SOIL SCIENCE SOCIETY OF BELGIUM

NATIONAL COMMITTEE OF SOIL SCIENCE

DAY OF YOUNG SOIL SCIENTISTS 2011

Wednesday February 23, 2011

Organization:

Eric Van Ranst
President SSSB

Seppe Deckers
Secretary-General SSSB

The Royal Academies of Belgium for Science and the Arts, Brussels

PROGRAMME

13.00 – 14.00
SSSB Board meeting
Bordet room

14.00 – 14.15
General Assembly SSSB

14.15 – 14.30
Presentation Guy Smith Award to Prof. em. R. Dudal

14.30 – 14.45
Biochar amendments change microbial community structure and activity and nutrient dynamics in Flemish loamy soils
N. Ameloot*, K.C. Das, D. Buchan and S. De Neve
**Ghent University, Department of Soil Management*

14.45 – 15.00
Local and global drivers of land-use changes: a case study of the Makonde plateau, South-Eastern Tanzania
A.K. Kabanza*, J.J. Tenga, S. Dondeyne, D.N. Kimaro, J. Poesen, E. Kafiriti and J. Deckers
**K.U.Leuven, Department of Earth and Environmental Sciences*

15.00 – 15.15
Magnesium isotopes as a proxy of physico-chemical processes controlling soil weathering fluxes
S. Opfergelt*, R.B. Georg, K.W. Burton, R. Guicharnaud, C. Siebert, S.R. Gislason and A.N. Halliday
**UCL, Earth and Life Institute*

15.15 – 15.30
Land reclamation using reservoir sediment in Tigray, northern Ethiopia
Gebreyohannes Girmay*, J. Nyssen, J. Poesen, R. Merckx, H. Bauer, Mitiku Haile and J. Deckers
**K.U.Leuven, Department of Earth and Environmental Sciences*

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15.30 – 16.00
Coffee break - Poster session

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16.00 – 16.15
The influence of nematodes on nitrogen mineralization during the decomposition of organic amendments
D. Buchan*, Mesfin T. Gebremikael, Habai R. Masunga and S. De Neve
**Ghent University, Department of Soil Management*

16.15 – 16.30
Analysing soil structure under different tillage systems using x-ray microtomography and pF curves
J. Beekkerk van Ruth*, A. Degré, M. Aubinet, C. Roisin, A. Léonard and E. Beckers
**ULg, GxABT, Hydrology and Hydraulic Engineering / Biosystems Physics*

16.30 – 16.45

Effect of compost on soil properties and crop growth

T. Vanden Nest[*], T. D'Hose, M. Cougnon, B. Vandecasteele and D. Reheul

[*]*Institute for Agricultural and Fisheries Research (ILVO)*

16.45 – 17.00

Bridging hydrology and pedology: An answer to the lack of soil hydraulic properties data in the Lower Congo

Y-D. Botula Manyala[*], W.M. Cornelis, G. Baert, A. Nemes and E. Van Ranst

[*]*Ghent University, Department of Soil Management / Department of Geology and Soil Science*

17.00 – 17.15

Origin of carbonate accumulation in termite mounds of the Upper Katanga, D.R. Congo

B.B. Mujinya[*], F. Mees, P. Boeckx, S. Bode, G. Baert, H. Erens, S. Delefortrie, A. Verdoodt, M. Ngongo and E. Van Ranst

[*]*Ghent University, Department of Geology and Soil Science / University of Lubumbashi, Laboratory of Soil Science*

17.15 – 17.30

Soil fractionation as a tool to understand soil organic carbon dynamics in eroding landscapes

S. Doetterl[*], J. Six and K. Van Oost

[*]*UCL, TECLIM*

17.30 – 17.40

Closing remarks

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ORAL PRESENTATIONS

BIOCHAR AMENDMENTS CHANGE MICROBIAL COMMUNITY STRUCTURE AND ACTIVITY AND NUTRIENT DYNAMICS IN FLEMISH LOAMY SOILS

N. Ameloot[1], K.C. Das[2], D. Buchan[1] and S. De Neve[1]

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Increasing levels of greenhouse gases in the atmosphere have lead to the search for new technologies to mitigate climate change. The use of biochar, which includes all kinds of carbonized biomass types, is believed to sequester carbon (C) into soils. However the addition of biochar to soils may also change physico-chemical soil properties, microbial activity, nutrient dynamics and consequently soil productivity (Glaser et al., 2002). Due to the excessive historic addition of manure and mineral fertilizers, Flemish soils are prone to nutrient losses, and especially nitrogen (N) leaching, with detrimental effects on the environment. The addition of biochar changes the availability of nutrients into soils (Gundale and DeLuca, 2006) and may even prevent N leaching from these soils (Steiner et al., 2008).

An incubation experiment was conducted over 98 days into two silty loamy soils, with different management histories, to which four different types of biochar were added. Biochar, prepared from either poultry litter or pine chips and combusted/pyrolized at both 400 °C and 500 °C, was added at a rate of 20 $Mg.ha^{-1}$. Every two weeks pH, mineral N (NO_3^-, NH_4^+) and plant available phosphorus (PPP) was determined. Initially and after 14, 56 and 98 incubation days soil microbial parameters, such as phospholipid fatty acid analysis (PLFA) for the microbial community structure, microbial biomass (by the fumigation-extraction method) and enzyme activities were measured.

Due to the biochar amendments nutrient cycles in these loamy soils were affected. Depending on the charring temperature and the biomass feedstock, N dynamics differed significantly among the treatments. Higher charring temperatures slowed the rate of N mineralization down. In pine wood biochar amended soils even an immobilization of N was observed. PPP increased in poultry litter amended soils, however charring temperature increase the amount of PPP. Also microbial community structure, biomass and activity were affected by the different biochar amendments. These changes were linked to the changed nutrient dynamics.

We conclude that the addition of biochar to Flemish loamy soils has a tremendous effect on microbial community and nutrient dynamics. Especially nitrate leaching and the accompanied environmental harm may be prevented by adding specific biochar types to these soils.

References

Glaser, B., Lehmann, J., Zech, W., 2002. Ameliorating physical and chemical properties of highly weathered soils in the tropics with charcoal – a review. Biology and Fertility of Soils 35, 219-230.

Gundale, M.J., DeLuca, T.H., 2006. Temperature and source material influence ecological attributes of ponderosa pine and Douglas-fir charcoal. Forest Ecology and Management 231, 86-93.

Steiner, C., Das, K.C., Garcia, M., Förster, B., Zech, W., 2008. Charcoal and smoke extract stimulate the soil microbial community in a highly weathered xanthic Ferralsol. Pedobiologia 51, 359-366.

Key words
Biochar, microbial community structure and activity, nutrient availability, soil fauna, microbial biomass, PLFA

LOCAL AND GLOBAL DRIVERS OF LAND-USE CHANGES: A CASE STUDY OF THE MAKONDE PLATEAU, SOUTH-EASTERN TANZANIA

A.K. Kabanza[1*], J.J. Tenga[1], S. Dondeyne[2], D.N. Kimaro[3], J. Poesen[4], E. Kafiriti[1] and J. Deckers[2]

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We assessed how land-use cover changed over a time span of about 40 years, in South-Eastern Tanzania. South-Eastern Tanzania has for long been regarded as the backward area of the country. Here, however, the Makonde plateau is the principal production area of cashew nuts, one of Tanzania's major export commodities. Comparing of aerial photographs of 1965 with satellite images of 2002, reveals that in general the area with fallow bush land decreased, while the areas with annual food crops under cashew groves increased. Widespread planting of cashew trees, which are mostly grown by small holders, only started in the 1960s. Population increase is a first, and local, identified driving force for land-use change. National policies, most notably the villagisation programme in the 1970s, is a second driving force which clearly affected land cover changes. As prices of cashew nuts have a strongly influence on farmers choices for land-use, the prices of cashew nut is a third and global driving force affecting land use changes in South-Eastern Tanzania. The fourth factor is the wave of mildew disease which raged though the area from late seventies through to early nineties, which discouraged the farmers to grow new cashew groves in that period.

Key words
Land cover, land use, policy, demography, cashew, South-eastern Tanzania

MAGNESIUM ISOTOPES AS A PROXY OF PHYSICO-CHEMICAL PROCESSES CONTROLLING SOIL WEATHERING FLUXES

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The weathering of continental silicate rocks influences the global climate by consuming atmospheric CO_2. As water passes through the *critical zone*, it makes contact with the *soil biogeochemical interfaces*, the porous aggregates formed by the association of weathering products such as clays, oxides and organic matter with plant roots and soil microorganisms. Chemical weathering fluxes and the resulting delivery of nutrients to the oceans are inextricably linked to the reactivity of these interfaces. Magnesium (Mg) is the eighth most abundant element in the continental crust and the fourth most abundant species in seawater, and is transferred from the continents to the oceans via rivers. Mg in rivers derives from continental weathering. During weathering reactions, Mg derived from dissolution of primary minerals may be incorporated into secondary minerals or retained on the soil exchange complex. Mg is also an essential plant nutrient used for the synthesis of chlorophyll. The recent advent of non-traditional stable isotopes, such as Mg, offer an unprecedented opportunity for gaining new insights into the sources and processes which control the release of chemical elements from the critical zone and therefore, for better interpreting riverine fluxes. Magnesium stable isotopes are used in an attempt to evaluate their potential as a proxy for the seasonal cycling of soil processes and associated nutrient export. We report the isotopic budget of Mg in distinct Mg pools (bedrock, vegetation, bulk soils, exchangeable Mg, soil solutions) in four basaltic soils from Iceland exposed to seasonal freeze-thaw cycles (Borgarfjordur catchment). Mg isotope ratios are measured by MC-ICP-MS (Nu Plasma HR) with an external reproducibility for DSM3 standard for δ^{26}Mg of ±0.15 ‰ (2SD). Vegetation takes up Mg and discriminates against lighter isotopes, resulting in organic decomposition which releases heavy Mg isotopes in more weathered acid soils during thaw period. Retention of Mg on the soil exchange complex, closely related to soil acidity, is shown to discriminate against light Mg isotopes in less weathered neutral soils, generating isotopically lighter soil solutions. These data provide the first evidence that the soil exchange complex has a role in the control of Mg isotope ratios in soils. Additionally, a preferential uptake of heavy Mg isotopes by vegetation contributes to lighter soil solutions. This study supports that Mg isotopes are useful to identify seasonal processes controlling Mg export from the critical zone and associated nutrient delivery to rivers and oceans.

Key words
magnesium isotopes, volcanic soil, basalt weathering, soil exchange complex, vegetation

LAND RECLAMATION USING RESERVOIR SEDIMENT IN TIGRAY, NORTHERN ETHIOPIA

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Accelerated soil erosion leads to siltation of reservoirs and decline of their life span. Many reservoirs in northern Ethiopia are dry at the end of the dry season, and we evaluated the potential of recycling deposited sediments for land reclamation. Bare lands, from where construction material had been excavated were covered with 0, 15 and 30 cm thick layer of sediments, respectively, and planted with a local garlic (*Allium sativum* L.) cultivar. The reservoir sediments applied were nutrient-rich with low to medium OC and N_{tot} contents, and high P_{av} and exchangeable cations. The results show that total biomass and bulb yield were 3 times higher on the reclaimed plots than on the control plots (11.7 t/ha versus 3.6 t/ha for the biomass; 7.7 t/ha versus 2.0 t/ha for the yield). When sediment transport and labour costs are taken into account, plots with 15 cm of sediments had in the first cropping season already a benefit-cost ratio of 3, while those with 30 cm had a benefit-cost ratio of 0.9. This study demonstrates that using reservoir sediment is an economically viable strategy for land reclamation that may improve of income resource-poor farmers with as much as 76%. In view of the magnitude of reservoir sedimentation in semi-arid areas throughout northern Ethiopia, the outcome of this research shows the way to turn this major problem into an opportunity which will contribute to poverty alleviation.

Key words
Sediment, Bare-land, Garlic yield, Benefit-cost ratio

THE INFLUENCE OF NEMATODES ON NITROGEN MINERALISATION DURING THE DECOMPOSITION OF ORGANIC AMENDMENTS

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Despite being crucial to successful crop production, the processes governing the supply of nitrogen to plants are not fully understood. In particular the exact mechanisms underlying nitrogen mineralisation – which is carried out exclusively by soil biota – remain largely unexplored. It has been concluded from food web models and a limited number of single-species inoculation experiments that soil fauna feeding on primary decomposers (mainly the bacteria and fungi that constitute the soil microbial biomass) are responsible for approximately 30 % of all N mineralised in soil. These microbial grazers consist mainly of protozoa, free-living nematodes and micro-arthropods – among which nematodes have the most easily recognizable diversity in terms of feeding mechanisms. Due to their high abundance and (functional) diversity in soil, few experiments have explored their interactions and collective effects on nitrogen cycling in a realistic manner. To address this issue, a methodology was developed in which soil fauna could be selectively removed from otherwise undisturbed soil cores by means of low-dose gamma irradiation. The total microbial biomass of defaunated soils was not decreased by this treatment. Entire viable nematode populations were separately extracted from bulk soil and successfully inoculated into defaunated soil, following which an incubation experiment was set up to track nitrogen mineralisation. The results presented here are the final of a series of re-inoculation & incubation experiments in which the influence on nitrogen mineralisation of nematode bacterivores, fungivores and their nematode predators could be quantified by comparing re-inoculated and simply defaunated soil. Although nematodes did not tend to increase the total amount of mineralised nitrogen, they consistently increased the amount of nitrate while reducing the amount of ammonium in soil during the decomposition of a variety of organic amendments. Further analysis of this data aims to investigate the relationships between the relative abundances of bacteria and fungi, their nematode grazers, the nature of the organic amendments, and the amount of nitrogen mineralised.

ANALYSING SOIL STRUCTURE UNDER DIFFERENT TILLAGE SYSTEMS USING X-RAY MICROTOMOGRAPHY AND PF CURVES

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Assessing soil structure is primordial when comparing tillage systems. Whilst most conventional techniques characterize global parameters, X-ray microtomography allows a characterization of the poral space at a µm-scale. These results, combined with data from pF curves, can form a solid basis in order to quantify soil physical fertility.

Soil samples were taken from the organic topsoil on two Belgian experimental sites implementing both conventional tillage (CT, ploughing) and simplified tillage (ST, superficial works), without straw restitution: Gentinnes, Brabant Wallon (March 2010), and Gembloux, Namur (November 2010). On the Gentinnes site (Aba(b)1), CT and ST have been implemented since October 2005, with a beet/winter wheat rotation. On the Gembloux site (Aba(b)), CT and ST have been implemented since September 2008, with a winter wheat cultivation since end 2009. Tomography (10 samples for Gentinnes, 8 for Gembloux) and pF curves (10 samples for Gentinnes, 14 for Gembloux) were used for analysis. Pressure pans were used in order to obtain the pF curves on 100 cm³ undisturbed samples. Soil cores (3 cm diameter, 5 cm height) were scanned using a Skyscan-1172 µ-CT device. The conical beam, operating at 100 kV, produced images having a 17µm pixel size, using a 16-bit 1048×2000 pixels camera equipped with an aluminium filter. The raw images were then treated under Matlab® for binarization, using a thresholding loop to fit the measured and the calculated porosity of each sample (Beckers et al, 2011). The 2D binary images were then analyzed under Matlab® and Skyscan™ CT-analyzer.

On the site of Gentinnes, pF analysis showed a greater available water content (between pF 4.2 and 2.5) for ST, and a greater efficient porosity (between saturation and pF 2.5) for CT. The differences in available water content, although not significant, were confirmed by site observation. Tomography analysis yielded the following: under ST, the pores are smaller and the anisotropy less developed. As for the poral connectivity, it was found greater in CT.
On the site of Gembloux, however, no significant differences were found between the tillage systems concerning the pF curves. Tomography analysis showed smaller pores for simplified tillage, but the differences deduced by the tomographic analysis of the Gentinnes samples concerning connectivity and anisotropy were not found in this case.

To conclude, from the results, the soil structure is found to differ between CT and ST. The pores tend to be smaller and less oriented in ST, whilst in CT pores are more connected. Soils undergoing a CT show a greater efficient porosity, whilst soils under ST display a greater available water content. However, these differences were mostly spotted on the Gentinnes site: in Gembloux, the differences between the samples were less marked. This could be due to the fact that the soil did not have time to differentiate yet (less than 3 years of tillage differentiation). More sampling is needed in any case

before inferring general conclusions from these observations. A further analysis of the soil images, especially concerning pore orientation, will be done in order to fully exploit the tomography results.

Reference

Beckers,E et al., 2011, *Impact of thresholding techniques on X-ray soil microtomogram analyses*, Geophysical Research Abstracts, Vol 13, EGU2011.

EFFECT OF COMPOST ON SOIL PROPERTIES AND CROP GROWTH

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In a long term field trial comparing compost treated and mineral fertilized plots, the effect of compost on soil bulk density, soil resistance, soil moisture, pH-KCl, Total Organic Carbon (TOC) level, crop yield, earthworm population, microbial population, degradation of the herbicide Linuron (3-(3,4-dichloorfenyl)-1-methoxy-1-methylureum), disease suppression and residual N was measured. There are three N-fertilization levels (0,100 and 200 kg/ha).The crop rotation of the field trial is Brussels sprouts (*Brassica oleracea convar. Oleracea var. gemmifera*), potatoes (*Solanum tuberosum* L.), maize (*Zea mays* L.) and fodder beet (*Beta vulgaris* L. *var. alba*). Each crop is grown every year.
Although the soil bulk density of the compost treated plots was slightly lower in the 0-30 cm layer, no significant differences were detected. In the compost treated plots, the soil resistance measured during the summer of 2009 was significantly ($p<0.05$) higher (on average 0.5 MPa) in the 15-25 cm layer. This is possibly caused by an inert compost-enriched layer, that was brought to this depth by the use of the rotary harrow after compost application. The soil moisture (w/w, %) of the 0-15 cm layer was 0.5% to 1% higher for the compost treated plots (not significant) in the autumn of 2009. Compost can be used for pH-buffering. The pH-KCl was on average 0.4 units higher ($p<0.01$) in the compost treated soil. As expected, the TOC-level increased significantly ($p<0.01$) by 0.15% by using compost. The Dry Matter yield (DM-yield) of the crops maize, Brussels sprouts and fodder beet was nearly always higher (but not always significant) in compost treated plots for all three N-fertilization levels. There was no difference in the DM-yield of the potatoes. The underwater weight of the potatoes was significantly ($p<0.05$) higher in the compost treated plots (0.380 kg/5 kg) than in non-treated plots (0.365 kg/ 5 kg) on the 200 kg N/ha fertilization level. There was a tendency (not significant) to larger earthworm populations in the compost treated soil. Although compost could increase the soil microbial C-level (not always significant), the influence of the crop was much larger ($p<0.001$). This might be due to the use of biocides and tillage practices associated with the crops. Despite an increasing microbial biomass, the degradation of Linuron was not faster in compost treated plots. Compost is considered to result a higher potential of disease suppression, but this could not be confirmed in scoring the diseases: *Erisyphe betae, Cercospora beticola* and *Uromyces betae* on fodder beet. On almost all soil sampling dates (autumn 2009) and all three N-fertilization levels, the residual N was only slightly higher in compost treated soils in the 0-90 cm layer. The risk of N-leaching is therefore not higher in compost treated soils.
Although these measurements indicate some less understood advantages of compost, they need to be replicated over time before general conclusions can be made.

Acknowledgements
We would like to thank the Department of Crop Protection's phytopharmacy research group (University of Ghent) for permission to use their laboratory facilities.

BRIDGING HYDROLOGY AND PEDOLOGY: AN ANSWER TO THE LACK OF SOIL HYDRAULIC PROPERTIES DATA IN THE LOWER CONGO

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The south-western part of D.R. Congo (the Lower Congo) has been an active research area since the 1980's in the field of soil sciences. A comprehensive soil database, completed with climatological and agricultural data, has been constituted for the Lower Congo. However, information related to hydraulic properties, like soil water content and hydraulic conductivity, is still lacking. These properties require time-consuming and costly measurements. Moreover, capacity building and acquisition of the necessary equipment are additional constraints in developing countries, like D.R. Congo. To circumvent the constraints of direct measurements, promising alternatives called "pedotransfer functions" (PTFs), have been proposed These are empirical relationships relating the soil hydraulic parameters to easy-to-measure soil properties such as soil texture, bulk density, organic matter content and/or other data largely available in soil survey reports. Hydraulic PTFs are one of the hot topics of hydropedology: a recent discipline which bridges hydrology and pedology. Yet, most published PTFs have been developed for soils in the temperate areas and less effort has been dedicated to develop PTFs valid for soils of the humid tropics. We have evaluated the most-widely published PTFs based on water retention measurements of several representative soils of the Lower Congo. The results proved that there is no one single set of PTFs that is valid for application to the soils of this region. This preliminary study recommended developing PTFs that are designed specifically for the Lower Congo region. PTFs for estimating the soil water retention curve (SWRC) are very important to allow a full exploitation of the available natural resources data. Indeed, the SWRC data are necessary for simulating the soil water balance and estimating crop yields under various management scenarios that are subjected to different rainfall regimes. In another direct practical application, the crop cycle of the typical crops cultivated in the Lower Congo can be fitted into the growing period, and as such climate-, soil- and crop-specific sowing dates avoiding water stress conditions as much as possible can be suggested. In general, the newly supplied soil water retention data will be very useful to define guidelines for the optimisation of the agricultural production and environmental protection at different spatial scales. Since the already published PTFs do not seem to be reliable for predicting hydrophysical properties of soils in the Lower Congo, new PTFs will be developed to predict water retention, hydraulic conductivity and bulk density of soils in the Lower Congo . Various state-ofthe-art approaches (e.g. multiple linear regressions, neural networks, k-nearest neighbour, support vector machines and others) will be tested in future studies.

ORIGIN OF CARBONATE ACCUMULATION IN TERMITE MOUNDS OF THE UPPER KATANGA, D.R. CONGO

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Dome-shaped termite mounds (ca. 8 m in height; ca. 15 m in width) are dominant features of the landscape around Lubumbashi (D.R. Congo). The fungus-growing termite *Macrotermes falciger* is the main occupant of primary active termiteria and the original builder of these massive fortress-style nest. These termite mounds are often enriched in exchangeable basic cations, and in some cases they contain carbonate concretions. Several theories have been proposed to explain carbonate accumulation in termite mounds. However, the source of this carbonate precipitation remains very controversial. This study attempted, therefore, to identify the origin ("pedogenic", "lithogenic" or a mixture) of the calcium carbonate accumulated within *Macrotermes* mounds of the upper Kantaga, using both field and laboratory techniques. Carbonate features were investigated in a termite-mound profile (± 9 m height/ depth, ± 1.5 m width) and within a cross section of an entire termite mound (± 5 m height, ± 3 m depth, ± 18 m width,) and adjacent termite-unaffected soil (± 3 m depth, ± 9 m width). Nodules, coatings and soft powdery materials were the field-identified carbonate forms in the fungus-growing termite mounds. Nature, distribution patterns, and colour contrasts of these carbonate features provided field evidence for a pedogenic rather than lithogenic origin. Micromorphological, scanning electron microscopy (SEM), X-ray diffraction (XRD), energy dispersive X-ray (EDAX) and ^{13}C stable isotope analyses confirmed the non-lithogenic origin of carbonate accumulations. Thin-section studies revealed that the carbonates occur predominantly as impregnative orthic nodules. Mineralogical (XRD, SEM, and SEM-EDAX) analyses showed that all segregated carbonate features contain exclusively pedogenic High-Mg calcite (HMC) enclosing various amount of clay impurities. The stable C-isotope composition of bulk carbonate ($\delta^{13}C_{carb}$) and SOC ($\delta^{13}C_{org}$) suggested that carbonate mainly precipitated in equilibrium with soil CO_2 generated during decomposition of soil organic matter and likely during anaerobic oxidation of methane (AOM). In-place dissolution and reprecipitation of pedogenic carbonate was evidenced by thin-section and SEM analyses. The study demonstrates that carbonate accumulated in *Macrotermes* mounds are pedogenic biogeochemical minerals derived from biotic precipitation of $CaCO_3$ and its subsequent abiotic dissolution and reprecipitation.

SOIL FRACTIONATION AS A TOOL TO UNDERSTAND SOIL ORGANIC CARBON DYNAMICS IN ERODING LANDSCAPES

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Recent findings indicate that soil redistribution processes have an important influence on the distribution of soil organic carbon (SOC) in sloping agriculturally used landscapes. Unclear is, however, the influence of these processes on SOC characteristics and how the stability of SOC along geomorphic gradients deviates from non-sloping land.

Here, our research focuses on the identification of SOC pools stabilized by differing mechanisms and their distribution with depth at different slope positions. We applied a series of chemical and physical fractionation schemes on samples from cropland sites in Belgium to identify these functionally important SOC pools and their distribution with depth at different slope positions. We accompanied this work with incubation experiments to assess differences in CO_2 emission potentials along geomorphic gradients.

Our results show that size and composition of SOC pools differ with depth and slope position with a strong gradient between eroded and depositional sites. Large amounts of carbon are stored in colluvial sediments at footslopes under virtually stable conditions. Larger amounts of carbon are found in microaggregates of the subsoils of depositional sites relative to stable and eroding sites, whereas eroded sites are dominated by silt & clay associated carbon fractions. In contrast, differences in the observed respiration potential between sites and for different depths are small: Subsoil carbon from different slope positions decomposes under surface conditions at similar rates. This might lead to large fluxes of greenhouse gases from soil to atmosphere as climatic changes and changing erosion patterns might re-mobilize these large SOC reservoirs if no measures are taken to reduce soil erosion.

POSTER PRESENTATIONS

FOREST COVER CHANGE AND ITS IMPACT ON LANDSLIDING

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In Ecuador, as in many tropical mountain regions, the increasing population and institutional reforms have forced numerous people to migrate to steep uplands less favourable to agriculture and highly sensitive to soil erosion. This migration induced rapid land cover change. Mass movements (often called landslides) are also very common in those areas. While various authors have shown that prolonged changes in land cover patterns influence the extent and frequency of mass movements, few studies have realised detailed chronosequential analyses of the impact of land cover change on mass movements. Therefore, it is not clear how fast landscapes respond to rapid land cover change.

The main purpose of this work was to analyse the temporal and spatial response of mass movements to land cover change in the Ecuadorian Andes. We particularly focused on the effect of different land cover trajectories in two steep catchments (of about 25 and 5km²) with different land cover histories. In the first one, Rio Llavircay catchment, deforestation mainly started in the mid-20th century while deforestation started few decades earlier in Rio Ingapata catchment located just few kilometres upstream.

Landslides localisations and land cover maps were created by interpretation of aerial photographs from 1963, 1973, 1983 and 1995, and by field surveys in 2008, 2009 and 2010. In total, 335 mass movements (reactivation excluded) were identified between 1963 and 2010 in the two catchments. During the same period of time, half of the primary forest (824ha) in Rio Llavircay catchment has been degraded or harvested and all of it (172ha) in Rio Ingapata catchment.

A statistical approach was used to analyse the main factors controlling mass movement occurrences. Due to the small size of the mass movement samples, standard statistical analyses could not be applied. To bypass this difficulty, we developed a statistical approach where we used Monte Carlo simulations to test if the spatial distribution of mass movements was random or dependant of some topographical variables and/or land cover trajectories.

According to the statistical results, topographic factors such as slope and distance to watercourses are significant variables explaining mass movement presence in both catchments. This is well understandable knowing that half the area is covered with slopes of more than 26°. Anthropogenic factors that are linked to recent land cover change have more importance in the catchment that was deforested in the last four decades (Rio Llavircay catchment). Forest conversion to agricultural land significantly explained mass movement presence, as well as the presence of roads and paths. Importantly, we observe no correlation between the degradation of forest and the pattern of mass movements. This suggests that a significant reduction in the density of trees in forests does not lead to a measurable increase in mass movement occurrence. Geophysical testing of soil samples taken in different land cover units will be realized to further investigate this trend.

MAPPING OF NATURAL HAZARD REGULATION IN MOUNTAIN ENVIRONMENTS ACCORDING TO DIFFERENT PRE-PROCESSING LEVELS OF HIGH-RESOLUTION SATELLITE DATA

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In this study, remote sensing techniques will be used to derive spatial proxies of ecosystem goods and services in mountainous areas with a focus on natural hazard regulation such as mass movements and soil erosion. In regard to mass movement regulation, detecting and mapping landslide occurrences over extensive areas is of great importance and cannot be accomplished by time consuming methods like point-based field measurements or aerial photographs analysis (Abdallah et al., 2007). Therefore, even if satellite images suffer from methodological challenges due to topographical and shadowing effects which require pre-processing steps, high spatial resolution satellite sensors with relatively high spectral and temporal resolutions might allow to consider regional scale landslide inventories. These latter are of critical importance in order to create a reliable map that predicts landslide hazard and risk in a certain area (van Westen et al., 2008). The Ecuadorian Andes were selected as a preliminary test site, as this region is facing intense land use changes and harsh biophysical constraints characterized among others by heavy rainfall and steep topography, causing major environmental threats. More particularly, temporal analysis of variations in landslide susceptibility caused by forest cover changes with both trends of deforestation and afforestation will be conducted.

Landslides are detected based on different high resolution remote sensing datasets and ancillary data in order to combine landscape unit characteristics. For this purpose, multi-spectral images have proven to be particularly effective for mass movement mapping, improving the 2D shape recognition of features, particularly with processing techniques such as color composites, vegetation indexes, pan-sharpening, band arithmetic or principal component analysis. Indeed, along with the importance of spatial resolution, spectral characteristics of remotely sensed data play a major role in detecting landslides. For instance, the ASTER sensor covers a part of the electromagnetic spectrum that enables to highlight more efficiently geological features in comparison to other data of similar spatial resolution such as a pan-sharpened LANDSAT ETM+ image. Along with these techniques, a focus will be made on analyzing the effect of topographic corrections on landslide detection accuracy. In a first step, semi-automated procedures, based on physio-chemical properties obtained from ASTER and LANDSAT ETM+ spectral signature, but also based on 3D instability factors such as topographic and geomorphic characteristics derived from a DEM, are being validated with the help of very-high resolution remote sensing imagery and field campaigns for ground-truthing. Secondly, these regional landslide inventories will be used to calibrate and validate a slope stability model. After this model adjustment, and based on forest cover maps, we will run the model in a dynamic mode to create slope stability maps as an indicator of natural hazard regulation.

Concerning runoff quantity and quality, hydrological data will be used to calibrate semi-distributed hydrological models and distributed erosion models in order to obtain indicators of flood and erosion regulations. A field campaign conducted in summer 2010 helped to confirm the highly dynamic behavior in terms of sediment production and transport in the selected test site.

NATURE AND AGRICULTURE SOLVE EACH OTHER'S PROBLEMS: THE POTENTIAL OF PLAGGEN AS A BIOSOLID AND SOIL IMPROVER

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Changes in management resulted in a considerable decrease in topsoil carbon and soil fertility of agricultural soils. Therefore, the use of biosolids as a soil improver to augment soil carbon stocks is gaining attention globally. Nevertheless, the major constraint in the use of these biosolids is their production, which often emits large quantities of CO_2. To improve soil fertility and soil carbon on poor, acidic sandy soils in the past, the potstal system was used for centuries, transporting heathland sods (plaggen) to the stables and later to the fields. This treatment resulted in the formation of Plaggic Anthrosols rich in carbon. Moreover, this carbon proved to be in a very stable form. Today, plaggen are a byproduct of nature management to counteract the euthrophication of heathland and – when treated as waste – are expensive to dispose of.

Hence, this study experiments with a modern version of the plaggen technique. Plaggen from the nature conservation area "Landschap de Liereman" was used as a soil amender on agricultural land, both in an in-field experiment as on a controlled experimental site. It aims at examining the combined effects of the addition of various amounts of plaggen, calcium carbonate and mineral fertiliser on the acidity, carbon contents and nitrogen dynamics of the soil.

SOIL QUALITY IMPROVEMENT ON HIGHLY WEATHERED SOILS OF JAFFNA PENINSULA, SRI LANKA

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The soil and water resources of the Jaffna Peninsula are both related to the limestone geology of the land. The soils are formed on the marine deposits and sediments under the influence of sea waves and winds on limestone. The complexity of Jaffna soils is not well understood. Few works were carried out until 1980's and there is a significant gap in our present knowledge and understanding of the complexity of soils in Jaffna. Due to the difficult political and security situation in the Peninsula over the last three decades there has been no systematic research in soil management or recommendation, which resulted in human-induced land degradation and poor soil quality in the region. The indiscriminate rates of fertilization and pesticides have lead to leaching of nitrates and heavy metals via the highly permeable soil and contamination of the groundwater (limestone aquifers) in Jaffna region. Recent investigations on groundwater chemical parameters in domestic and agricultural wells by different teams have shown that the nitrate concentrations of groundwater were greater than the threshold value given by the WHO (10 mg l^{-1} of nitrate N). The same was true for salinity levels.

During the year 2005 an attempt was made to investigate toposequence variations in soil properties of four soil series with agricultural potential on variable landscapes. The representative colour plates of single soil profile from each soil series were obtained. The four soil profiles of selected soil series were separately characterized. The infiltration rate was determined with three replicates. The bulk density, soil texture, moisture characteristics, pH, and EC measurements were carried out for all major layers of four soil profiles. The Inuvil and Chankanai soil series showed the higher infiltration rate of 29.5cm h^{-1} and the lowest level of 0.5cm h^{-1} was observed in Uppu Aru soil series. The top profile layers of Inuvil, Chankani, Vaddukodai and Uppu Aru soil series' had available moisture content on a volumetric basis 14.7, 18.1, 21.6 and 33.5 respectively. The first three layers of Uppu Aru seemed to be saline, the EC ranged between 12.7 – 7.6 dS m^{-1} but the Inuvil and Chankanai series EC was within 0.01 – 0.12 dS m^{-1}.

A variety of research has shown that biochar gives positive responses when applied to highly weathered soils, such as improved water holding capacity, reduced soil strength and toxin neutralization. Lehmann and Joseph (2009) demonstrated that the ability of biochar to retain applied fertilizer against leaching resulted in increased fertilizer use efficiency because of higher surface area of biochar. The addition of biochar in soil thus also seems to be very promising in combination with materials such as crop residues of green manures, farmyard manure or composts for soil quality improvement.

The addition of biochar and uncharred organic amendments on highly weathered Jaffna soils may enhance the overall soil quality (physical, chemical and biological) and fertility. This will allow higher yields with minimal external inputs, and reduce nutrient losses from these permeable soils, reducing environmental pollution problems.

CAN PHOSPHATE SOLUBILISING BACTERIA BE OF USE ON PHOSPHATE SATURATED SOILS?

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Due to decades of excess phosphorus fertilization in Flanders, most acid sandy soils became P saturated. This saturation implies that farmers in these areas are bounded to very strict P fertilization rules. The bulk of the (excessive amount of) P in the soil is strongly adsorbed and not directly available for plant uptake. Therefore, it is necessary to look for a way to make the P more available to the crop, even in these P saturated soils. Phosphate solubilising bacteria (PSB) transform unavailable P into plant available forms, and could thus proof to be very useful even in P saturated soils under severe fertilization restrictions. The goal of this research is to investigate the survival and performance of PSB in conditions of high total P content in soil.

Five PSB species, namely three Bacillus and two Pseudomonas species, where selected. Firstly they were tested on different media with different amounts of insoluble phosphate, to check their survival and their P solubilising potential under completely controlled conditions. Then the bacteria will be brought in a more realistic environment, namely in quartz sand with a nutrient solution that supplies all nutrients to the bacteria except P. The P will be provided in an insoluble form as FePO4, AlPO4 or CaPO4. In a next step, the bacteria will be inoculated in P saturated soil under controlled conditions, to test their P solubilising capacities under these specific conditions, and crop P uptake will be monitored simultaneously.

ORGANIC MATTER DECOMPOSITION IN THE SOIL PORE NETWORK: A COMBINED X-RAY CT –INCUBATION STUDY

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A better understanding of the mechanisms involved in the protection of SOM will be important in predicting the evolution of soil quality and the impact of SOM on global change. Few studies focused on the role of the soil pore system in SOM decomposition (Strong et al., 2004; De Gryze et al., 2005). The relationship between soil structure and SOM dynamics is indirect, as soil water and air distribution influence the biological activity in different pore classes (Strong et al., 2004). Soil water distribution is mainly influenced by pore necks, which determine at given water potential if a pore will be water-filled or air-filled. It is thus necessary to quantify this pore neck size distribution if a relationship between soil structure and SOM dynamics is to be studied. X-ray computed tomography (X-ray CT), a nondestructive imaging technique, can provide us images of soil samples in three dimensions. When processing these images, it is possible to gain spatial information about the soil pore system, the pore neck size distribution and its water distribution and relate this spatial information directly to SOM dynamics.

THE EFFECT OF SOM IMPROVING STRATEGIES ON THE BEHAVIOUR OF SOIL PHOSPHORUS AVAILABILITY AND LEACHING POTENTIAL IN FLANDERS AND THE NETHERLANDS

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In response to nutrient leaching to the environment, the European Commission introduced the nitrate directive in 1991. The nutrient leaching was caused by over-fertilisation, which led the Flemish and Dutch government to regulate farmers' fertiliser and manure use. The subsequent restrictions on the N and P-supply has decreased the leaching of nutrients, but it is still substantial. Further restriction is needed to protect the environment from eutrophication. In Flanders, the total organic carbon content of the soil has declined over the last twenty years. The proportion of soils with an excessively low organic carbon content increased by 23% to 35% depending on the region. This decrease is due to several factors: the conversion of grassland into arable land, the increasing plough depth, the use of slurry instead of farm yard manure, and the imposed restrictions in application of animal manure. If manure application is further reduced, the soil's organic carbon content might fall even faster. The nutrient supply to the soil has to be lowered, but the supply of organic matter to the soil needs to be increased at the same time. The nutrient supply has to be decoupled from the organic matter supply, while manure contains both. N can be separated from organic matter by manure treatment, but this is not possible for P.

The objective of this research is to study the effects of different types of animal manure, compost, mineral fertilizers, soil tillage and green manures on the P-fractions of the soil, the P-leaching and the soil organic matter content (SOM). This will provide us an understanding about the types of manures or combination of practices that the farmer can use to maintain the SOM at a sufficient level, while at the same time meeting crop P-requirements and decreasing P-leaching.

During several multi-annual field experiments in Flanders and the Netherlands, we will study the evolution of SOM and the differences in soil P-fractions under different conditions of fertilization. These field experiments are designed to compare different fertilization types. The P-leaching will be tested on soils with different textures in incubation-percolation-experiments under laboratory conditions. The measured parameters in the different soil and percolation water samples will be: TOC, HWC, PAL, Olsen-P, organic P, P ($CaCl_2$), P (DGT), ortho-P and total P. Special attention will be given to compost and green manures. Compost is typically used to improve SOM and it releases its nutrients only gradually. Green manures are part of Good Agricultural Practices, and can influence the P-availability for the succeeding crop.

Key words

nutrient leaching, phosphorus (P), soil organic matter (SOM), animal manure, compost, green manure

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IMPROVEMENT OF SOIL FERTILITY IN THE REGION OF BUTEMBO, NORTH KIVU

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Butembo, a town spread over an area of 200 km^2, is located in the eastern region of the Democratic Republic of Congo, North Kivu, near Lake Edward, at an altitude ranging between 1700 and 2000 m. The state of war that prevailed in this region has created serious food shortages and malnutrition. A collaborative project intended to restore food self-sufficiency has been established. One component of the project was to improve soil fertility, particularly through better management of local organic matter by composting. A detailed mapping of soils in the region Butembo was conducted to identify possible problematic areas, the fertility of which could be corrected by adding compost.

With regard to the results of particle size analysis, most of the soils of Butembo have a fine texture consisting in clay, silty clay, silty clay and sand. The textural analysis shows that the soils are of ferralitic nature. The results of chemical analysis showed that the soils were acidic with pH_{H2O} below 6.8 and leached by rain. The pH_{KCl} was less than 4.5 indicating that these soils are susceptible to a risk of aluminum toxicity. Exchangeable bases were positively correlated with their correspondents. So Potassium correlated positively with the content in clay, Calcium with pH_{H2O}, Phosphorus with Iron and Magnesium with salinity. The observed values were for the most in acceptable standards. Values for trace elements, manganese and iron are also within acceptable standards. Regarding trace metals, Cadmium and Lead were below critical thresholds; less than 1.5 mg/kg for Cadmium and less than 600 mg/kg for lead.

The soils C / N ratios ranged between 9 and14, and were generally not deficient in term in humus and total organic matter content. Moreover Butembo soils had good potential respiratory activities ranging from 375 to 2075 mg evolved CO_2/kg on a 48 hrs period at 30°C. Given the present results we conclude that the approach of compost addition to remove constraints related for example to texture and pH should be a profitable approach to improve fertility of the Butembo soils.

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