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PROGRAMME AND BOOK OF ABSTRACTS

SOIL SCIENCE FOR THE FUTURE

19.10.2012, Tulln

Venue: University for Natural Resources and Life Sciences
Konrad Lorenz Strasse 24, 3430 Tulln an der Donau, Austria

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Soil as a multifunctional, but limited resource is and will be in the focus of all activities to cope with problems like food security, climate change adaptation and mitigation, water quality and availability – to name just the most prominent ones. Soil science is challenged in two different ways: On the one hand fundamental knowledge of several processes is still lacking. So, topics of basic science are still of great importance. On the other hand, there is an urgent demand for practical guidance. Farmers, gardeners, but also spatial planners and nonetheless politicians are requesting sustainable solutions for the use of soil. This symposium is supposed to give an overview of soil related activities especially of young scientists and the possible contribution to solve current and future problems with respect to soil. Michael Schmidt from the Zurich University will give the introduction, highlighting the question: "**Soil Science for the Future - A Future for Soil Science**"

Program

08:30 – 9:00	**Registration**
09:00	**Welcome address**

Chair: Univ. Prof. Dr. Sophie Zechmeister-Boltenstern

09:10 – 09:40	**Prof. Michael Schmidt** (Zurich University): **Soil Science for the Future - A Future for Soil Science**
09:40 – 09:50	**Kubiena research award 2012**
09:50 – 10:40	**Presentations of the Kubiena research award winners 2012** **Ika Djukic,** Franz Zehetner, Andrea Watzinger, Micha Horacek and Martin H. Gerzabek: In situ carbon turnover dynamics and the role of soil microorganisms therein: a climate warming study in an alpine ecosystem **Andreas Schwen:** Agricultural Impacts on Soil Hydraulic Properties: Measurements and Simulations
10:40 – 11:00	**Coffee break**
11:00 – 12:30	**Parallel Sessions (oral presentations)**

Parallel Session I "Rhizosphere"
Chair: Univ. Prof. DI Dr. Walter Wenzel

11:00-11:20	**Álvarez-López Vanessa**, Prieto-Fernández Ángeles, Becerra-Castro Cristina, Rodríguez-Garrido Beatriz, Herzig Rolf, Puschenreiter Markus, Kidd Petra**:** Improving phytoextraction efficiency of high-biomass crops using microbial inoculants and organic amendments

11:20-11:40 **Katharina Fallmann,** Melanie Kuffner, Brigitte Hai, Michael Schloter, Thomas Pattei, Dmitrij Turaev, Markus Puschenreiter and Angela Sessitsch: Rhizosphere bacterial communities of Cd and Zn accumulating Salix

11:40-12:00 **Christoph Höfer,** Markus Puschenreiter, Jakob Santner, Walter W. Wenzel: Elemental sulphur oxidation and heavy metal bioavailability in the rhizosphere of Salix smithiana

12:00-12:20 **Eva Oburger,** Barbara Gruber, Yvonne Schindelegger, Walter Schenkeveldt, Stephan Hann, Stephan Krämer, Markus Puschenreiter: Fate of phytosiderophores in the rhizosphere

Parallel Session II "Soils in Cold Environs/Novel Method Development"
Chair: Dr. Andreas Baumgarten

11:00-11:20 **Hans Göransson,** Harry Olde Venterink, Erland Bååth: Soil bacterial growth and nutrient limitation along a chronosequence from a glacier forefield

11:20-11:40 **Birgit Wild,** Jörg Schnecker, Olga Rusalimova, Robert Mikutta, Georg Guggenberger, Andreas Richter: Dynamics of organic nitrogen in cryoturbated Arctic soils

11:40-12:00 **Jörg Schnecker,** Birgit Wild, Olga Rusalimova, Robert Mikutta, Georg Guggenberger, Andreas Richter: Potential enzyme activities in cryoturbated organic matter of Arctic soils

12:00-12:20 **Jakob Santner** and Walter W. Wenzel: Diffusive gradients in thin films – a versatile tool for phosphorus sampling, testing, and chemical imaging in soils

12:20 – 13:30 Lunch break

Chair:
13:30 – 14:50 Parallel Sessions (oral presentations)
Parallel Session III "Climate Change and Plant Stress"
Chair: Dr. Michael Englisch

13:30-13:50 Joost A. Keuskamp, Bas J.J. Dingemans, **Taru Lehtinen,** Judith M. Sarneel, Mariet M. Hefting: Crowdsourcing method for soil science for the future: Tea Bag Index for decomposition

13:50-14:10 **Mathias Mayer** and Klaus Katzensteiner: Effects of Forest Disturbance on the Dynamics of Soil Respiration

14:10-14:30 **Nadine Präg,** Paul Illmer**:** The Climate Relevance of Subalpine Soils: The Effect of Fertilisation, Temperature and Water content on Methane Production and Methane Consumption

14:30-14:50 **Boris Rewald,** Jhonathan E. Ephrath, Shimon Rachmilevitch: Morphological, anatomical and physiological plasticity of Citrus root systems under NaCl stress

Parallel Session IV "Biochar"
Chair: Dr. Michael Tatzber

13:30-13:50	**Keiblinger K.M.,** Mentler A., Sandor B., Seyrl K., Cip M., Zehetner F., Zechmeister-Boltenstern S.: Proteins in soil and adsorption characteristics of proteins to soil-biocharcombinations
13:50-14:10	**S. Kloss,** F. Zehetner, B. Wimmer, A. Watzinger, S. Zechmeister-Boltenstern, B. Kitzler, M. Lauer, G. Soja: Biochar application to soil – results from an interdisciplinary Austrian project
14:10-14:30	**Ochsenhofer Thomas,** Klinglmüller Michaela, Zechmeister-Boltenstern Sophie, Bernhard Wimmer, Watzinger Andrea, Franz Zehetner, Gerhard Soja, Kitzler Barbara: The effects of biochar application on greenhouse gas emissions from agricultural soils
14:30-14:50	**Judith Prommer,** Rebecca Hood-Nowotny, Gerhard Soja, Bernard Vanlauwe, Wolfgang Wanek: Biochar arrests soil organic nitrogen cycling
14:50 – 16:00	**Poster Presentation and Coffee (Chair: DI Sigbert Huber)**
16.00 – 17:00	**guided tour to the new university building**
17:00 – 18:00	**General Assembly of the Austrian Soil Science Society – Generalversammlung der Österreichischen Bodenkundlichen Gesellschaft**
18:00	**common dinner – Gemeinsames Abendessen**

The symposium language will be English.

The conference is free of charge and sponsored by the Austrian Soil Science Society (ÖBG) and the University of Natural Resources and Life Sciences (BOKU)

Publication:
The abstracts are available as download (pdf) from the website (http://oebg.boku.ac.at)

Posterpräsentationen:

Andreas Kreuzeder, Jakob Santner, Thomas Prohaska and Walter W. Wenzel: Diffusive gradients in thin films (DGT) as a method for chemical imaging of solute dynamics in soils

Balakrishnan Ravindran Vivek, Brader Günter, Waldner Georg, Muhammad Naveed, Friesl-Hanl Wolfgang and Sessitsch Angela: Role of plant growth promoting bacteria and soil amendments in phytoremediation of heavy metal contaminated sites

***Gernot Bodner*:** Influence of wetting-drying cycles on soil hydraulic properties

Lucia Fuchslueger, Michael Bahn, Karina Fritz, Roland Hasibeder, Andreas Richter: Drought induced changes of plant belowground carbon allocation affect microbial community function in a subalpine meadow soil

Aleti, G., Plesko, M., Sessitsch, A., Brader, G.: Secondary metabolites in plant associated Bacilli

Gruber, B. , Oburger, E., Wenzel, W.W., Schindlegger, Y., Regelsberger, A., Hann, S., Schenkeveld, W.D.C., Kraemer, S.M., Robinson, B., Puschenreiter, M.: The Effect of Iron Deficiency on Metal Bioavailability in Wheat Rhizosphere

Angela Hudribusch: Influence of charcoal application on the near-surface soil-water regime of an arable land in Weitersfeld/NÖ.

M. Kasper, H. Schmid, B. Freyer, K.J. Hülsbergen, B. Amon, J. K. Friedel: Calculating the humus- and nitrogen-balances of different agricultural systems in Austria

Lukas Kranzinger, Sonja Leitner, Michael Zimmermann, Katharina M. Keiblinger, Sophie Zechmeister-Boltenstern: Comparing greenhouse gas fluxes CO2, CH4 and N2O on a pure beech transect on the basis of two different treatments.

Martina Mannel, Jakob Santner and Walter W. Wenzel: A novel, diffusion-based extraction for the estimation of plant available soil phosphorus

Eva Prem & Paul Illmer: Abundance and activities of aerobic and anaerobic microorganisms in Alpine soils along a grazing and manure gradient in special consideration of methanogenic Archaea

Christoph Schürz, Andreas Schwen, Stefan Strohmeier, Andreas Klik: Spatial Distribution and Temporal Behavior of Soil Properties as Indicators of the Effect of Soil Conservative Measures

Shady Selim, A. Klik, S. Kloss, F. Zehetner, G. Soja, M. Fürhacker: Impact of biochar amendment on the adsorption – desorption of chloridazon in agriculture soils

***Shady Selim, A. Klik, A. Mentler, M. Fürhacker*:** Modelling Adsorption – Desorption Kinetics of Glyphosate in Soils

S. Strohmeier: A. Klik, S.K. Nouwakpo: Impact of rill erosion morphology on flow hydraulics using Manning-Strickler equation

Regina Fleischanderl: Soil quality in the Bahariya Oasis (Egypt), with particular focus on soil salinity

Cecilie B. Foldal, Ika Djukic, Ulrike Tappeiner & Georg J. Lair: Organic matter composition in intensively used grasslands along an elevation gradient in the Ötztaler Massiv, South Tyrol, Italy

Magdalena Landl: The concept of the critical water content for hydrophobic soils in New Zealand

T. Peham, A. Matteazzi, J. Rüdisser, U. Tappeiner, E. Tasser, E. Meyer, F. Steiner, B. Schlick-Steiner: Ecometagenetics, Morphology and Biodiversity Indices of Soil Meso- and Microfauna for the Agricultural Area of South Tyrol

A. Wawra, G. Trümper, A. Klik: Short-term Measurements of Soil CO2 Efflux from two Agricultural Sites in Lower Austria

Andreas Schwen, Yang Yang, Riley J. Walton and Ole Wendroth: **A new experimental design overcomes limitations due to spatial soil variability in a field solute leaching experiment**

Presentations of the Kubiena Award Winners of 2012

In situ carbon turnover dynamics and the role of soil microorganisms therein: a climate warming study in an alpine ecosystem

Ika Djukic[1], Franz Zehetner[1], Andrea Watzinger[2], Micha Horacek[2] and Martin H. Gerzabek[1]

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Abstract

Litter decomposition represents one of the largest fluxes in the global terrestrial carbon cycle. The aim of this study was to improve our understanding of the factors governing decomposition in alpine ecosystems and how their responses to changing environmental conditions change over time. Our study area stretches over an elevation gradient of 1000 m on the Hochschwab massif in the Northern Limestone Alps of Austria. We used high-to-low elevation soil translocation to simulate the combined effects of changing climatic conditions, shifting vegetation zones, and altered snow cover regimes. In original and translocated soils, we conducted in situ decomposition experiments with maize litter and studied carbon turnover dynamics as well as temporal response pat- terns of the pathways of carbon during microbial decomposition over a 2-year incubation period.A simulated mean annual soil warming (through down- slope translocation) of 1.5 and 2.7 °C, respectively, resulted in a significantly accelerated turnover of added maize carbon. Changes in substrate quantity and quality in the course of the decomposition appeared to have less influence on the microbial community composition and its substrate utilization than the prevailing environmental/site conditions, to which the microbial community adapted quickly upon change. In general, microbial community composition and function significantly affected substrate decomposition rates only in the later stage of decomposition when the differentiation in substrate use among the microbial groups became more evident. Our study demonstrated that rising temperatures in alpine ecosystems may accelerate decomposition of litter carbon and also lead to a rapid adaptation of the microbial communities to the new environmental conditions.

Agricultural Impacts on Soil Hydraulic Properties: Measurements and Simulations

Andreas Schwen

Institute of Hydraulics and Rural Water Management, University of Natural Resources and Life Sciences Vienna, Austria

Agriculture affects the soil's capability for water infiltration and storage. In the present thesis the agricultural impacts in terms of subsurface compaction and different tillage techniques on the soil hydraulic properties and the underlying pore characteristics were analyzed. In-situ tension infiltrometer measurements were used to quantify changes in the near-saturated hydraulic conductivity, the water-conducting porosity, and inversely estimated parameters of the van Genuchten/Mualem (VGM) water retention model. In the first part of this thesis, infiltration measurements in differently compacted subsoil treatments of a silt loam soil in Lincoln/New Zealand were used to characterize the effects on the soil's porosity and its associated water-conducting properties. A high susceptibility to the applied compaction was found, as the saturated hydraulic conductivity of the heavy compacted soil was 81% less than that of the loosened soil. This soil property may be used as a proxy for compaction-induced changes in hydraulic characteristics. Increasing compaction decreased the number of hydraulically effective macropores, reduced the flow- weighted mean pore radius, and the αVG parameter of the VGM model. In the second part, the impact of different tillage techniques – conventional (CT), reduced (RT), and no-tillage (NT) – and their temporal dynamics on another silt loam soil in Raasdorf/Austria were captured using repeated tension infiltrometer measurements. The results show that the near-saturated hydraulic conductivity was in the order CT > RT > NT, with larger treatment-induced differences in the mesopore range. The VGM model parameter αVG was in the order CT < RT < NT, with high temporal variations under CT and RT. NT resulted in the greatest water-conducting pore radii. The results give indirect evidence that NT leads to a greater connectivity and smaller tortuosity of macropores, and to a better temporal stability. Variations in mesopore-related quantities could be explained sufficiently by an interaction of tillage and time. In the third part, the inversely estimated hydraulic parameters were used to parameterize a soil water simulation for two consecutive seasons. Simulated water dynamics of the near-surface soil with constant and time-variable hydraulic parameters were compared to measured water contents. The use of time-variable hydraulic parameters significantly improved simulation performance for all treatments, resulting in average relative errors below 13 %. The study demonstrates the applicability of inversely estimated hydraulic properties for soil water simulations. The simulated water balance indicated that RT and NT result in a better near-surface water storage than CT. This may increase water efficiency, especially under dryer climatic conditions.

Oral Presentations

Improving phytoextraction efficiency of high-biomass crops using microbial inoculants and organic amendments

Álvarez-López Vanessa[1], Prieto-Fernández Ángeles[1], Becerra-Castro Cristina[1], Rodríguez-Garrido Beatriz[1], Herzig Rolf [2], Puschenreiter Markus[3], Kidd Petra[1]

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Phytoextraction aims to remove trace metals from the soil through their uptake and accumulation by plants. Current phytoextraction practises employ either hyperaccumulators or fast-growing high biomass plants. One of the objectives of the EU FP7 "Greenland" project is to develop biotechnological methods for improving the phytoextraction process; based on the selection of appropriate plant species, soil amendments or microbial inoculants which can affect plant growth or soil metal bioavailability.
Within the framework of the Greenland project we evaluated the effect of soil amendments (compost elaborated from municipal solid wastes) and/or microbial inoculants on the growth and metal accumulation of *Salix caprea* (clone BOKU 01 AT-004) and *Nicotiana tabacum* (*in vitro*-bred clone NBCu10-8). Both have been described as efficient metal phytoextractors (Herzig et al. 2003; Dos Santos Utmazian and Wenzel, 2007). Plants were grown (for 20 weeks) in soil collected from an abandoned Pb/Zn-mine. Soils (<8 mm) were amended with or without compost (5% w/w) and inoculated with 5 bacterial strains isolated from the rhizosphere soil of metal-tolerant plants growing in the same mine. Isolates were selected according to phenotype (metal-tolerance, ability to mobilise soil metals or plant growth promoting traits), and identified as members of the genera *Pseudomonas* sp. (P29), *Rhodococcus* sp. (P30), *Streptomyces* sp. (P64), *Tsukamurella* sp. (P75) and *Massilia* sp. (P87). The effects of inoculants (alone or in combination with compost) on biomass production, plant photosynthetic efficiency and metal extraction (Cd, Pb, Zn), and changes in soil metal labile pools, will be discussed.

Dos Santos Utmazian, MN and Wenzel, W (2007) J Plant Nutr. Soil Sci. 170: 265-272.
Herzig, R et al. (2003) In: Phytoremediation Inventory: COST Action 837 View. Eds.: Vanek T, Schwitzguébel JP, COST 837

Rhizosphere bacterial communities of Cd and Zn accumulating *Salix*

Katharina Fallmann[1,2], Melanie Kuffner[1], Brigitte Hai[3], Michael Schloter[3], Thomas Rattei[4], Dmitrij Turaev[4], Markus Puschenreiter[2], and Angela Sessitsch[1]

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[4] University of Vienna, Department of Computational Systems Biology, Vienna, Austria

Soil pollution with heavy metals limits the usability of land for agriculture and other purposes. Phytoextraction, which is the removal of heavy metals from soil via uptake by certain accumulator plants, such as *Salix* species, can be used as a gentle, cost-saving technique for soil remediation but currently suffers from the long time that is required for the process. Bacteria are known to affect the uptake rates in plants but little is understood about the mechanisms involved.

We studied bacterial rhizosphere communities of eight *Salix* clones known to have different potential to accumulate Cd and Zn in their leaves, with four clones *S. smithiana,* which is particularly promising for phytoextraction, and one clone each of *S. babylonica, S. fragilis, S. matsudana x alba*, and *S. purpurea*. Cuttings were grown in pots with fresh soil from a contaminated site in Arnoldstein, Carinthia, and the concentration of Cd and Zn in the leaves was analysed. Mixed bacterial DNA was isolated from the rhizosphere of each plant, and a 250 nucleotide long fragment of the 16S rRNA gene, which is present in all bacteria but varies between different taxa, was pyrosequenced. 3598 high quality DNA sequences per sample were used for statistical comparison of the bacterial community in the rhizosphere.

Both the type of *Salix* clone and the foliar Cd concentrations were found to be linked to the bacterial richness in the rhizosphere, such that high Cd concentrations respectively two *S. smithiana* clones were connected with low richness. The rhizosphere community structure was significantly shaped by the type of *Salix*, with the four *S. smithiana* clones forming a distinct group. 68 bacterial groups were shown to be significant indicators of *S. smithiana* rhizosphere.

Our results show that despite their close relationship, trees of the same species can harbour bacterial rhizosphere communities which significantly differ in taxa richness and community structure, and that *Salix* plants with different foliar Cd concentrations also differ with regard to rhizosphere bacteria. The analysis of specific bacterial groups which preferentially occurred in the rhizosphere of *S. smithiana* provides a shortlist of bacteria to be studied in more detail concerning their possible role in bioavailability, uptake and translocation of heavy metals to the leaves of *Salix*, which can help to develop new technologies using soil bacteria to enhance the phytoextraction process.

Elemental sulphur oxidation and heavy metal bioavailability in the rhizosphere of *Salix smithiana*

Christoph Höfer, Markus Puschenreiter, Jakob Santner, Walter W. Wenzel

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Phytoextraction is a soft soil remediation technique. The purpose is to transfer trace metals from the soils matrix to plant shoot tissues by the interaction of plants roots and microbial communities in the rhizosphere. The efficiency of phytoextraction depends on (1) metal concentrations in the shoots, and (2) biomass production. The metal concentration in the harvestable biomass is strongly influenced by the plant's ability to accumulate and tolerate high metal concentrations, but also on the availability in the rhizosphere. Soil amendments and rhizosphere processes can increase trace metal bioavailability and flux in the soil. In previous studies, chelating agents (e.g. EDTA) or soil acidification were used to enhance phytoextraction.

Here, we investigated the effect of elemental sulphur on trace metal availability in the rhizosphere of *S. smithiana* in a moderately Zn and Cd contaminated soil from Arnoldstein, Austria. Chemical and microbial sulphur oxidation acidifies the soil locally and lowers the soil solution pH, which leads to metal solubilisation. The focus was to investigate potential co-dissolution processes and solubilization mechanisms triggered by amending sulphur.

To study these processes, a rhizobox experiment was conducted for 61 days to continuously measure pH change in the soil solution, soluble metals and anions using ICP-MS and IC. The willows were harvested, separated in roots, shoots and leaves and analyzed for total concentrations using ICP-MS. A Ca(NO3)2 extraction of metals in bulk soil and rhizosphere compartments was done to assess the influence of rhizosphere processes on bioavailable metal fractions.

Additionally in a rhizotron experiment a 2D in-situ application of the DGT (diffuse gradients in thin films) technique was performed. The spatial distribution of available sulphide and trace metals was assessed using AgI and Chelex gels in a combined approach and analyzed using laser ablation ICPMS. Simultaneously, 2D chemical imaging of O2 and pH distribution was obtained and visualized using planar optodes.

First results show an average pH decrease of 1.5 units in the sulphur treatment, whereas Mn, Fe, Zn, Cd solubility strongly increased compared to the control. Rhizosphere processes and microbial community composition may play a key role for possible metal co-dissolution or precipitation. At this point of research, data analysis and the rhizotron experiment are still in progress.

Fate of phytosiderophores in the rhizosphere

Eva Oburger[1], Barbara Gruber[1], Yvonne Schindelegger[2], Walter Schenkeveldt[3], Stephan Hann[2], Stephan Krämer[3], Markus Puschenreiter[1]

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Phytosiderophores (PS) are extremely efficient Fe-mobilising root exudate compounds which are released by grass species only (Strategy II). Surprisingly, detailed information on their concentration, activity and fate in the rhizosphere is still largely incomplete, since the vast majority of PS studies were conducted in hydroponic conditions. In an ongoing FWF project (P22798-B16) we are working on closing this knowledge gap looking at the fate and function of deoxymugineic acid (DMA), the major phytosiderophore released by wheat.

Due to recent advances in analytical techniques we were able to measure DMA *in-situ* in the rhizosphere of wheat (*Triticum aestivum* cv Tamaro) growing on Fe deficient soils. DMA concentrations in the rhizosphere soil solution ranged from 0.1 to 1.5 µM depending on the different soils.

Using rhizoboxes combined with a novel root exudate collecting tool, we were also able to measure *in-situ* DMA exudation rates from soil grown wheat for the first time. Average DMA release by soil grown wheat roots was 1.8 nmol DMA g^{-1} root dwt.s^{-1}, which is about a factor 100 lower than PS exudation rates reported in the literature obtained under hydroponic growth conditions and zero Fe supply.

Synthetically ^{13}C enriched DMA was applied to bulk and rhizosphere soil, freshly sampled from rhizoboxes at a high spatial resolution (1 mm) and monitored for changes in the $\delta^{13}C/^{12}C$ signature of the evolved CO_2 for 7 days. Result clearly show a faster microbial response to the added ^{13}C-DMA with increasing distance to the root surface, indicating a customization effect of the microbial community in the close vicinity of the root. To the best of our knowledge, this is the first study investigating the microbial breakdown of PS in soil.

Soil bacterial growth and nutrient limitation along a chronosequence from a glacier forefield

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Resource availability and limiting factors for bacterial growth during early stages of soil development (8-138 years) were studied along a chronosequence fromthe glacial forefieldof the Damma glacier in the Swiss Alps. We determined bacterial growth (leucine incorporation) and we investigated which factor (C, N or P) limited bacterial growthin soils formed by the retreating glacier. The latter was determined by adding labile sources of C (glucose), N and P to soil samples and then measuring the bacterial growth response after a 40 h incubation period. Bacterial growth increased with increasing soil age in parallel with the build up of organic matter. However, lower bacterial growth, when standardized to the amount of organic C, was found with time since the glacier retreat, indicating decreasing availability of soil organic matter with soil age. Bacterial growth in older soils was limited by the lack of C.The bacteria were never found to be limited by only N, only P, or N+P. In the youngest soils, however,neither the addition of C, N nor P singly increased bacterial growth, while a combination of C and N did.Bacterial growth was relatively more limited by lack of N than P when the C limitation was alleviated, suggesting that N was the secondary limiting resource. The availability of N for bacterial growth increased with time, as seen by an increased bacterial growth response after adding only C in older soils. This study demonstrated that bacterial growth measurements can be used not only to indicate direct growth effects, but also as a rapid method to indicate changes in bacterial availability of nutrients during soil development.

Dynamics of organic nitrogen in cryoturbated Arctic soils

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Arctic soils are estimated to store about twice the amount of carbon as today's atmosphere, with a large proportion of this C in subsoil horizons. Within the subsoil, cryoturbated organic matter (OM), i.e. OM buried by freeze-thaw processes, represents a large store of poorly decomposed material. Although soil organic matter (SOM) decomposition is known to be affected by nitrogen status of the microbial biomass, knowledge about N dynamics and N availability in the subsoil of arctic soils is particularly scarce.

We here report on microbial transformations of organic N, i.e. protein/peptide depolymerization (the rate limiting step for the soil N cycle), microbial amino acid uptake and N mineralization. We hypothesized that gross rates of N transformations would decrease with increasing SOM decomposition, while N availability would increase as a consequence of decreasing C/N ratio. We sampled topsoil (organic), cryoturbated and subsoil horizons of tundra sites in Greenland and Siberia, and applied a set of ^{15}N pool dilution assays to measure gross rates of protein depolymerization, microbial amino acid uptake and N mineralization. From these assays we also calculated microbial N use efficiency (NUE), i.e. the efficiency of microorganisms to incorporate organic N into the biomass, as an indicator of N availability for microorganisms. Furthermore, we investigated the effect of easily available organic C and N sources on soil microbial processes: We incubated soils amended with ^{13}C labelled amino acids, protein, glucose and cellulose, and measured C and N mineralization rates as well as microbial community composition and potential activities of extracellular enzymes.

We found that all gross N transformation rates decreased significantly from topsoil organic over cryoturbated to subsoil mineral horizons. While the differences between topsoil organic and subsoil mineral horizons were sufficiently explained by SOM content, cryoturbated horizons had significantly lower rates even when calculated on a carbon basis. NUE was generally high, did not differ significantly between horizons, and was not correlated to the C/N ratio of SOM, suggesting that N limitation for microorganisms was similar across the soil profile. The addition of organic N (amino acids and protein), however, resulted in a two-fold increase in SOM mineralization in cryoturbated horizons, while the addition of organic C only (glucose and cellulose) had no effect. Taken together, our results suggest that an increased N availability in cryoturbated horizons might lead to an increase in SOM decomposition by altering the function of the microbial decomposer community. Increasing SOM decomposition in turn is likely to increase N availability for microbes, which may lead to a positive feedback on SOM decomposition.

Potential enzyme activities in cryoturbated organic matter of arctic soils

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An estimated 581 Gt organic carbon is stored in arctic soils that are affected by cryoturbtion, more than in today's atmosphere (450 Gt). The high amount of organic carbon is, amongst other factors, due to topsoil organic matter (OM) that has been subducted by freeze-thaw processes. This cryoturbated OM is usually hundreds to thousands of years old, while the chemical composition remains largely unaltered. It has therefore been suggested, that the retarded decomposition rates cannot be explained by unfavourable abiotic conditions in deeper soil layers alone. Since decomposition of soil organic material is dependent on extracellular enzymes, we measured potential and actual extracellular enzyme activities in organic topsoil, mineral subsoil and cryoturbated material from three different tundra sites, in Zackenberg (Greenland) and Cherskii (North-East Siberia). In addition we analysed the microbial community structure by PLFAs.

Hydrolytic enzyme activities, calculated on a per gram dry mass basis, were higher in organic topsoil horizons than in cryoturbated horizons, which in turn were higher than in mineral horizons. When calculated on per gram carbon basis, the activity of the carbon acquiring enzyme exoglucanase was not significantly different between cryoturbated and topsoil organic horizons in any of the three sites. Oxidative enzymes, i.e. phenoloxidase and peroxidase, responsible for degradation of complex organic substances, showed higher activities in topsoil organic and cryoturbated horizons than in mineral horizons, when calculated per gram dry mass. Specific activities (per g C) however were highest in mineral horizons. We also measured actual cellulase activities (by inhibiting microbial uptake of products and without substrate addition): calculated per g C, the activities were up to ten times as high in organic topsoil compared to cryoturbated and mineral horizons, the latter not being significantly different.

The total amount of PLFAs, as a proxy for microbial biomass, was significantly higher in topsoil organic horizons than in cryoturbated and mineral horizons. Changes in the microbial community composition were mainly caused by the relative amount of fungal biomarkers. Within the fungal community the biomarker 18:2w6, which is often associated with ectomycorrhiza, was negatively correlated to the general fungal biomarker 18:1w9. This negative correlation indicates a shift from mycorrhizal to saprotrophic fungi from topsoil towards cryoturbatad and mineral subsoil horizons.

In summary, the measured oxidative and hydrolytic (potential) enzyme activities cannot explain the previously observed retarded decomposition in cryoturbated horizons. The measured actual cellulase activity however was strongly reduced in cryoturbated material compared to topsoil horizons. A possible explanation for the observed strong reduction of actual cellulase activity could lie within the fungal community structure which shifted towards saprotrophic fungi from topsoil to cryoturbated horizons.

Diffusive gradients in thin films – a versatile tool for phosphorus sampling, testing, and chemical imaging in soils

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Many methods for sampling soluble P fractions in soils are hampered by the lack of specificity in targeting 'labile' or 'plant-available' soil P fractions. As a result a wide variety of extraction procedures and other methods (e.g. resin strips) have been developed. Diffusive gradients in thin films (DGT) is a solute sampling technique that operates by establishing a steady diffusive flux into the sampling setup, much like the way plants take up P from soil. The high correlation of DGT-P with plant biomass production and yield, especially under deficient conditions, is largely owed to this similarity. Important properties of the technique include its suitability for localised sampling at a spatial resolution of ~ 100 µm and the *in situ* analyte pre-concentration which can be a crucial feature for the analysis of very low concentrations.

Applications of DGT in soil research include the estimation of P bioavailability, usually as P-index. Our recent work however evaluates a DGT-based extraction procedure for the quantitative measurement of the plant-available P pool and the measurement of P-desorption kinetics from soil under zero-sink conditions. Furthermore, two-dimensional chemical imaging of P in the vicinity of plant roots is currently being extended to a multi-element technique that can be combined with planar optode imaging methods. More recently, commercial DGT applications are emerging such as the calibration of DGT as an agricultural soil P test in Australia.

Crowdsourcing method for soil science for the future: Tea Bag Index for decomposition

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Can drinking tea help us understand climate change? Yes. Teabags can provide vital information on the global carboncycle, if we study their decomposition in soils.Terrestrial soils contain three times more carbon than the atmosphere and therefore changes in the balance of soil carbon storage and release can significantly amplify or attenuate global warming.Climate predictions of today are strongly hampered by data limitation and consistency due to varying methodology and high costs of gaining global data with sufficient coverage. Many factors affecting the global carbon cycle are already known and archived; however, an index for decomposition rate is still missing.
We developed a cost-effective and standardised method to gather data globally on decomposition rate and carbon stabilisation; by using commercially available teabags as standardised test-kits for simplifiedlitter bag experiments. The so acquired Tea Bag Index (TBI) provides process-driven information on soil functions at local, regional and global scales essential for future climate modelling; and it is sensitive enough to discriminate data between different ecosystems and soil types. TBI requires only little means and knowledge, making data collection by crowdsourcing (i.e. volunteer-assisted data collection by means of Internet applications) possible. Engaging the general public and especially schools as co-researchers will in turn increase awareness of soils and provide essential development in including soils more frequently into the natural sciences and environmental classes at schools. The numerous data points collected will allow for a great leap forward in understanding and modelling the global carbon cycle.

Effects of Forest Disturbance on the Dynamics of Soil Respiration

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Stand replacing disturbances such as windthrow or bark beetle infestations are supposed to have significant impacts on the soil CO_2 efflux rates (soil respiration) of forest ecosystems by changing particular driving parameters and constituents. An absence of a shading tree layer results in increased soil temperatures as well as in a change of the soil moisture regime. Carbon mineralization is enhanced, carbon dioxide derived from tree roots and associated mycorrhizal fungi is however mostly suppressed. At forest sites of the Northern Calcareous Alps, where shallow organic soils above bedrock (*Folic Histosols* and *Rendzic Leptosols*) are dominating, it is conceivable that an increase in mineralization rates will contribute to drastic humus losses and thus to serious site degradations. The present study tries to reveal the effects of forest disturbance on the dynamics of soil respiration of a mixed spruce-beech-fir forest located in the Northern Calcareous Alps of Upper Austria.

We measured soil respiration, soil temperature and soil moisture at two sites which were blown down in 2007 and 2009 respectively, as well as in an adjacent mature mixed forest. Measurements were taken in a biweekly to monthly interval during the vegetation periods of 2010, 2011 and 2012.

Soil respiration rates were mainly driven by soil temperature, but soil moisture had a significant influence as additional driver. After computing standardized soil respiration rates at 10° C temperature (R_{10} rates) valuable insights into seasonal and inter annual efflux fluctuations could be demonstrated. Higher R_{10} rates were found in the mature stand compared to the disturbed sites. At the disturbed sites inter annual declines in soil respiration were ascertained especially at locations with organic soil types. Our findings support the hypotheses that carbon mineralization can contribute to augmented losses in soil organic carbon after a forest disturbance regime. Organic humus soils tend to be particularly vulnerable.

This study is part of the INTERREG Bayern-Österreich 2007 -2013 project ‘SicAlp – Standortssicherung im Kalkalpin’ which is funded by the European Regional Development Fund (ERDF) and national funding.

The Climate Relevance of Subalpine Soils: The Effect of Fertilisation, Temperature and Water content on Methane Production and Methane Consumption

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Methane is, besides CO_2, the most important greenhouse gas. Net methane emissions by soils are the result of various methanogenic and methanotrophic activities. In many soils, methane is produced in appreciable amounts but the vast majority of it is reoxidised on site. The factors influencing methane production and methane consumption are still unclear, although these mechanisms are of considerable global interest.

The present study used an abandoned soil from the subalpine altitudinal belt near the Kaserstattalm in Stubaital Valley/Tyrol (47°07´N, 11°19´E). In order to investigate the influences of temperature, fertilisation and water content on methane production and methane consumption, the soil samples were incubated in 5-L pot scale at two different temperatures (5° C or 10° C), with or without fertilisation (1% cow dung) and at two water regimes (water saturated or field moisture).

In our investigations, we could prove the presence of methanogenic *Archaea* and methanotrophic *Bacteria* in subalpine soils. Despite the natural conditions that were simulated, the study clearly showed that considerable differences in methane production and methane consumption existed between the respective variations. Methane production and consumption were clearly influenced by incubation temperature and water regime. Although an "upscaling" from laboratory results to outdoor conditions is not appropriate, the results show interesting impacts on the methane cycle in subalpine soils.

Morphological, anatomical and physiological plasticity of Citrus root systems under NaCl stress

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Knowledge about the root system architecture and the uptake efficiency of root systems is critical to understand the adaptive plasticity of plants towards stress. This study is describing the morphological, anatomical and physiological plasticity of *Citrus* rootstocks under severe NaCl stress.

Four year-old *Citrus volkameriana*rootstocks were grown either under control or 90 mM NaCl treatment for six month in aerated, temperature-controlled hydroponics; allowing for homogeneous growth conditions. We compared *in situ* water flux rates, root anatomy and morphology, and root architecture (i.e. branching frequency)between control and salt-stressed plantson the level of root orders (i.e. branching hierarchy). The recovery of water uptake after short-term salt stress release was measured on the salt-stressed plants.

Morphological and anatomical root traits known to influence water uptake, e.g. branchingfrequency, specific root area, cortical thickness and xylem traits, did not change homogeneously throughout the root system but changes under stress were root order-specific. Cl^- accumulation significantly increased with decreasing root order. Water flux densities of first order roots (i.e. root tips) decreased to <20% under salinity and did not recover after stress release. The water flux densities of higher root orders changed marginally under salinity and increased two to six-fold in second and third root orders after short-term stress release.

Changes in root order frequency, morphology and anatomy indicate rapid (< 6 month) and major modification of *Citrus volkameriana* root systems under excess salinity. Reduced water uptake under salinity was related to changes of water flux densities among root orders and to reduced root surface areas. The importance of root orders for water uptake changed under salinity from root tips towards higher root orders. The root order-specific changes reflect differences in vulnerability (indicated by the salt accumulation) and ontogenetic status and point to functional differences among root orders under stress such as excess salinity. The implications of these findings for wateruptake models and future breeding efforts will be discussed.

Proteins in soil and adsorption characteristics of proteins to soil-biocharcombinations

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Soil metaproteomics is a new molecular approach with the potential to study the diversity of environmental microbial communities in very high resolution. However, it is still a challenge to handle different soil types and soil amendments (e.g. biochar, compost) as their physical and chemical properties varystrongly especially in terms of heterogeneity and adsorption characteristics. In a preliminary study for a metaproteomics approach in soil-biochar combinations, we determined the adsorption equilibrium capacity of an adsorbent containing only one simple protein (bovine serum albumin BSA). So far there are no experimental adsorption equilibrium isotherms available for soil-biochar combinations with BSA. The main objective of this study was the evaluation of BSA adsorption from aqueous solutions onto 6 types of soil-biochar combinations. These biochar materials were derived from different livestock, namely wood chips (WC), vineyard pruning (VP) and straw (S), and varied in concentration (1% and 3% added to soil, respectively)and hydrothermal treatment (pyrolysis temperature T1=400°C; T2=525°C). It was noticed that biochar causes a liming effect and decreases protein adsorption capacity. The adsorption results for the five materials follow the order: soil> VP3%T2> S3%> VP3%T1 ~ WC3%> WC1%. In order to study the adsorption equilibrium, three isotherms were used, the linear, the Freundlich and the Langmuir isotherm. According to the results, the adsorption system was best described by the Langmuirisotherm.

To further develop this method this enables to recover several functions important for providing nutrients and energy to microbes thatcan be quantitatively be assigned to the level of microbial species. In a previous study, a comparison of four different extraction protocols to extract proteins from soil was evaluated. These extraction procedures were applied to a forest and a potting soil. A metaproteomics approach - unique spectral countingcombined with two-dimensional liquid chromatography/tandem mass spectrometry (2D-LC-MS/MS SDS) - was employed to investigate the soil microbial community structure and function. The microbial community in both soil types was dominated by bacteria, whereby Proteobacteria prevailed. The procedure proved suitable for the functional analysis of the metaproteome of potting soil as well as forest soil. This new technique of soil metaproteomics should be applied more frequently in soil sciences in the future, to this end we intend to further improve the methodological issue which includes some challenges dealing with soil-biochar combination, with the advantage that microbial structure and function provides a powerful tool for future assessment of soil quality and degradation.

Biochar application to soil – results from an interdisciplinary Austrian project

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Biochar (BC) results from the thermal decomposition of biomass under anoxic conditions (pyrolysis). Due to its high stability and recalcitrance BC application to soil is currently investigated as a climate mitigation strategy. In addition, BC features some unique characteristics such as high pH and porosity, high specific surface area, cation exchange capacity (CEC) and nutrient contents that can be manipulated by the choice of feedstock and pyrolysis conditions such as the highest treatment temperature (HTT). BC application to soil may thus contribute to soil fertility and environmental quality by adding nutrients to the soil as well as by increasing pH, CEC, water holding capacity and contaminant retention. Benefits of BC application on soil nutrient status and plant growth were found in the Amazonian Terra Preta soils; however, detailed information on agricultural soils in temperate regions is scarce.

The Austrian project "Biochar for Carbon Sequestration in Soils: Analysis of production, biological effects in the soil and economics" started in spring 2010 and investigates the effects of BC application to temperate soils. The project includes extensive BC characterization using different feedstocks and pyrolysis temperatures. Based on those results, a large-scale pot experiment and two field experiments were implemented to investigate the effects of BC application to soil on three different agricultural soils from Lower Austria and Styria (Planosol, Chernozem, Cambisol). Soil nutrient status, crop yield and elemental composition were investigated at defined intervals.

Individual treatments were additionally subjected to heavy metal (Cd, Cu) adsorption experiments. Also, a long-term incubation experiment using 13C labeled BC has been started to examine BC decomposition at two different temperatures.

Selected results of the different sub-studies will be presented, which show that beneficial effects of BC application on soil nutrient status, nitrate and heavy metal retention were immediately found. However, positive effects of BC application on crop yield were only found in the longer term and were mainly dependent on the type of feedstock. This discrepancy will be discussed and shows that there is a promising potential for BC application to temperate soils but also that we are only at the beginning of interdisciplinary BC research.

The effects of biochar application on greenhouse gas emissions from agricultural soils

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The application of biochar to soils is a promising technology to mitigate the greenhouse gas carbon dioxide (CO_2) by increasing long-term soil carbon sequestration. Biochars are the remaining residues when organic matters like wood chips and straw have been pyrolysed.

This work is part of the project "Biochar for carbon sequestration in soils: Analysis of production, biological effects in the soil and economics" which raises data to evaluate the effects of biochar application in an agricultural context. To evaluate the soil-atmosphere flux CO_2 emission, but also potent non-CO_2 greenhouse gases such as methane (CH_4) and nitrous oxide (N_2O) have to be considered.

In a pot experiment we carried out a monthly measurement of these three gases over several stages of the plant development using the closed chamber technique. The 25 different treatments varied in soil type, in biochar application rate (0%, 1%, 3% [w/w]), in biochar origin and pyrolysis temperature (vineyard pruning 400°C and 525°C, wheat straw 525°C, woodchips mixture 525°C), in N fertilization rate and vegetation (barley, mustard, red clover, no vegetation). Furthermore we analysed NO_3^- , NH_4^+ concentration and N in the microbial biomass (N_{mic}) of the soils. Our hypothesis was that biochar-treated and non-treated soils would show significant differences.

Especially at the beginning of the experiment, when barley and mustard were grown, a reduction of CO_2 and N_2O emissions could be measured at biochar treated pots. Considering the whole experiment a 3% biochar application rate and biochar produced at 525°C (pyrolysis temperature) led to a higher reduction. CH_4 emissions could not be reduced with biochar.

The soil water content had an influence on CO_2 emissions when red clover was grown. The NO_3^- contents also varied significantly between biochar and non-biochar treated pots. Significant differences of N_{mic} were detected at this time in pots varying in different fertiliser application rates.

Biochar arrests soil organic nitrogen cycling

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Ancient Amazonian soil practices of nurturing Terra Preta through the addition of charcoal to soil and its modern equivalent, biochar production followed by soil incorporation, could provide humanity carbon farming solutions to global climate change and escalating food demand. There is evidence to suggest that biochar amendment causes fundamental changes in soil nutrient cycles, often resulting in marked increases in crop production, particularly in infertile tropical soils with low soil organic matter contents (*1, 2*). We offer insight into the mechanisms underpinning these observations by focusing attention on the soil nitrogen (N) cycle, specifically on hitherto unmeasured processes of organic N cycling in both tropical and temperate arable soils.

The impacts of biochar addition on gross rates of production and consumption of organic and inorganic N were measured via a novel toolbox of isotope pool dilution assays.

Biochar reduced soil organic nitrogen (SON) dynamics by ~ 90 % but accelerated gross nitrification rates more than three-fold in both soils. These findings indicate a de-coupling of the intrinsic organic and inorganic soil N cycles. We invoke a “mesopore protection hypothesis” (*3*) to explain the retardation of SON cycling. It suggests that SON is adsorbed into mesopores which are highly abundant in biochar (*4*) and this occlusion hinders decomposition by exclusion of degrading enzymes (*3*).

The large surface area of macropores in biochar could provide soil microbes, e. g. ammonia-oxidizers, with favorable microhabitats through the protection against grazers or competitors and the co-location of nutrients and increased soil water retention (*4*). This and alterations in local microsite pH (+1 pH unit) due to the liming effect of biochar in the acidic Kenyan soils, might explain the increases in nitrification rates observed. The proposed mechanisms are also reflected in the soil N status, with significant reductions in low-molecular weight organic N and significant increases in nitrate, notably in the tropical soils.

Impediment of SON cycling ultimately leads to the dichotomy of two intertwined agronomic processes; the build-up of SON and the slowing-down of inorganic N release from SON essential for crop growth. Addition of fertilizer-N in combination with biochar effectively decouples these processes, with plants and microbes drawing on fertilizer-N for growth, in turn fuelling the belowground build-up of SON. SON and particularly refractory soil organic matter are peptide dominated materials (*5*). The accumulation of SON therefore is expected to enhance soil carbon sequestration due to non-biochar derived soil organic matter.

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Poster presentations

Diffusive gradients in thin films (DGT) as a method for chemical imaging of solute dynamics in soils

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Solute dynamics in the vicinity of plant roots are highly complex due to solute uptake, efflux and the active foraging of roots for nutrients by releasing e.g. protons or carboxylate anions. The distribution of solutes is therefore highly variable at the micro scale. Data on the distribution of solutes in the root zone at sub-mm spatial resolution can therefore substantially progress our understanding of nutrient and contaminant cycling in the rhizosphere.

Diffusive gradients in thin films (DGT) is increasingly used as a quantitative method for the estimation of bioavailable nutrient and contaminant concentrations. Combined with laser ablation - ICPMS it also allows for the two-dimensional visualisation of labile element concentrations in the rhizosphere, but also at other hotspots of solute dynamics in soils.

This poster presents our ongoing development of a DGT gel capable of simultaneous chemical imaging of anions and cations of elements involved in the P nutrition of plants (P, Fe, Al, Ca). The potential combination with another highly resolving chemical imaging method, planar optodes, is discussed as well.

Role of plant growth promoting bacteria and soil amendments in phytoremediation of heavy metal contaminated sites

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On a global basis, soil contamination with cadmium, lead, and zinc is one of the most pervasive environmental problems. In the surroundings of a former Pb/Zn smelter in Arnoldstein (Austria) heavy metal concentrations exceed thresholds for food and feedstuffs. Phytoremediation (in our case the combination of immobilization and phytoexclusion) could be a cost-effective system for improvement of the use of contaminated areas. The aim was to study the effects of plant growth-promoting bacteria (PGPB) and immobilizing soil amendments on heavy metal tolerance of plant and uptake. Pot experiments were performed whereby two maize cultivars were cultivated in varying contaminated soil and treatments (*Burkholderia phytofirmans* strain PsJN with and without amendment). Inoculation with strain PsJN significantly improved the root and shoot biomass of maize. Rhizosphere and leaves were analyzed for heavy metal content. Results indicated that immobilizing amendments had significant effects on the reduction of ammonium nitrate extractable Zn (< 80%) and Pb (<50%) compared to the controls. Concentration of Zn and Pb in plants was reduced by combined immobilizer and PGPB up to 65% and 40%, respectively. Three different media allowed the selection of 500 isolates based on colony morphology from contaminated soil and plants. For characterization of bacteria, 16S rDNA genes were sequenced from the isolates and the plant growth-promoting potential was analysed by screening for the production of 1-aminocyclopropane-1-carboxylic acid deaminase, siderophores and indole acetic acid. Selected strains will be further tested for heavy metal mobilization and plant growth-promoting effects in interaction with the plant.

Keywords: Immobilization, Phytoremediation, Treatment, Heavy metals, 16S rDNA

Influence of wetting-drying cycles on soil hydraulic properties

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Hydraulic properties underlie significant temporal variability. Wetting-drying cycles are known as important driving forces of soil structure formation and therefore affect soil hydraulic properties particularly in the macropore range. However there are only few studies that try to address this relation under field conditions.

Our study presents results from a three year field experiment on factors that influence temporal variability of soil hydraulic properties. We present an approach to quantify wetting-drying cycles from field water content measurement time series via spectral analysis und show the relation of temporal changes in soil hydraulic parameters with wetting-drying behavior. Our objective is to develop a dynamic modeling approach for temporally changing hydraulic parameters driven by wetting-drying cycles.

Drought induced changes of plant belowground carbon allocation affect microbial community function in a subalpine meadow soil

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Climate projections suggestmore frequent heat waves accompanied by extreme drought periods in many parts of Europe, including the Alps. Drought is considered to decreaseplant C uptake and turnover, which may in turn decrease belowground C allocation and potentially has significant consequences for microbial community composition and functioning. However, information on effects of drought on C dynamics at the plant-soil interface in real ecosystems is still scarce.

Our studyaimed at understanding how summer drought affectssoil microbial community composition and the uptake of recently assimilated plant C by different microbial groups ingrassland.We hypothesized that under drought 1) the microbial community shifts, fungi being less affected than bacteria, 2) plants decrease belowground C allocation, which further reduces C transfer to soil microbes and 3) the combined effects of belowground C allocation, reduced soil C transport due to reduced soil moisture and shift in microbial communities cause an accumulation of extractable organic C in the soil. Our study was conducted as part of a rain-exclusion experiment in a subalpine meadow in the Austrian Central Alps.After eight weeks of rain exclusion we pulse labelleddrought and control plots with $^{13}CO_2$ and traced C inplant biomass, extractable organic C (EOC) and soil microbial communities using phospholipid fatty acids (PLFAs).Drought induced a shift of the microbial community composition:gram-positive bacteria became more dominant, whereas gram-negative bacteria and fungi were not affected by drought. While total microbial biomass (as estimated by total microbial PLFA content) dramatically increased during drought, less ^{13}C was taken up, most pronounced for bacterial marker, than in controls. Interestingly, fungal PLFAs incorporated almost the same amount of ^{13}C in drought as control plots.Finally, drought led to an accumulation of EOC in the soil and to a higher amount of ^{13}C in EOC. This reflects a decreased connectivity in the soil, thus reducing the availability of plant derived C especially for bacteria.

Inconclusion, our results suggest that in mountain grassland drought 1) affects microbial community structure, favouring fungal over bacterial communities, 2) reduces C transfer to bacterial communities more strongly than to fungal communities, and 3) leads to an accumulation of extractable organic C in the soil, whichis most likely driven by a microbial die-off and by reduced diffusion of available C to microbes.

Secondary metabolites in plant associated Bacilli

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The bacterial genus Bacillus comprises important plant associated strains and is utilized in biocontrol of plant diseases and for plant growth promotion. Lipopeptides and polyketides are considered as crucial components in these activities as they act as antifungal and antibacterial metabolites, but these secondary metabolites also have been shown to stimulate plant defense and play a role in root colonization and biofilm formation.

We have been utilizing and establishing PCR-based selection methods for the detection of metabolic clusters in collections of endophytic Bacilli, related Firmicutes and in environmental DNA (in metagenomic libraries). The aim of the screening is to characterize the role of these secondary metabolites in beneficial plant-bacteria interactions, to evaluate the potential of PCR based screening methods in detecting so-far uncharacterized secondary metabolite clusters, to estimate the success rate in detecting potential plant beneficial bacteria by PCR screens and to evaluate the reservoir of so far uncultivated Firmicutes to produce lipopeptides and polyketides.

The Effect of Iron Deficiency on Metal Bioavailability in Wheat Rhizosphere

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Graminaceous plant species overcome Fe deficiency by the release of non-proteinaceous amino acids, so called phytosiderophores (PS), which have a high affinity to chelate Fe. Additionally, the release of PS may have an effect on the bioavailability of other heavy metals present in soil. The objectives of this work were to examine if Fe deficiency and thus potentially enhanced PS exudation rates, increase the solubility and bioavailability of heavy metals (Ni, Cu, Zn, Cd, Pb) and if PS exudation rates are affected by soil metal concentrations. Therefore, wheat (*Triticum aestivum* cv. Tamaro) was grown according to a rhizotest designed by Chaignon and Hinsinger (2003). In the hydroponic stage Fe or no Fe was supplied to the seedlings. After 2 weeks, the roots of the wheat plants were exposed to 4 contaminated soils with varying contamination levels and pH values. Fe deficient plants mobilised overall more Cu, Zn and Ni (in the Ni contaminated soil), which was likely due to increased PS exudation. These results are however not corresponding to the initial DTPA-available concentration of the contaminants. The highest effect of mobilisation was observed in soil with medium pH around 6.5.

Influence of charcoal application on the near-surface soil-water regime of an arable land in Weitersfeld/NÖ.

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The application of charcoal on arable land can be a possibility to sequestrate carbon and enhance soil characteristics. This is known from tropical “terra preta” soils, but there is less knowledge about the impact of charcoal on soil properties in temperate regions. This study investigates the influence of the application of charcoal on some parameters of the soil-water regime. Therefore,an agricultural area in themunicipalityWeitersfeld/ NÖwas chosen, where two different types of charcoal were applied in December 2012. One type of charcoal was composted with manure and lost its hydrophobic characteristics; the second type of charcoal is still hydrophobic.For the characterization of changes in the soil- water regimethrough the charcoal amendments, some parameters had been selected: soil-hydraulic conductivity, water- retention characteristics, aggregate stability and total organic carbon. Soil samples were taken from the two plots and had been analyzed. The computing and assessment of the analysis results haven’t been finished yet and therefore can’t be mentioned in the abstract;but the outcome will then be presented in the poster.

Calculating the humus- and nitrogen-balances of different agricultural systems in Austria

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About 8.8 % (UBA, 2010) of the total greenhouse gas (GHG) emissions in Austria are caused by agricultural practices. Besides the release of climate relevant gases C-sequestration occurs depending on the natural conditions and farming system and can partially counterbalance GHG emissions.

Main focus of the HUMUS-project was to describe the GHG-emissions and sinks of the most relevant farming types, organic and conventional, within the main production areas of Austria.

Based on the input data model-farms were created with the programme REPRO (Küstermann et al. 2008). Forage production, cash crop, animal husbandry and permanent crop systems were considered. As expected the results showed differences between and within the considered systems.

The humus-balance was calculated (HE-method dynamic, Hülsbergen et al. 2000) for each farming system. All had positive results, ranging from optimum to very high, and sequestered carbon in the soil, especially in forage production systems. However, this may lead to a reduced N-efficiency and N-losses.

Furthermore the N-balance was calculated and due to the use of mineral fertilizers a higher N balance occurred in all conventional systems. Organic systems on the other hand were able to utilize nutrients to a wider extent.

Comparing greenhouse gas fluxes CO_2, CH_4 and N_2O on a pure beech transect on the basis of two different treatments.

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Following master project is conducted in the BOKU Forest Demonstration Center Rosalia, Lower Austria. The study site is a pure beech transect on a metamorphic rock with a siliceous soil type. Field measurements will be performed from July until the end of October 2012. During this measuring period greenhouse gases like CO_2, CH_4 and N_2O will be determined weekly. In addition soil samples will be taken in a monthly frequency. The greenhouse gas measurements are taken manually with static chambers. These chambers are made out of PVC and have a diameter of 20 cm. They have a lid into which a plastic membrane is integrated. Chambers normally kept open and stay closed for 60 minutes during gas measuring for for GC-analysis in the lab. During gas sampling, soil temperature, air temperature and soil moisture will be determined. The total number of chambers is twelve pairs. Each pair consists of two treatments: a control treatment with no manipulation and a stress-treatment where the litter layer has been removed and replaced by a black garden foil. Thereby nutrient input from the litter into the soil is stopped without changing soil moisture and temperature. The analyses in the laboratory will focus on the greenhouse gases nitrous oxide, carbon dioxide and methane. In addition soil and litter samples will be taken monthly from around the chambers. The soil samples get analyzed in the laboratory to measure pH, total C, total N, NO_3^-, NH_4^+, PO_4^{3+}, DOC/TN and microbial parameters like microbial biomass C and N, glucose and respiration with a photometer. In the beginning of the measuring period in July and at the end in October soil profile samples will be taken to determine distribution of C, N and roots in the soil profile.

The study aim is to demonstrate the influence of litter on a beech forest soil and it's thereby greenhouse gas production, as well on the nutrient balance.

A novel, diffusion-based extraction for the estimation of plant available soil phosphorus

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Soil phosphorus tests are essential for assessing the P status of agricultural soils. Conventional soil tests (e.g. CAL, Olsen) are chemical extractions that do not specifically target the plant available soil P fraction, as the equilibration-type solubilisation process does not mimic plant P uptake. On contrary, diffusive gradients in thin films (DGT) extracts P from soil by exposing the soil to a constant zero-sink, much like the way P is taken up by plants. Correlation of DGT-extractable P with plant yield or biomass production is therefore often much better than that of conventional P tests. All P tests, including conventional DGT deployments can only be interpreted as P indices because a quantitative determination of the plant available soil P fraction has not been possible so far.

The objective of this work was to develop a DGT method for the quantification of the P fraction that can be extracted from soils solely through desorption, as this fraction is deemed to constitute the main source of readily phyto-available P in soil.

In a 30-day DGT experiment P was extracted from six soils with largely varying P status until P desorption reached a plateau, indicating that the limit of potential resupply from the solid phase was reached. To compare the DGT data with plant performance, a pot experiment with maize grown on the same soils was conducted in a greenhouse. Results showed a strong correlation (r2=0.99) between desorbed P and P concentration in plant tissues. Current work also explores the correlations between conventional P tests and our novel DGT-based approach as well as its interpretation in terms of desorption kinetics and its contribution to P uptake in plans. The new approach is deemed to provide not only a powerful tool for further research on P use efficiency of (crop) plants but may also serve as plant-independent reference method for the evaluation of conventional P tests.

Abundance and activities of aerobic and anaerobic microorganisms in Alpine soils along a grazing and manure gradient in special consideration of methanogenic *Archaea*

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Methanogenic *Archaea*areresponsible for the biological production of methane which is a strong and important greenhouse gas. In the last decades several studies showed that not only methanotrophic *Bacteria*, but also methanogenic *Archaea*known as obligate anaerobes are able to inhabit aerobic soils where they survive in anaerobic microniches. With increasing interest in soil methane cycle increasing numbers of physical (e.g. temperature) and biological (e.g. vegetation) factors come to light which have considerableinfluence on the incidence of methanogens in the soil, their (interactive) effects not clearly understood so far.

The aim of our present work was to examine the methane productionpotential of three subalpine soils with similar soil properties and climate conditions but different land management (in this case cattle grazing and mowing) and to correlate the data with abiotic and biotic parameters. In a laboratory approach soil samples got incubated anaerobically under different temperature and soil water conditions for several weeks in order to measure the methane production via gas chromatography. Our results show that cattle husbandry and mowing have a significant influence not only on the physical-chemical but also on microbiological properties in these soils. The influence became most apparent in connection with soil methanogens which showed an increase in potential methane production along the grazing and manure gradient, especially under favourable temperature and water terms. Anyways, further investigations are necessary to verify our results and to get further insight into the soil conditions which determine methane production and oxidation as well.

Spatial Distribution and Temporal Behavior of Soil Properties as Indicators of the Effect of Soil Conservative Measures

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Stone bunds are a common practice for soil and water conservation in the Ethiopian highlands. Applying such measures influences the translation processes of runoff and therefore affects the temporal and spatial properties of soil physical parameters. The study is part of the project "Unlocking the potential of rain fed agriculture in Ethiopia for improved rural livelihoods" in the Gumara Watershed, Maksengit, Ethiopia. Within the scope of this project, soil conservation measures were set to decrease surface runoff and soil erosion.

The objective of this research is to find a relationship between the spatial distribution of soil properties and the location of the stone bunds, but also to monitor the spatial behavior of those soil parameters. Two transects were selected that, in terms of slope steepness and treatment are representative for agricultural areas in the watershed. One transect was arranged within stone bunds, the second covers a field where no conservative measures were applied. Over one rainy season soil properties were monitored in specific spatial intervals along the transects but also in specific temporal scales. The measurements along the transects include bulk density, soil texture, saturated and near saturated hydraulic conductivity, shallow volumetric water content but also volumetric water content over depth. By surveying and photo-grammetric approach also slope steepness and stone cover along the transects were assessed

The experimental approach with knowledge of the spatial distribution of the measurements will support studying the spatial behavior of the soil properties. Showing a cyclic behavior at the same scale as the conservation measurements may indicate an influence on the soil properties and soil erosion. Finding cross correlations between properties can indicate the strength of influence of properties to each other. Finding significant temporal changes of specific soil properties over the rainy season may result in a better knowledge of the temporal influence of conservative measures on soil properties.

Impact of biochar amendment on the adsorption – desorption of chloridazon in agriculture soils

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Biochar application to soil has been proposed as a mechanism for improving soil quality and the long term sequestration of carbon. The implications of biochar on pesticide behaviour remains poorly understood. Here we investigating the sorption isotherm and desorption kinetic behaviour of chloridazon in two soils and them amendment with two percentage of commercial biochar 1% and 3%. Adsorption batch experiments were carried out over 24 hours using six initial concentrations ranging from 0.5 to 16 mg L^{-1} and were followed by 6 desorption steps using successive dilution. Both linear and Freundlich equations were used to describe sorption isotherm, Freundlich equation provided better fitting for our data then linear. Amendment biochar with the soils dramatically increased their adsorption capacity. K_f of a clay loam soil increased from 6.6 to 28 L Kg^{-1} with 1% amendment biochar soil and to 87.7 L Kg^{-1} with 3% biochar soil. K_f of the loam silt soil increased from 1.5 to 43 and to 168.8 L Kg^{-1} with 1% and 3% amendment biochar soils respectively. Chloridazon adsorption by all soils was nonlinear and its nonlinearity increased by adding biochar; n for a clay loam and loam silt soils decreased from 0.75 to 0.53 and from 0.79 to 0.44, respectively. Strongly marked irreversible and hysteretic desorption of chloridazon was related to biochar adding to the soils. After successive dilutions, the amount of chloridazon released form non biochar clay loam soil was 31.4-57 % of adsorbed amount and decreased to 3.1-13.4% and to 1.3-0.9% of adsorbed amount for 1% and 3% amendment biochar soils, respectively. Non biochar silt loam soil released 52-64% of adsorbed amount and decreased to 0.7-2.5% and to 0.9-0.5% of adsorbed amount for 1% and 3% amendment biochar soils. A kinetic multireaction model was successful in describing sorption isotherm behaviour. The model was equally successful in describing observed hysteretic chloridazon behaviour during desorption for all input concentrations. The addition of different amounts of biochar in the soil alter adsorption-desorption trends versus time.

Key words: Chloridazon, Biochar, adsorption-desorption, multireaction model, retention kinetics, hysteresis

Modelling Adsorption – Desorption Kinetics of Glyphosate in Soils

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Sorption- desorption interactions of herbicides with soil are important processes that influence the amount of herbicide retained by the soil and that which is susceptible to runoff or movement in the soil profile. Our goal was to quantify the reactivity (adsorption-desorption) of glyphosate by soils having different properties, to examine the characteristics of glyphosate retention and release, kinetic sorption batch experiments were performed, followed by glyphosate desorption using successive dilutions. Freundlich equation provided better predictions than Linear equation of glyphosate adsorption isotherm at different reaction times. Sorption of glyphosate by all soils was nonlinear with N_{24} ranged from 0.49 to 0.63 and K_{F24} ranged from 39.8 to 178.2 L Kg^{-1}. Desorption of glyphosate was strongly irreversible and hysteretic in nature, indicating lack of equilibrium retention and/or irreversible or slowly reversible processes. After successive dilutions, the amount of glyphosate released or recovered ranged from 3.2% to 24.3% of the total amount adsorbed. Soils with highest iron and aluminium oxide, organic matter, and clay content exhibited the strongest affinity for glyphosate and least kinetic behaviour. The version of a nonlinear multireaction model with one kinetic and one consecutive irreversible reaction sites was the best successful to describe the retention and subsequent release of glyphosate on the different soils over other model versions. The model was capable of predicting glyphosate adsorption and desorption or release for all soils and over the entire wide range of input concentrations. The model exhibited robust predictions. One set of model parameters was capable of predicting desorption or release kinetics (i.e., hysteresis) over a wide range of glyphosate concentrations.

Key words: Glyphosate, adsorption-desorption, multireaction model, retention kinetics, hysteresis

Impact of rill erosion morphology on flow hydraulics using Manning-Strickler equation

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Concentrated flow in most soil erosion models is represented using simplified and optimized flow equations to take readily available input parameters. Particularly empirical flow equations like Manning-Strickler`s approach use a single roughness parameter to account for friction impact on flow. Furthermore, idealized assumptions of approximately uniform and steady state channel flow are hardly consistent with flow conditions and morphologies occurring in the field. By means of a flume experiment rill hydraulic measurements of different discharge and rill morphology were analysed based on Manning-Strickler equation ($v = k_{St} R^{2/3} I^{1/2}$). A 1.95 m long, 0.60 m wide and 0.35 m deep flume was set on a 10% slope and filled with loamy soil representing a segment of a natural hill slope. A single erosion channel was enforced to develop in the flumes soil bed by means of steady state runoff. Testing different morphologies, two different rill erosion types were initiated: I.) a Straight Constrained Rill (SCR) by concentration of the runoff into a prepared straight initial rill and II.) a Free Developing Rill (FDR) providing unconstrained back-cut erosion through the plain soil body. Assuming that the observed rill flows were adequately described by Manning-Stickler's equation, calculated roughness coefficients k_{St} for SCR runs accounted for skin friction solely because of straight in line rill morphology. In contrast, FDR runs accounted for the dual impact of skin and shape friction because of channel meanders. Based on the present flume study significant dependency of Manning-Stickler's roughness parameter and rill morphology was observed. From our experiments, k_{St} related to skin friction only (SCR) was up to one third higher than roughness values out of FDR experiments. Based on flume observations rill flow path tortousity was used as continuous variable describing rill morphology and was correlated to Manning-Strickler roughness. According to significant correlation between k_{St} value and flow path tortuosity locally energy dissipation because of varying channel flow conditions can be assessed by morphological characteristics. However, this study showed that more research is needed to better understand the limits of applicability of simplified flow equations and to suggest comprehensible ranges of parameter inputs for large computer simulations.

Key words: rill erosion, Manning-Strickler equation, morphology, friction, roughness,

Soil quality in the Bahariya Oasis (Egypt), with particular focus on soil salinity

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The Bahariya Oasis in the Western Desert of Egypt is characterized by traditional irrigation techniques and the date palm as the main cultivated plant. The older areas of the Oasis, which have been cultivated for several thousand years, are formed by deep soils with a relative high percentage of clay and are shaded by dense tree canopy. Since 1952, through to the project "New Valley", the agricultural production considerably increased by land reclamation in the desert. As a result of the irrigation of the new land by deep wells, the groundwater level decreased, most of the old wells dried up and parts of the old oasis fell into disuse. Another problem of irrigated farming in arid ecosystems is soil salinity, mainly caused by the negative water balance and a high potential evaporation. This can lead to capillary rising of the groundwater, often reinforced by saline irrigation water and poor drainage. In further consequence, the dissolved salts precipitate in the soil, and are the main cause of reduced soil quality.

In this work, soil quality should be investigated with the focus on soil salinity and plant productivity, using a Minimum Data Set of soil properties. For each site at least three soil samples were taken, mixed and analyzed on particle size distribution and chemical properties (CEC, pH, TC, TOC, C/N and electrical conductivity). Further, the factors that influence soil quality primarily should be identified. For this question, a collection of possible factors were defined: (1) the quantity and frequency of irrigation, which leaches the salts out of the soil, (2) the shading by plants, tackling the evaporation, (3) the drainage conditions, which influences the groundwater table, (4) irrigation water quality and (5) the age of the investigated area. The data will be statistically evaluated by using basic statistic analysis and factor analysis (PCA) with the R-software.

Organic matter composition in intensively used grasslands along an elevation gradient in the Ötztaler Massiv, South Tyrol, Italy

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By the end of this century the mean annual temperature is predicted to increase by 3°C in the European Alps. Precipitation will decrease and it is unknown how the changed climatic condition will impact the stored soil organic carbon in alpine grasslands. Alpine grasslands are known to accumulate high amounts of soil organic matter and present an important terrestrial carbon pool. Four sites along an elevation gradient form 1000 to 2000 m asl in the South Tyrolean Alps were studied. By keeping main parameters constant (i.e. geology, soil type, aspect, vegetation, management intensity) we aimed to follow changes of main soil properties as well as of soil organic matter taking humic acids as a fast-changing indicator along the elevation/climatic gradient. Besides basic soil characteristics (e.g. pH value, nutrient status, particle size distribution, (hydr-)oxides) we applied simultaneous thermal analysis (STA) on bulk soil and Fourier Transform Infrared Spectrometry on extracted humic acids (1 M NaOH) gained from soil of depths down to 40 cm. We found that soil organic carbon accumulated with 0.48 kg/m2 pro 100 m altitude in the grassland sites. Soil organic matter was dominated by thermal labile compounds in all studied profiles. Labile aliphatic bounds and N-related compounds in the humic acids showed altitudinal variations and enabled a clear division of the sites. We found organic matter decomposition at all sites to be limited to an early (i.e. labile) stage, which can be related to the very high annual inputs of manure and a negative water balance during the vegetation period in the study area. By an increase of the main annual temperature with 3°C at the studied sites, we can roughly estimate a release of 2.4 kg m-2 soil organic carbon from the upper 0 – 15 cm into the atmosphere by organic matter mineralization. At the same time an expansion of productive grassland in higher elevations would compensate the loss of soil organic carbon in deeper regions.

The concept of the critical water content for hydrophobic soils in New Zealand

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Soil water repellency is an important problem for pasture farming in New Zealandcausing low infiltration rates and increased surface runoff. However, the real extent ofthis issue is not yet evaluated. Water repellency is thought to appear on dry soils when the water content falls below a critical limit. The main objective of this study was the examination of this critical water content for 10 sites with 5 different soil types under pastoral land use on the north island of New Zealand. A further objective of the study was to detect the particular time of the year when soil water repellency is likely to occur with the help of a water balance model. Soil water repellency was measured with the Water Droplet Penetration Time Test (WDPT) and the Molarity of Ethanol Droplet Test (MED) during 4 wetting and drying cycles on 3 replicates each of disturbed and undisturbed soil samples. Repellency tests confirmed that water repellency does not exist at high water contents. It generally starts to appear at a certain limit, increases rapidly up to a peak value and finally decreases slowly when the water content approaches 0. Critical water contents were very high in the first wetting cycle and stabilized at a rather constant level during the 2nd, 3rd and 4th wetting cycle. This phenomenon may be due to inhomogeneous water distributions within the field moist soil samples in the 1st wetting cycle and it was thus chosen to take the critical moisture content from the 2nd wetting cycle for further analysis. The critical water contents appeared to differ between the various soil types and showed values between 0, 34 (m^3/m^3) for recent soil and 0, 44 (m^3/m^3) for organic soil.

In the modeling part a water balance model, which is based on the parameters infiltration, drainage and evapotranspiration, was used to calculate the volumetric water content in the top-soil layer (upper 50mm). This model was fed with climate and geographic data from the sampling sites, with the site-specific physical soil properties such as field capacity and wilting point as well as with the critical water contents obtained in the experimental part of the study. The model was run for four years, from April 2008 until April 2012. Soil water repellency was found to be the rule rather than the exception and to occur during two to three thirds of an average year. Repellency induced surface runoff was found to be a considerable issue especially in regions where high rainfall intensities are combined with high critical water contents as it is the case for organic soil in the New Zealand Taranaki region. Even though having the potential to occur all year round, soil water repellency was found to appear more likely in the summer months between November and January and less likely in the winter months between May and October. The occurrence of water repellency was compared for average, wet and dry years. The differences, however, were not significant. Using a water drop penetration time of 60 seconds as the threshold for moderately persistent soil water repellency, it was evaluated on how many days per year this more severe soil water repellency was reached on the different sampling sites. The results showed big variances between the different regions and also between the different soil orders presenting values between 0 and 7 months per year of moderate soil water repellency.

It was not possible to detect any seasonal pattern in the occurrence of moderate soil water repellency. All model results, however, are merely a first approximation of the situation. A better match with reality could be achieved by improving the model structure and varying the input data.

Ecometagenetics, Morphology and Biodiversity Indices of Soil Meso- and Microfauna for the Agricultural Area of South Tyrol

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Soil fauna diversity is crucial for the entire ecosystem, but there is still a far way to go towards a comprehensive understanding of soil communities, their composition and the factors driving it. At the same time, soil diversity is endangered by land use changes, management intensification, loss of landscape heterogeneity, and pollution caused by pesticide use. Consequently, the Food and Agriculture Organisation established the soil biodiversity initiative focusing on the increasing recognition of the essential service provided by soil biodiversity across all production systems and its relation to land management. One of the actions to achieve these aims is the assessment and monitoring of soil biodiversity.

For South Tyrol, few data are available on soil faunal diversity especially for agricultural production sites. Assessing and monitoring soil biodiversity has been impeded mainly by it being hidden in the soil and the difficulties and biases arising from conventional methods of extraction and morphological identification. The novel approach of metagenetics based on next-generation sequencing holds the promise to significantly assist in overcoming this hurdle.

In the project proposed here, the University of Innsbruck, the European Academy Bozen/Bolzano and the Laimburg Agriculture and Forestry Research Centre will cooperate closely to make the soil meso- and microfauna of South Tyrol better accessible, for use in both basic and applied research. In particular, we are aiming to:

(i) characterise the soil meso- and microfaunal diversity in agricultural production sites of South Tyrol in the context of environmental data using conventional morphological identification,
(ii) test a nuclear and mitochondrial DNA marker combination using next-generation sequencing for metagenetic soil meso- and microfauna diversity assessment,
(iii) evaluate the complementarity of the conventional and the metagenetic approach of diversity assessment, and
(iv) explore the implementation of all diversity data in soil biodiversity indication
Finally, this project supports the sustainability strategy and the strategy for soil protection of South Tyrol by contributing data about the interrelationship of soil management and soil health to the scientific basis for agropolitical decisions in South Tyrol, which is a member of the European Land and Soil Alliance.

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SHORT-TERM MEASUREMENTS OF SOIL CO_2 EFFLUX FROM TWO AGRICULTURAL SITES IN LOWER AUSTRIA

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Agricultural soils play an important role in the global carbon cycle. Depending on their management they may act as both, a source and a sink of carbon [1]. Plowing breaks down soil aggregates and exposes soil carbon to microbial decomposition [2], thus soil tillage increases soil respiration and decreases the soil organic carbon content. Adapted soil management strategies, however, could reduce CO_2 efflux and enhance carbon sequestration in soil. Soil respiration is affected by environmental factors like temperature and water content, which vary hourly, weekly, seasonally, and annually [3].

The objective of this study was to assess the short-term variabilities of soil respiration derived from different soil tillage systems: conventional tillage (CT), reduced tillage (RT) and no tillage (NT). Therefore, soil respiration was measured on two long-term soil tillage experiment sites in Lower Austria in intervals of few days or even several times per day during April and May 2010 using a closed dynamic chamber system (SRC-1 and EGM-4, PP Systems). The main difference between the two sites was the different soil texture: sandy silt in Pixendorf, loamy clay in Tulln [4]. Additionally, soil temperature, soil moisture, soil organic carbon (SOC), and soil nitrogen were measured.

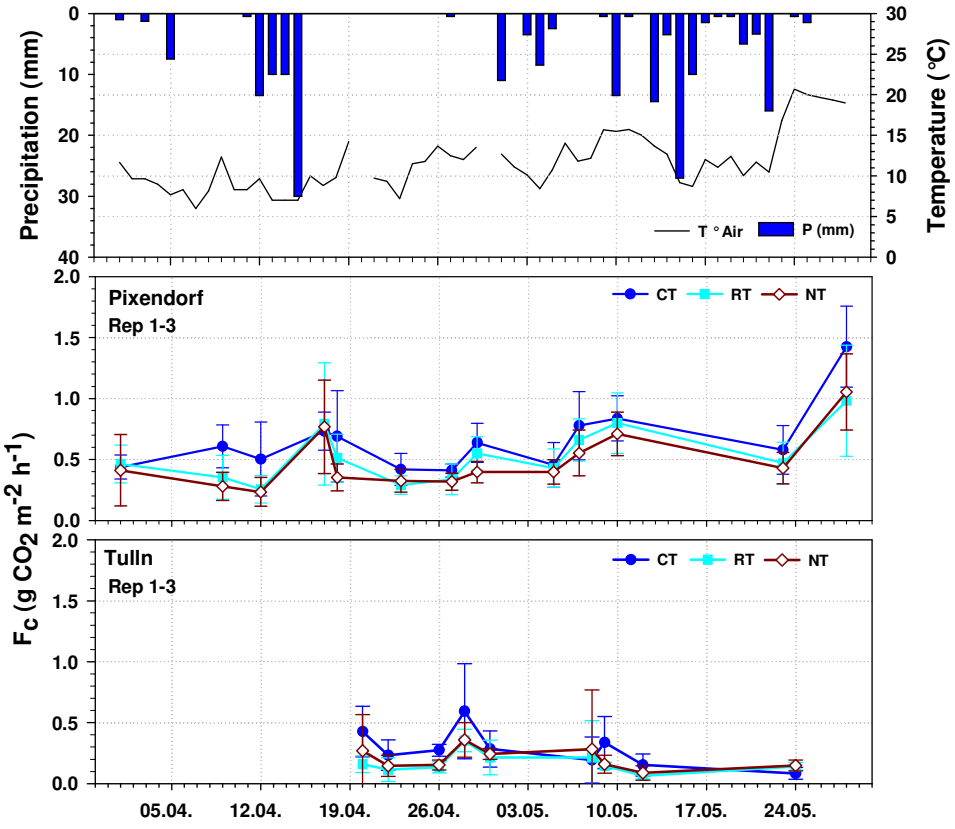

FIG. 1. Measured CO_2 efflux in Pixendorf and Tulln in context with precipitation and air temperature [5] in April and May 2010.

Higher soil respiration was measured in Pixendorf than in Tulln (Fig. 1), mainly due to the different soil textures, which influence soil water and gas transport properties. Compared to RT and NT plots, the CT plots emitted a higher

amount of CO_2. The sandy silt in Pixendorf showed a tillage-induced soil respiration trend of Fc(CT) > Fc(RT) > Fc(NT), while the loamy clay in Tulln followed the trend of Fc(CT) > Fc(NT) > Fc(RT). In Pixendorf, the soil respiration rate correlated with soil temperature and soil moisture. The experiment indicated a high spatial heterogeneity within the three field replications of each tillage system.

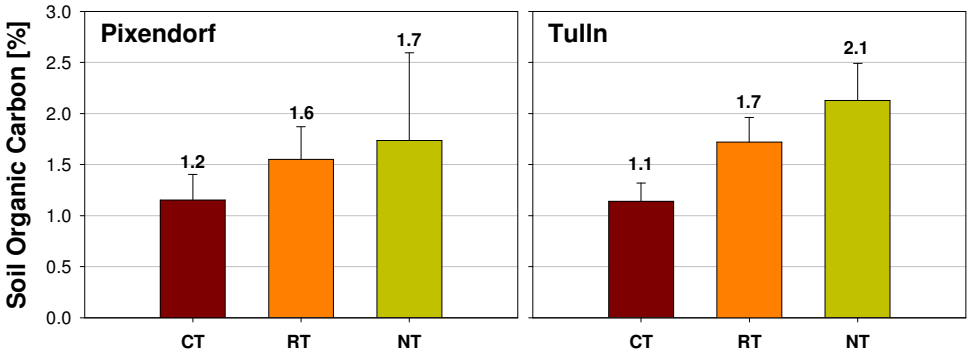

FIG. 2. Mean results of soil organic carbon on fields of each tillage system on three field replications in Pixendorf and Tulln, April- May 2010.

Soil chemical analysis of soil samples from both experiment sites showed a trend of higher soil organic carbon content for RT and NT than for CT (Fig. 2). In comparison to weekly measurements the short-term measurements showed higher variabilities of soil respiration due to the influences of varying environmental factors.

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A new experimental design overcomes limitations due to spatial soil variability in a field solute leaching experiment

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Understanding the leaching of surface-applied solutes and pesticides under different land use conditions is critical to our knowledge on water flow and solute transport in soils and efforts to model these flow processes. One problem inherent in the measurement of solute leaching in field experiments is the considerable high natural spatial variability of flow-controlling soil properties. Thus, analyzing treatment effects based on the mean and the variance of observations can become obsolete if there is a huge inherent variance in the set of measurements, and if no spatial range of influence can be derived from the observations. To overcome this limitation, the spatial covariance and cross-variance between measurements was used in the present study. We demonstrate that applying an additive state-space model can help to differentiate between scale-specific variance components within the solute leaching behaviour along an experimental transect. Applying a novel experimental scheme, where the treatments were arranged in a scale-dependent manner, leaching of a conservative tracer (KBr) under two contrasting land use systems (cropland vs. grassland) was compared. After surface application of the bromide, the experimental field was irrigated using different time delays as well as two different irrigation amounts and two different intensities. At the end, the Br-concentration in the soil profile was determined from auger sampling. Upon spatial statistical data analysis, an additive state-space model was applied to separate the small- and large-scale components of bromide leaching behaviour.

Subsequently, the large-scale processes of water infiltration and Br leaching were described in an autoregressive state-space model. The experimental approach and the separation of small- and largescale variability components support studying soil ecosystem processes that vary at different scales even in the presence of underlying small-scale variability that is currently considered obstacles in field research. Our result has implications not only for agricultural management experiments but also for large-scale hydrological and transport studies in landscapes and watersheds.