spectroscopy model, with validation R2, RMSE, and PRD values of 0.80, 0.05, and 1.62, respectively. These findings demonstrate that the FD+BPNN model established using spectroscopy from samples sieved to 0.25mm effectively predicts soil total nitrogen content.

What controls the expansion of urban gullies in tropical environments? Lessons learned from cities in D.R. Congo with contrasting soil types

Mawe, G.I.[1,2,3,*], Landu, E.L.[1,3,4], Imwangana, F.M.[3,5], Hubert, A.[1], Dille, A.[6], Bielders, C.L.[7], Poesen, J.[8,9], Dewitte, O.[6], Vanmaercke, M.[8]

*lead presenter - guy.ilombemawe@doct.uliege.be

[1]University of Liège, Department of Geography, Belgium

[2]Université Officielle de Bukavu, Department of Geology, D.R. Congo

[3]Université de Kinshasa, Geoscience Department, Kinshasa, D.R. Congo

[4]Université de Kinshasa, Department of Natural resources management, D.R. Congo

[5]Geological and Mining Research Center, Geomorphology and Remote Sensing Laboratory, D.R. Congo

[6]Royal Museum for Central Africa, Department of Earth Sciences, Belgium

[7]Université catholique de Louvain, Earth and Life Institute - Environnemental Sciences, Belgium

[8]KU Leuven, Department of Earth and Environmental Sciences, Belgium

[9]Maria-Curie Sklodowska University, Institute of Earth and Environmental Sciences, Poland

Urban gullies (UGs) are a growing concern in many tropical cities of the Global South. Addressing this new geo-hydrological hazard requires good insights into the rates and controlling factors of this process.

Therefore, we investigate the expansion rates of a representative sample of UGs in Kinshasa (n=17) and Bukavu (n=29), two contrasting cities in D.R. Congo. We reconstruct long-term (10-17 years) expansion rates, making a distinction between headcut retreat and sidewall widening, and analyse the environmental factors potentially explaining these rates.

Total expansion rates varying between 12.6 and 863 m^2y^{-1}. Most of this expansion happens through sidewall widening. In Kinshasa, which is mainly characterized by sandy soils, contrasts in expansion rates are mainly correlated to the characteristics of the upslope drainage area of the gullies. Especially the road density and a hypothetical runoff index (combining drainage area, land use and soil characteristics) explain a significant part of the observed variation. In Bukavu, such trends are less apparent. This is likely because the clayey nature of the soils provides more resistance against gullying, resulting in overall smaller and less actives UGs. Furthermore, the already low infiltration rates of these soils probably make the relative impact of urbanization on runoff production smaller. Our results also indicate that UGs located in recent landslides have higher gully expansion rates. The mechanisms behind remain poorly understood. Overall, our work opens promising perspectives to model and predict gully expansion rates in urban settings but may also guide efforts aiming to stabilize UGs.

Unravelling soil organic carbon (SOC) stability in Belgian floodplain

[1*]Kovacs, N., [1]Colinet, G., [1]Longdoz, B., [2]Vancampenhout, K., [2]Verstraeten, G., & [1]Meersmans, J.

*lead presenter - nicolas.kovacs@uliege.be

[1]Gembloux-Agro Bio Tech, Belgium

[2]KULeuven, Belgium

Floodplains have a high potential for storing soil organic carbon (SOC). In Belgium, numerous pressures, such as land-use changes, urbanisation and artificial drainage, have reduced carbon concentrations. As a consequence, these ecosystems risk becoming carbon sources in the atmosphere. Moreover, there is an incomplete understanding of C-storage variability and the specific environmental factors, such as soil type, floodplain processes, or land use practices, that influence and regulate it.

The present research aims to study the SOC quality better to understand its protection and storage mechanisms in floodplains. Three contrasting hydrological zones were selected in the Dyle Valley (Belgium), each of which includes three land uses typically found in floodplains. The SOC quality will be studied by unravelling its (i) physical, (ii) thermal and (iii) chemical stability. These aspects will be assessed by (i) fractionation, (ii) differential scanning calorimetry and (iii) mid-infrared (MIR) spectroscopy, respectively. Finally, these data will be analysed in relation to the cumulative relative soil CO_2 efflux (mgC-CO_2 gC^{-1} h^{-1}) measured over a year.

Trade-off between microbial carbon use efficiency and microbial resource limitations is regulated by root exudation under long-term nitrogen fertilization

[1,2]Lian, J., [1]*Zhang, J.

*lead presenter - zhangjianfeng@caas.cn

[1]National Engineering Laboratory for Improving Quality of Arable Land, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 100081, P.R. China

[2]Laboratory of Integrated and Urban Phytopathology, Gembloux Agro-Bio Tech, University of Liège, Passage des déportés 2, 5030 Gembloux, Belgium

Root exudates input and its mediated nutrient cycling process of driven by N fertilizer are among the important mechanisms shaping root-associated microorganisms in plant-soil systems. However, microbial resource limitations and their drivers under long-term N fertilizer application in greenhouse vegetable systems have rarely been investigated. Here, we selected a 15-year greenhouse vegetable system to explore how N fertilizer application impact root carbon and nitrogen exudation rates, microbial resource limitations and their link to microbial carbon use efficiency (CUE), estimated using stoichiometry theory (CUE_{ST}). The experiment included four chemical nitrogen application rates: high nitrogen fertilizer (N3), medium nitrogen fertilizer (N2), low nitrogen fertilizer (N1), and no chemical nitrogen fertilizer (N0). The results showed that chemical N reduced the root C and N exudate rates. Interactions between fertilizer and plant roots altered microbial N/P and C limitation which is an opposite trend for CUE_{ST}; Rhizosphere soil microbial C limitation increased while soil microbial CUE_{ST} decreased with the reduce of N fertilizer quantity. In rhizosphere soils, microbial C limitation positively correlation with root C and N exudate rates. microbial CUE_{ST} negatively correlation with microbial carbon limitation, root C and N exudate rates. Structural equation model revealed that soil NH_4^+content had significant negatively effects on the root exudate rates (the average of root C and N exudate rates) after long-term N chemical fertilizer reduced resulting in increased rhizosphere soil microbial metabolic limitations could reduce microbial CUE_{ST} that is microbial C turnover potentially reducing soil C sequestration. Overall, this study highlights the critical role of root exudation rates in microbial resource limitation and CUE changes in plant-soil systems, and further our understanding of plant-microbial interactions.

Direct-seeding: a promising approach to reduce methane emissions in rice-crayfish ecosystems

[1]*Liu, Y.

*lead presenter - YLiu@student.uliege.be

[1]Université de Liège, Gembloux 5030, Belgium

In recent years, the Rice-crayfish rotation (RC) system has rapidly expanded in China, attributed to its notable socioeconomic benefits. Direct-seeding (DS) is a promising approach to reducing methane (CH_4) emission in rice paddies. However, the impact of using DS on the CH_4 emissions in the RC is poorly understood. In this study, we conducted field experiments over varied durations within the RC system to compare greenhouse gas emissions from DS and the conventional transplanted Rice (TP) method. Results showed that DS significantly reduces CH_4 emissions during the vegetative stages, lowering overall emissions by 27-39% compared to TP. Although DS leads to increased nitrous oxide (N_2O) emissions in reproductive phase, it effectively reduces the Global Warming Potential (GWP) by 26-36%. DS was found to reduce the abundance of the *mcrA* gene in the vegetative stage soil, thereby curtailing CH_4 production at critical periods. Beyond environmental benefits, DS also offers economic advantages by reducing seedling and labor costs, although its economic viability largely hinges on rice yield. Our results suggest that DS presents a promising alternative to TP in RC systems, offering a balanced approach to reducing greenhouse gas emissions while considering economic implications.

Mapping the spatiotemporal dynamics of cropland abandonment and recultivation across the Yangtze River Basin, China

[1,2*]Long, Y., [2]Sun, J., [1]Wellens, J., [1]Colinet, G., [2]Wu, W., [1]Meersmans, J.

*lead presenter - yuqiao.long@doct.uliege.be

[1]TERRA Teaching and Research Centre, Gembloux Agro-Bio Tech, University of Liège, Gembloux, Belgium

[2]State Key Laboratory of Efficient Utilization of Arid and Semi-arid Arable Land in Northern China, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing, China.

Whether China can achieve the United Nations Sustainable Development Goals (SDGs) largely depends on the ability of main food-producing areas to cope with multiple land use change challenges. Despite the fact that the Yangtze River Basin is one of the main regions for China's food security and carbon sequestration, the spatiotemporal dynamics of cropland abandonment and recultivation remain largely unexplored in this region. The present study assesses the evolution of the agricultural system within the Yangtze River Basin between 2000 and 2020 by mapping cropland abandonment and recultivation using MODIS time series and multiple land cover products. The results highlight a widespread cropland abandonment process (i.e. 10.5% of the total study area between 2000 and 2020), predominantly in Western Sichuan, Eastern Yunnan, and Central Jiangxi [Figure 1]. The highest rates of abandonment are in mountainous regions. However, by 2020, 74% of this abandoned cropland had been recultivated at least once [Figure 2]. Hence, as this is one of the first studies that unravels the complex interaction between cropland abandonment and recultivation in a spatio-temporal explicit context, it offers (i) scientists with a novel methodological framework to assess agricultural land use issues across large geographical entities, and (ii) policy-makers with new insights to support the sustainable transition of the agricultural sector.

Runoff retention structures effectiveness in controlling urban gullying in tropical cities, case of Kinshasa in DR Congo

[1,2,3*]Landu, E.L., [1,4]Mawe, G.I., [2]Imwangana, F.M., [5]Bielders, C., [6]Dewitte, O., [7,8]Poesen, J., [1]Hubert, A., [7]Vanmaercke, M.

*lead presenter - ELutete@doct.uliege.be

1 Geography Department, University of Liege, Belgium

2 Geoscience Department, Université de Kinshasa, DR Congo

3 Natural resources Management Department, University de Kinshasa, DR Congo

4 Department of Geology, Université Officielle de Bukavu, DR Congo

5 Earth and Life Institute - Environnemental Sciences, UCLouvain, Belgium.

6 Royal Museum for Central Africa, Belgium.

7 Department of Earth and Environmental Sciences, KU Leuven, Belgium.

8 Faculty of Earth Sciences and Spatial Management, Maria-Curie Sklodowska University, Lublin, Poland

In numerous tropical cities, the rapid and chaotic urbanization leads, in combination with the highly erodible soils and intensive rainfall conditions, to the formation and expansion of large, destructive urban gullies. To prevent and limit these gullies, runoff retention measures (e.g. water tanks and infiltration basins) are often constructed, even if less effective. Nonetheless, from first principles, limiting and retaining runoff in the contributing area is likely the best strategy to control gully erosion. This study aims to better understand the potential of these measures as a strategy to limit runoff quantities at urban gully heads. Based on detailed field surveys in two catchments affected by urban gullies in Kinshasa, we map and characterize all runoff retention measures present. Using the Soil Water Management (SWMM) model we evaluate their likely influence on runoff and explore the potential of other measure implementation scenarios.

Our results show a limited influence of these structures, although a large majority (77%-88%) of the parcels in the catchments have at least one structure implemented. For example, they likely reduce the runoff volume by only 24 to 30% during a rainfall event with a recurrence interval (RI) of 2 year and by 14 to 16% for an event with an RI of 75 years. Better maintenance of the measures would likely increase runoff reduction with ca. 5%. Considering that most of them are not scaled appropriately to the parcel size, adapting the volume of each measure so that it could capture all parcel runoff produced during a rainfall event with a 10-year RI could potentially reduce the runoff volume at the gully head with 70-80%, even during a rainfall event with a RI of 75 years. Overall, our results demonstrate that, while current efforts remain largely ineffective, better coordinated efforts could clearly have a large effect, making them promising.

Comparing four nematode exclusion methods in soil samples: heating vs freeze-thaw cycles vs gamma irradiation vs microwaving

[1]*Mahabbah, H., [1]Hu, J., [1]De Neve, S.

* lead presenter - hayyu.mahabbah@ugent.be

[1] Ghent University, Belgium

The influence of nematodes in soil can be studied through microcosm experiments. These experiments often require partial soil sterilization to remove nematodes while preserving soil structure and microbial community. Here, we tested four methods to exclude nematodes: heating (48-hour at 65°C, two 48-hour cycles at 65°C with a 72-hour break, and 4-hour at 100°C), freeze-thaw cycles (three 72-hour cycles with freezing temperature at -20°C and -80°C), gamma irradiation (6 kGy and 8 kGy), and microwaving (900 W – 2450 MHz for 2 and 4 minutes). We hypothesized the effectiveness of these methods depends on the soil type. We conducted two-stage experiments. First, we applied these methods to sandy loam soil. Then, we tested effective methods on silt loam and clay loam soils. After treatments, we incubated the soils with and without grass in three replicates for 56 days. We took subsamples on day 14 (without grass) and day 56 (with grass). We measured nematode abundance, dehydrogenase and β-glucosidase activity, and levels of ammonium (NH_4^+) and nitrate (NO_3^-). We utilized one-way ANOVA to compare nematode abundance in the first stage and two-way ANOVA in the second stage to assess treatment effects and interactions between soil types and treatments.

Sensitivity analysis of the BeSOCC model

*[1]Mertens K., [1]Quataert P., [1]Ruysschaert G.

*lead presenter - kaat.mertens@ilvo.vlaanderen.be

[1]ILVO, Belgium

The Belgian Soil Organic Carbon Calculator (BeSOCC) is a Roth-C based model specifically developed for Flanders. Roth-C is a model that simulates the turnover of soil organic carbon (SOC). The BeSOCC model differs from the models in many other European countries in the methodology of the calculation of the C inputs and in the method of initialisation. A high uncertainty still exists on the accuracy of the inputs and initialization although multiple studies have been performed on these.

The BeSOCC model will be used to simulate the effect on the C-stock of current management practices and several alternative management scenarios for the whole of Flanders. This will require simplification and assumptions regarding the inputs. It is important to define which parameters will impact the model's output the most and thus requires more research to improve its accuracy. Especially, since the Roth-C model's output has been found to be highly dependent on its inputs.

The objective of this study is to perform a sensitivity analysis to evaluate which input parameters impact the model output the most, and thus require the highest accuracy. The sensitivity analysis will be performed on the following inputs: C-supply and the ratio decomposable plant material to resistant plant material (DPM/RPM) of crops; C-content, DPM/RPM ratios and dose of organic fertilizers; the percentage of incoming C supplied by the fertilizer going to Roth-C's HUM pool; initial SOC percentage and the initial distribution of the SOC stock over the DPM, RPM, BIO and HUM pool. A global sensitivity analysis is performed by using the Monte Carlo approach to consider all interactions between the parameters.

The preliminary results indicate that the parameter with the highest impact is the initial SOC percentage while the parameter with the lowest impact appears to be the DPM/RPM ratios.

Impact of reduced tillage and mulching on soil water balance and crop growth

[1]*Oloyede, O.E., [1,2]Willemet, R., [2]De Boever, M. & [1]Cornelis, W.M.

*lead presenter - Oluwadamilare.Oloyede@UGent.be

[1]Dept. of Environment, Ghent University, Belgium

[2]Plant Sciences Unit, Flanders Research Institute for Agriculture, Fisheries and Food, Belgium

The impacts of climate change on agriculture are observed on global, regional, and local scales. Like in most parts of the world, the climate in Belgium is changing. This change is characterized by an increase in mean annual temperature and erratic rainfall patterns leading to increase in evaporation and decrease in water availability. One of the possible adaptation responses is change in soil and water management. Several studies have considered single effects of different conservation practices, under conventional tillage, on soil properties and crop growth but studies which have considered their effects under reduced tillage are limited.

This study aims to evaluate the impact of mulching, under reduced tillage, on soil water balance and crop growth. A field experiment was laid out in a randomized complete block design (RCBD). A variety of potatoes (Connect) was planted on four blocks with 3 treatments of mulch – control, 6 cm, and 12 cm. Soil moisture sensors, soil temperature sensors, and tensiometers were installed at different depths to monitor the temperature and water content of the soil through the study period. Undisturbed soil samples were collected to determine the pF curve for each plot and to determine other soil physical properties. Drone flights were used to acquire multispectral images of the plots for crop growth analysis. A regression analysis will be conducted to determine the relationship between soil moisture measurements by sensors and those from the laboratory. Data collected will be analyzed using R and QGIS.

The results of the study are expected to show a significant difference in soil water balance, crop growth and yield as influenced by reduced tillage and mulching compared to the control.

Soil phosphorus (P) mining in agriculture – Impacts on P availability, crop yields and soil organic carbon stocks in a 10-year experiment

[1]*Ramirez-Moguel, A. & [1]De Neve, S.

*lead presenter - angelica.ramirez@ugent.be

[1]Ghent University, Belgium

Two experimental sites with a sandy loam soil texture were established in 2015 in Flanders, Belgium, to make field trials with null P fertilization. Experiments on site confirming that reducing P fertilizer input to zero while cropping reduces the plant available P pool are rare. A previous four-year analysis has been done on these plots. In this master thesis, we will evaluate the total P balance of the 10-year P mining experiment in these two sites. To look at the effects of full P mining on the current soil P status, P dynamics, and the consequences of P depletion for the long-term soil organic matter evolution. We will try to answer the following questions: (i) how did P mining (i.e. also no addition of organic material) influence SOC content, (ii) how did P mining influence the potential P leaching risk, (iii) how did P mining influence the ratio P_{org}/P_{inorg} and the phosphatase activity and (iv) how did P mining affect the P distribution over different P fractions (Hedley fractionation). The dataset we created could help solve the P accumulation problem in soil and eutrophication on surface waters in sites with similar conditions.

Co-deployment of enhanced weathering and organic amendments for carbon sequestration in agricultural soils

[1]*Roussard, J., [1,2]Cosgrove, M., [2]De Boever, M., [2]Vandecasteele, B. & [1]Vicca, S.

*lead presenter - jasper.roussard@uantwerpen.be

[1]UAntwerpen, Belgium

[2] Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), Belgium

Climate change carries many risks for humanity (e.g. increased incidence of extreme weather events like heat waves). To minimize these adverse effects, global warming needs to be limited to 2 °C. To achieve this goal we will need carbon dioxide removal (CDR) technologies to compensate for greenhouse gas (GHG) emissions that are “hard to tackle”. Enhanced weathering (EW) of silicate minerals is a promising CDR technology with application potential in agricultural soils. EW accelerates the naturally extremely slow weathering process by grinding silicate rocks very finely and applying it on soils. As the silicates weather, bicarbonates are formed that can be stored in soils or leached out and stored in the oceans. Because of potential co-benefits for soil health (e.g. nutrient release and improved water retention), EW is attractive to be applied on agricultural soils.

Co-deployment of EW with organic soil amendments (such as biochar, compost and digestate) could elevate the CDR potential of agricultural soils compared to applying the single products separately. Moreover, potential synergistic effects can be hypothesized under co-deployment: In example, organic amendments could increase EW rates by binding EW reaction products and increasing soil CO_2 concentrations.

Despite these potential promising synergisms, the interactions of EW with organic soil amendments are understudied. Therefore, using mesocosm experiments, we are investigating interactions between silicate minerals (basalt, steel slags and construction and demolition waste) and organic amendments (biochar, compost and digestate), by studying effects on weathering rates, mineralogical changes, inorganic and organic carbon dynamics and GHG emissions. Our main goals are (1) to understand interactions between EW and organic amendments by identifying potential synergistic and antagonistic effects and (2) to quantify carbon sequestration potential and soil health benefits for different product combinations in agricultural croplands. First results will be presented during the conference.

Heavy metals drive microbial community assembly process in farmland with long-term biosolids application

[1]*Sun, T., [2]Li, G., [2]Mazarji, M., [1]Delaplace, P., [3]Yang, X., [2]Zhang, J., [2]Pan, J.

*lead presenter - tsun@student.uliege.be

[1]Gembloux Agro Bio Tech, University of Liège, 5030, Belgium

[2]State Key Laboratory of Efficient Utilization of Arid and Semi-arid Arable Land in Northern

China, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 100081, China

[3]Key Laboratory of Agro-Forestry Environmental Processes and Ecological Regulation of Hainan Province, School of Ecology and Environment, Hainan University, Haikou 570228, China

Biosolids are considered an alternative to chemical fertilizers due to their rich nutrients. However, long-term biosolids application can lead to heavy metals accumulation, which severely affects soil microbial community compositions. The factors influencing soil microbial community assembly were explored under a 16-year long-term experiment with biosolids applications. Our results indicated that biosolids application significantly increased fungal richness while not for bacterial and arbuscular mycorrhizal (AM) fungal richness. Besides, biosolids application significantly affected soil bacterial, fungal compositions, and AM fungal community. Soil microorganisms were clustered into different modules with bacterial and AM fungal communities were affected by both organic matter and heavy metals, while fungal communities were affected by heavy metals (Cr, Ni, and As). The soil bacterial community assembly was dominated by stochastic processes while the fungal and AM fungal community assemblies were mainly driven by deterministic processes. Random forest analysis showed that heavy metals were identified as major drivers (Hg, Cu, Cd, and Zn for bacteria, Pb and Cr for fungi, and As and Ni for AM fungi) of the community assembly process. Overall, our study highlights the significant role of heavy metals in shaping microbial community dynamics and gives a guide for controlling biosolids application.

Contribution of Sentinel-2 seedbed spectra to the digital soil mapping of soil organic carbon

[1]*Vanongeval, F., [1,2]Gobin, A. & [1]Van Orshoven, J.

*lead presenter - fien.vanongeval@kuleuven.be

[1]Department of Earth- and Environmental Sciences, KU Leuven, Belgium

[2]Flemish Institute for Technological Research (VITO), Belgium

Soil organic carbon (SOC) plays a pivotal role in the functioning of terrestrial ecosystems, has the potential to mitigate climate change and provides several benefits for soil health. Understanding the spatial distribution of SOC can help formulate sustainable soil management practices. Digital soil mapping (DSM) has emerged as a powerful approach that uses geospatial technologies and statistical methods to predict soil properties across large areas. Predictor variables for DSM include climate data, topographical features, geological attributes, legacy soil maps, land management practices, spatial information and remote sensing data. The spectral response of bare soil may reflect the presence of particular soil components, hence satellite derived spectra may be adequate predictors for SOC. Nevertheless, studies incorporating bare soil spectra in DSM models remain scarce. After all, difficulties remain with regard to the extraction of bare soil pixels minimally influenced by factors such as soil roughness, crusting, crop residues or moisture. This study made use of Sentinel-2 derived spectra during seedbed preparation in spring to estimate SOC and texture across agricultural parcels in Flanders, northern Belgium. For SOC, the prediction performance of a DSM model using bare soil spectra was compared to that of a DSM model using environmental covariates related to topography, climate, texture and vegetation; and to that of a DSM model including both bare soil spectra and environmental covariates. Soil texture (sand, silt, clay) was adequately predicted using spring seedbed bare soil spectra (R^2: 0.56-0.78; RPD: 1.46-2.21), but the predictive performance for SOC was poor (R^2: 0.18; RPD: 1.11). All three DSM models showed poor to intermediate predictive performance for SOC, with the best performance for the model including all covariates (R^2: 0.33; RPD: 1.27). The results provide valuable insights into challenges and potential improvements of estimating soil properties using a DSM approach with spectral and environmental data.

‘From soils to fertilizers’: synthesis of layered double hydroxides from weathered soil of Madagascar

[1]*Willems, E., [1]Wells, F., [2]Kaur, S., [2]Kirschhock, C., [1]Smolders, E. & [1]Everaert, M.

*lead presenter - elden.willems@kuleuven.be

[1]KU Leuven, Department of Earth and Environmental Science, Division of Soil and Water Management, Belgium

[2]KU Leuven, Department of Microbial and Molecular Systems, Centre for Membrane Separations, Adsorption, Catalysis, and Spectroscopy for Sustainable Solutions (cMACS), Belgium

The weathered soils of Madagascar are characterized by poor plant availability of soil phosphorus (P) due to strong sorption on iron and aluminium oxyhydroxides. This is a major constraint for soil fertility, leading to low crop yields. Responsible use of P fertilizers is the key to improving soil fertility. Yet, fertilizer adoption is still lacking due to limited return on investments with current fertilizer prices and practices. Madagascar is one of the poorest countries in Africa. Hence, there is a search for alternatives to conventional P fertilizers for resource-poor, smallholder farmers. Also in Madagascar, urban waste systems often lack wastewater treatment, and consequently, P emissions into surface water are an important source of eutrophication. Recycled P fertilizers have the potential to tackle two problems at once, improving the quality of surface water and using the recovered P as a renewable P source in crop production.

In this study, the strong P sorption properties of weathered soils are used to our advantage to recycle P from liquid P-rich waste in a process optimized by using layered double hydroxides (LDH). This recycled P can be returned to the soil in a plant-available form. Therefore, the present work proposes a novel technology where weathered soil is converted into an LDH mineral by hydrothermal treatment with a soluble magnesium salt for 72 h at a temperature of 165 °C. The potential of this novel material as an adsorbent for P from wastewater and, subsequently, as a renewable P-fertilizer will be evaluated and discussed.

The expected outcome is the development of a recycled P-loaded material that can be used as a P fertilizer for agriculture on the weathered soils of Madagascar. This would have a substantial contribution to improving food security and the quality of surface waters in the resource-poor agricultural systems of Madagascar.

Changes in bacterial community structure and carbon metabolism in sandy soil under the long-term application of chitin-rich organic material and attapulgite

[1, 2]*Zhang, H., [2]Degré, A., [2]De Clerck, C., [1]Li, S., [1]Lian, J., [1]Peng, Y., [1]Sun, T., [1]Luo, L., [1]Yue, Y., [1]Li, G., [1]Zhang, J.

*lead presenter

[1]State Key Laboratory of Efficient Utilization of Arid and Semi-Arid Arable Land in Northern China, Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, Beijing 100081, PR China

[2]University de Liège, GxABT, Terra Research Center, 2 Passage des Déportés, 5030, Gembloux, Belgium

Chitin-rich organic material and attapulgite have been considered efficient materials to improve degraded soil based on their rich nutrient contents and unique structures. However, their potential effects on microbial community and functions in sandy soil are poorly understood. Therefore, we conducted a 4-year field experiment featuring amendment with chitin-rich organic material and attapulgite and investigated the effect of amendments on microbial community diversity, structure and function using amplicons (16S and ITS) and metagenomic sequencing.

The four treatments were as follows: (1) CK: no soil amendment; (2) SA: CK + attapulgite amendment; (3) SC: CK + chitin-rich organic material; and (4) SCA: CK + chitin-rich organic material + attapulgite amendment.

The results indicated that the concentrations of soil organic carbon (SOC), total nitrogen, available phosphate (AP), available potassium, and enzyme activities increased while pH decreased with chitin-rich organic material application. Microorganisms have different responses to different soil amendments. Bacteria are the main components of microorganisms and their community structure was altered under chitin-rich organic material treatments. Furthermore, 14 OTUs belonging to five phyla (Proteobacteria, Actinobacteriota, Firmicutes, Gemmatimonadota, and Patescibacteria) related to the decomposition of organic matter were enriched in SC, while 22 OTUs belonging to six phyla (Proteobacteria, Actinobacteriota, Firmicutes, Gemmatimonadota, Patescibacteria, and Cyanobacteria) were enriched significantly in SCA, suggesting that the combination of the two amendments had the potential to further alter the bacterial community compared with a single amendment. The metagenomic analysis revealed a decrease in the relative abundance of genes involved in carbon metabolism in SCA, with soil pH, AP, enzyme activity, SOC, and bacterial community structure identified as primary influencing factors.

In conclusion, we conducted a comprehensive analysis of the effects of chitin-rich organic material and attapulgite on microorganisms in sandy soil and found a link between soil properties, bacterial community structure, and microbial carbon metabolism function.

Soil ridging combined with biochar or calcium-magnesium-phosphorus fertilizer application: Enhanced interaction with Ca, Fe and Mn in new soil habitat reduces uptake of As and Cd in rice

[1,2,]*Zhang, T., [1] Sayem Jiku, M.A., [1]Li, L.Y., [1]Ren, Y.X., [1]Li, L.J., [1]Zeng, X.B., [2]Colinet, G., [3]Sun, Y.Y., [4]Huo, L.J. & [1,]*Su, S.M.

*lead presenter - ting.zhang@student.uliege.be, sushiming@caas.cn

[1]Institute of Environment and Sustainable Development in Agriculture, Chinese Academy of Agricultural Sciences, China

[2]TERRA-Water-Soil-Plant Exchange dpt., Gembloux Agro-Bio Tech, University of Liege, Belgium

[3]School of Life Sciences, Guizhou Normal University, China

[4]School of Environment and Resources, Taiyuan University of Science and Technology, China

Reducing the bioavailability of both cadmium (Cd) and arsenic (As) in paddy fields is a worldwide challenge. We investigated whether ridge cultivation combined with biochar or calcium-magnesium-phosphorus (CMP) fertilizer effectively reduces the accumulation of Cd and As in rice grains. Field trial showed that applying biochar or CMP on the ridges was similar to the continuous flooding, which maintained grain Cd at a low level, but grain As was reduced by 55.6%, 46.8% (IIyou28) and 61.9%, 59.3% (Ruiyou 399). Compared with ridging alone, the application of biochar or CMP decreased grain Cd by 38.7%, 37.8% (IIyou28) and 67.58%, 60.98% (Ruiyou399), and reduced grain As by 38.9%, 26.9% (IIyou28) and 39.7%, 35.5% (Ruiyou 399). Microcosm experiment showed that applying biochar and CMP on the ridges decreased As in soil solution by 75.6% and 82.5%, respectively, and kept Cd at a comparably low level at 0.13–0.15 $\mu g \cdot L^{-1}$. Aggregated boosted tree (ABT) analysis revealed that ridge cultivation combined with soil amendments altered soil pH, redox state (Eh) and enhanced the interaction of Ca, Fe, Mn with As and Cd, which promoted the concerted reduction of As and Cd bioavailability. Application of biochar on the ridges enhanced the effects of Ca and Mn to maintain a low level of Cd, and enhanced the effects of pH to reduce As in soil solution. Similar to ridging alone, applying CMP on the ridges enhanced the effects of Mn to reduce As in soil solution, and enhanced the effects of pH and Mn to maintain Cd at a low level. Ridging also promoted the association of As with poorly/well-crystalline Fe/Al and the association of Cd on Mn-oxides. This study provides an effective and environmentally friendly method to decrease Cd and As bioavailability in paddy fields and mitigate Cd and As accumulation in rice grain.