wageningen conference
on applied soil science

SOIL SCIENCE IN A CHANGING WORLD

WAGENINGEN UNIVERSITY
WAGENINGEN UR

Soil Science in a Changing World

18–22 SEPTEMBER 2011

EDITORS
Saskia Keesstra
Gerben Mol

PROGRAM AND ABSTRACT BOOK

Wageningen Conference on Applied Soil Science

'Soil Science in a Changing World'

Editors:
S.D. Keesstra
G. Mol

18 - 22 September 2011
Wageningen
The Netherlands

Wageningen Conference on Applied Soil Science
'Soil Science in a Changing World'
18 - 22 September 2011
Wageningen
The Netherlands

Editors: Saskia Keesstra[1] and Gerben Mol[2]

[1] Wageningen University, Land Degradation and Development Group, PO Box 47, 6700 AA Wageningen, The Netherlands
[2] Wageningen University and Research Centre, Alterra, PO Box 47, 6700 AA Wageningen, The Netherlands

Lay-out: Hedy Wessels, Feike Fliervoet
Cover design: Vormgeverij Mol

ISBN: 978-946173-168-5

Printing: Wageningen UR, Communication Services, Wageningen, The Netherlands

Contents

Sponsors

The Organising Committee gratefully acknowledges the support of:

Wageningen UR

OECD

The opinions expressed and arguments employed in this publication are the sole responsibility of the authors and do not necessarily reflect those of the OECD or of the governments of its Member countries.

The Conference was sponsored by the OECD Co-operative Research Programme on Biological Resource Management for Sustainable Agricultural Systems, whose financial support made it possible for the keynote speakers to participate in the Conference.

KNAW

Delta T

Eijkelkamp

Schweizerbart – Borntraeger

BRILL

Organising Committee

- Dr. Saskia Keesstra
  Wageningen University, The Netherlands
- Dr. Gerben Mol
  Alterra, Wageningen UR, The Netherlands
- Dr. Joop Okx
  Alterra, Wageningen UR, The Netherlands
- Drs. Anne Zaal
  Alterra, Wageningen UR, The Netherlands

Conference Secretariat

- Hedy Wessels
  Wageningen University, The Netherlands

Scientific Committee

- Prof. dr. P. (Peter) de Ruiter (chairman)
  Wageningen University, The Netherlands
- Prof. dr. R.D. Bardgett
  University Lancaster, United Kingdom
- Prof. dr. T. Breure
  RIVM, Radboud University, The Netherlands
- Prof. dr. K. Kalbitz
  Universiteit van Amsterdam, The Netherlands
- Prof. dr. M. Kibblewhite
  Cranfield University, United Kingdom
- Prof. dr. R. Lal
  Ohio State University, The United States
- Dr. L. Montanarella
  European Commission, Italy
- Prof. dr. J. Poesen
  Catholic University of Leuven, Belgium
- Prof. dr. W.H van der Putten
  Netherlands Institute of Ecology, The Netherlands
- Prof. dr. K.V. Ragnarsdottir
  University Iceland, Iceland
- Prof. dr. S. Rousseva
  Poushkarov Inst. for Soil Science, Bulgaria
- Prof. dr. H. Verhoef
  Free University Amsterdam, The Netherlands
- Prof. dr. T. Scholte
  University of Tubingen, Germany
- Prof. dr. S. Thiele-Bruhn
  University of Trier, Germany

- Prof. dr. D. Wall
  Colorado State University, The United States
- Prof. dr. I. Young
  University of New England, Australia
- Prof. dr. J. Bouma
  Wageningen University, The Netherlands
- Prof. dr. L. Brussaard
  Wageningen University, The Netherlands
- Prof. dr. W. van Riemsdijk
  Wageningen University, The Netherlands
- Prof. dr. L. Stroosnijder
  Wageningen University, The Netherlands

Welcome

Welcome

Soil is the primary resource for life on our planet. It is also a very vulnerable resource. Human activities may cause that soils degrade and that it loses its value for vital ecosystem services, such as the production of food, the storage of clean water, and the habitat for species rich natural ecosystems. Soil is also a key component in the global environmental processes. It governs the global cycling of carbon and nutrients, and by this climate change, food productivity and ecosystem eutrophication.

Therefore, understanding 'soil' has become an integral part in our thinking about sustainability, both in terms of human health and welfare as in terms of environmental quality and biodiversity conservation. Soil science is recognised as key discipline in achieving some of the most important *Millennium Development Goals*, such as the eradication of hunger and the sustainable development of our environment. Also, Rockström and colleagues (Nature **461**, 472-475, 2009) argue that to avoid catastrophic environmental change, humanity must stay within defined 'planetary boundaries' for a range of essential Earth-system processes. For all the nine planet processes that are analyzed, soil is a key determinant in the proposed sustainability boundaries.

The Wageningen Conference on Applied Soil Science has chosen to take the role of soil for our society as focal point. Key-note lectures, parallel sessions and interactive workshops will deal with issues like food security, water resources, climate change, biodiversity, and governance. As the international society asks us to meet the millennium development goals, this conference provides the opportunity for soil scientists to reflect on the contribution of the soil sciences in this context, and how we as a scientific discipline should go forward.

We wish you all a very inspiring four days.

Prof. dr. Peter C. de Ruiter,
chair scientific committee

Dr. Arian Steenbruggen,
Head Soil Science Centre

Organizing committee

Saskia Keesstra

Gerben Mol

Joop Okx

Anne Zaal

Programme

Programme

Sunday, September 18th 2011

18.00 – 20.00 *Icebreaker – Down Under bar*
Registration – Lobby

Monday, September 19th 2011

07.30 Registration desk open - *Lobby*

08.30 – 08.50 **OPENING ADDRESS** – *Haakzaal*
Peter de Ruiter, Chair of the Scientific Committee

08.50 – 09.00 **SHORT ADDRESS** – *Haakzaal*
John Sadler, co-ordinator of the research theme "The Natural Resources Challenge" of the OECD Co-operative Research Programme on Biological Resource Management for Sustainable Agricultural Systems

THEME 1: GLOBAL FOOD SECURITY
Chair: Prem Bindraban

09.00 – 09.25 **KEYNOTE** – *Haakzaal*
Hans Eenhoorn, retired vice president Unilever Food, member UN Task Force on Hunger
The fight against chronic hunger: a holistic and entrepreneurial approach

09.25 – 09.50 **KEYNOTE** – *Haakzaal*
Bruce Campbell, CCAFS, Denmark
Ensuring food security in the face of climate change

09.50 – 10.30 Plenary discussion - *Haakzaal*

10.30 – 11.00 One minute poster pitches – *Haakzaal*

Presented posters:

Etienne Bahr: Effects of different N-fertilizers on nitrogen mineralization and microbial activity in colluvial and upper slope soils of southern Ecuador

Janjo de Haan: Less organic matter input reduces nitrate leaching, crop yield and soil quality on a sandy soil in the Netherlands

Olivier Dewitte: Predicting gully initiation susceptibility with common spatial data

Annemieke Gärdenäs: Modeling potentual long-term accumulation of radionuclides in the soil-plant-system originating from an eventual groundwater contamination

Ciro Gardi: Use of corine land cover data for the evaluation of land take impact on soil resources at European scale

Simone Verzandvoort and Erik van den Elsen: The DESIRE project: desertification mitigation and remediation of land - a global approach for local solutions

Sherif Lushaj: Land /soil erosion and measure planning control in Albania

Evgeny Milanovskiy: Hydrophilic and hydrophobic components of soil humic substances: distribution, stability and function

Titia Mulder: The use of remote sensing for soil mapping at regional scale

Jordana Ninkov: Copper levels and distribution in soils of active and abandoned vineyards at the Vršac site in Serbia

Birthe Paul: Effects of conservation agriculture on crop yields, soil aggregation, and C & N dynamics in a soybean-maize rotation in western kenya

Emmanuel Frossard: Nutrient use and dynamics in conservation agriculture including legumes in the midwest of the Malagasy highlands

Endla Reintam: Soil productivity losses due to compaction in Estonia

Angela Straathof: Do soil amendments applied for the suppression of plant pathogens influence dissolved organic carbon pools?

Guy Thallon: Approaches to integrated spatial data management for the provision of soil ecosystem services and food security

Gergely Tóth: Land availability, soil productivity and food security in the European union: status and prospects

Petra van Vliet: Dealing with soil heterogeneity to reach a more sustainable agriculture

Ann Verdoodt: Adequacy of legacy soil data for agricultural land suitability and land degradation assessments – the case of Rwanda

11.00 – 11.30 Coffee break – *Terraszaal and Wolfswaardzaal*

11.30 – 13.00 **PARALLEL SESSION**

2 workshops or masterclasses

11.30 – 13.00

Paul Römkens, Piet Otte, René Rietra and Johannes Lijzen
'Soils and the city': Risk assessment tools to assess the impact of urban soil quality on human health
Pomonazaal 1

Tomislav Hengl, Hannes Reuter and Gerard Heuvelink
Global Soil Information Facilities
Pomonazaal 2

2 sessions with 6 oral presentations

	Session 1.1: Nutrient management for food security – *Peppelzaal 1 and 2*	**Session 1.2: Assessing physical, chemical and biological soil functioning for food security** – *Haakzaal*
	Chair: Kristin Vala Ragnarsdottir (Univ. of Iceland)	Chair: Prem Bindraban (ISRIC, Wageningen UR)
11.30 – 11.45	*Maurits van den Berg* Potential impacts of resource efficiency strategies on global agricultural land and phosphorus use	*Albert Materechera* The NEWSTART eco-garden: an innovative food production system for smallholder farmers
11.45 – 12.00	*Marijn van de Velde* Maize nutrient response in tropical and subtropical regions as evidenced from historic crop trials	*Walter Schenkeveld* The effectiveness of chelates in preventing iron deficiency in crops
12.00 – 12.15	*Delwende Innocent Kiba* Understanding the importance of the diversity of sites and fertilizations practices on soil fertility and lettuce production in urban areas of Burkina Faso	*Ann Verdoodt (replaces Liming Ye)* A theoretical framework for assessing food security and food policy effectiveness in China
12.15 – 12.30	*Lulseged Tamene* Assessing the role of atmospheric fertilization in concealing the severity of land degradation in West Africa	*Harm Bartholomeus:* Improved spectral estimation of multiple soil properties by stratification on ancillary and spectral data
12.30 – 12.45	*Kristin Vala Ragnarsdottir* Development of soil sustainability indicators	*Raymond Jongschaap* Crop yield gap and gap in soil information
12.45 – 13.00	*Christy van Beek* Evaluation of nutrient management strategies at farm level in Ethiopia for improved food production	*Willem Hoogmoed* Can food security be achieved in Africa without tillage?

13.00 – 14.30 Lunch with postersession – *Terraszaal and Wolfswaardzaal*

THEME 2: WATER RESOURCES

Chair: Leo Stroosnijder

14.30 – 14.55 **KEYNOTE** – *Haakzaal*
Victor Jetten, ITC, Twente University, The Netherlands
Using soils information in natural disaster analysis: value for money

14.55 – 15.20 **KEYNOTE** – *Haakzaal*
Neil McKenzie, CSIRO Land and Water, Australia
Soil knowledge and the global water challenge

15.20 – 16.00 Plenary discussion - *Haakzaal*

16.00 – 16.30 One minute poster pitches – *Haakzaal*

Presented posters:

Manuel Seeger: Estimation of mean flow velocity of overland flow in a flume

Manuel Seeger: Influence of hydraulic parameters on sediment transport under shallow flows

Olivier Dewitte: Towards the reproducibility in soil erosion modeling: a new pan-European soil erosion map

George Citu: Heavy metals concentrations in soil and water on the Rosia Montana area

Steve Crittenden: Effect of reduced soil disturbance on earthworm density and diversity and soil physical quality

Pietro Teatini: Saltwater contamination in the Venice lagoon margin, Italy. 1: the influence of the geomorphological setting

Geertje Enting: Project WaterSense, an integral Decision Support System (DSS) for watermanagement

Anwar Aly: Impact of irrigation management on water table fluctuation and soil salinity in Siwa oasis

Mirko Knezevic: Analysis of yield of wine grapes on brown soil on gravel and conglomerate in Bjelopavlicka plain – Montenegro

Dario Mantovani: Water use efficiency of bioenergy crops on degraded soils in southern Brandenburg – a comparison between black locust and giant knotweed

Demie Moore: Soil water repellency – a confounding factor in soil and water management

Joao Saad: Rational use of water using irrigation supression in one of the bean phenological stages

Evgeny Shein: Granulometric composition of soils: the problems of preparation and analysis by different methods

Jannes Stolte: Snowmelt driven discharge modeling for a small catchment in Norway

Leo Stroosnijder: Assessment and mitigation of droughts in African Drylands

Gerson van Luijk: Quantification of ecosystem services in the Baviaanskloof, South Africa

Domenico Ventrella: Simulation of soil water dynamics in an irrigated district of southern Italy

Bernard Voortman: The future groundwater recharge: evapotranspiration response of natural vegetation to climate change

Shangguan Wei: Land use as a stress factor to soil diversity and its protection in China

Heydar Ali Kashkuli: Temporal variation of soil hydrolic parameters affected by land use

16.30 – 17.00 Coffee break – *Terraszaal and Wolfswaardzaal*

17.00 – 18.30 **PARALLEL SESSION**

2 workshops or masterclasses

17.00 – 18.30	*Hans Reuter* Green water credits, Soil and Water Conservation in Africa *Pomonazaal 1*	*Thom Kuyper* Revitalizing Soil Science Education – how to maintain pedological literacy *Pomonazaal 2*

2 sessions with 6 oral presentations

	Session 2.1: Water use efficiency and water harvesting in dry lands – *Haakzaal*	**Session 2.2: Soil as a filter** – *Peppelzaal 1 and 2*
	Chair: Leo Stroosnijder (Wageningen University)	Chair: Saskia Keesstra (Wageningen University)
17.00 – 17.15	*Erik van den Elsen* The Water Reuse project: optimization of water use efficiency and use of treated waste water in different European agricultural settings	*Violette Geissen* Effects of commercial banana production on water quality: an example from tropical Mexico
17.15 – 17.30	*Eli Argaman* An innovative approach for analyzing water balance of a Liman system in the northern Negev Desert, Israel	*Kim Mosse* Effects of winery wastewater application on soil physicochemical and biological properties
17.30 – 17.45	*Abdulaziz Alharbi* The effect of mulching on the surface energy balance and key soil physical variables, under Sub-humid and Semi-arid conditions	*Sirpa Piirainen* Do forestry operations decrease the ground water quality for household use?
17.45 – 18.00	*Mitchell Pavao-Zuckermann* Soil knowledge for improving urban environments and regreening cities	*Loes van Schaik* Explicit parameterization of macropore flow based on earthworm species distribution models
18.00 – 18.15	*Birhanu Temesgen* Participatory development of in-situ rainwater harvesting techniques through field experimentation and modeling with the FAO's Aquacrop model	*Elia Scudiero* Saltwater contamination in the Venice Lagoon margin, Italy. 2: the influence on the soil productivity. First results.
18.15 – 18.30	*Stan Kostka* Optimizing Soil and Water Productivity through Management of Soil Water Repellency	*Minze Leistra* How uniform are water flow and pesticide transport in cultivated sandy soils?

18.30 – 20.00 Snacks with refreshments and poster session – *Terraszaal and Wolfswaardzaal*

Tuesday, September 20th 2011

Excursion day, with various options. Most of the excursions will leave around 08.30 at the Hof van Wageningen and return around 18.00 hrs; transport, coffee/tea, packed lunch and refreshments are included. At the reception desk at the start of the conference, you are able to subscribe to the excursions and receive a detailed programme per excursion. All excursions have a limit of the amount of participants. So we can advise you to subscribe as early as possible! The excursions will be guided by scientists and mainly have a scientific character; some are combined with a cultural or culinary treat.

Excursion to the National Park Hoge Veluwe (http://www.hogeveluwe.nl/en). National Park Hoge Veluwe is a relict from glaciers that covered the Netherlandsduring Saalien (2 104 – 1.2 104 years ago). It is a large complex of ice-pushed ridges with an elevation up to 110 m+NAP. Excess rainwater can infiltrate in the sandy soil and feeds the underlying aquifer. This groundwater rises to the surface in springs and brooks in the surrounding area. In this excursion the geology and related water management of the region will be shown. The excursion will start on top of an ice-pushed ridge with an overview to the adjacent river landscape. Then we will visit an old mill-brook, which is fed by Veluwe water, and some of the upper branches of this brook (manmade springs). This field trip is followed by a visit to the National Park Hoge Veluwe and the Kröller Muller Museum which hosts many famous paintings of Dutch masters such as Van Gogh. De Hoge Veluwe National Park is the largest actively managed conservation area in private hands in the Netherlands. The Park covers 5,400 hectares of woodland, heathland, peat bogs and drift sand. It enjoys a wide variety of plants and animals and provides habitats to extremely rare Red List species. You have the possibility to have a guided nature walk in the park or enjoy a visit to the Kröller-Müller museum on your own.

A geological/soil scientific excursion by bus through the western and central part of the Netherlands. The trip will start with a visit on the beach along the Dutch North Sea coast by Lisse: the formation of young dunes and the recent development of the Dutch coastline. After this visit, we will visit sites in Haarlem (including the Cruqius Museum), Amstelveen, Nieuwer ter Aa and Veenendaal where the development and differences in the Dutch geological land(soil-)scape will be explored and explained. We will return in Wageningen around 18.00 hours.

A combined excursion in Wageningen: Wageningen Campus and Mushroom excursion, wine tasting at the Wageningse Berg. The excursion starts with a tour of the Wageningen campus, including laboratories and a lunch in the Atlas building. In the afternoon you will visit the forest of the Oostereng around Wageningen, guided by a soil and mushroom expert. Oostereng is the name for a number of forest fragments between Wageningen and Bennekom. We will visit the forest fragment close Oranje Nassau Oord. It lays within walking distance of the vineyard. The forest consists of plantations of conifers (Pinus, Pseudotsuga, Larix), and there are also stretches with various deciduous trees (Quercus, Betula) and a lane with old beech trees (Fagus). The soils in the area are generally sandy and have a low pH. At some places remains of the old plaggic soils are present, and there are characterised by higher nutrient levels, especially P. Due to the dominant tree species the major humus profile types are mor and moder. The trees are almost all forming ectomycorrhizal associations. During the excursion we will show the common mushroom species that can be found on such soils in the

Netherlands. We will explain which species are mycorrhizal (and show the distribution of mycorrhizas over the soil profile) and which ones are saprotrophs (decomposers) of litter and wood. For litter decomposers we will show extensive bleaching by some (not all) species and the spatial pattern in soil carbon and nutrients that it can generate. During the last five years 160 species of mushrooms have been recorded. However, total species richness of mushroom will probably be a factor 3-5 higher.
The afternoon program will be concluded by a a wine tasting experience accompanied with special Dutch cheeses at the Wageningen winery on the special soils (terroir) of the Wageningse Berg (="Mountain"; height 42 m (!)).
(See: http://www.wijngaardwageningseberg.nl/engels/)

An excursion about 200,000 years of landscape formation in the surroundings of Wageningen: consequences for current day use. The Saalien ice age has set the scene for today's landscape around Wageningen: the cover ice reached the area and deep depressions and pushed moraines were formed. Since then, the landscape was further shaped by a combination of climate change, geomorphological processes, soil formation, vegetation dynamics, and human influence. This excursion tells the fascinating story of this dynamic landscape and discusses the consequences for current day use. The bus leaves at 8:30 from the 'Hof van Wageningen' and returns at ca. 17.00 (We will have relatively little 'bus time' but spend most of the time in the field).

An excursion to The Netherlands Open Air Museum (http://www.openluchtmuseum.nl/en/): Holland in just one day. The Netherlands Open Air Museum uses authentic buildings, objects and true stories to bring the past to life.
Come with us on a journey through the last two hundred years. The museum, with its farmyards, farmhouses, cottages and businesses, farmer's café and shops, is a hive of activity. The living history will make a lasting impression, bringing back memories and astonishing you by turns. Immerse yourself in the past and get to know the Dutch people and their history. We will have a guided tour in the museum, with a scientific explanation about the type of buildings in the Netherlands, specifically related to the soil conditions of that area. We will also have the opportunity to visit the HollandRama experience and enjoy the museum by ourselves. This excursion returns to Wageningen around 16.00 hours.

19.30 Conference diner – *Hotel de Wereld, Restaurant O'Mundo*

Hotel de Wereld is located in the city centre of Wageningen. It reopened in the spring of 2004 after a complete renovation and resumed its former function of a hotel. In the past 'De Wereld' has known many different designations, the most impressive of which is that it was the backdrop for the signing of the German surrender on May 5, 1945. The modern and stylish interior now contrasts nicely with the building's historic character.

On the ground floor of Hotel de Wereld you will have the opportunity to enjoy the culinary treats on the chef's menu in Restaurant O Mundo. The restaurant is awarded a Michelin star since 2009 for its innovative, honest kitchen and its use of pure ingredients with special attention to vegetables. A light, contemporary style restaurant with clean lines, serving modern personalised cuisine prepared in the kitchen guests can peak into.

Wednesday, September 21st 2011

08.00 Registration desk open - *Lobby*

THEME 3: BIODIVERSITY
Chair: Lijbert Brussaard

08.30 – 08.55 **KEYNOTE** – *Haakzaal*
Diana Wall, Colorado State University, The United States
Biodiversity is key to sustaining soils

08.55 – 09.20 **KEYNOTE** – *Haakzaal*
Louise Jackson, University of California, The United States
Nitrogen cycling, soil biota and agricultural intensification

09.20 – 10.00 Plenary discussion - *Haakzaal*

10.00 – 10.30 One minute poster pitches – *Haakzaal*

Presented posters:

Lina Ahlbäck: Spatial diversity patterns in forest springtail (collembola) communities

Jan Bengtsson: Springtail diversity and plant decomposition in the Fynbos biome, South Africa

Felix Bianchi: Putting soil management in a landscape context for ecological intensification of agriculture

Karst Brolsma: Rhizosphere effects on soil microbial activity

Rachel Creamer: Indicators of soil biodiversity from national perspectives to European policy

Hamid Custovic: Peatland degradation processes in the mediterranean karst region of Bosnia and Herzegovina

Christian Geißler: The role of biodiversity for throughfall kinetic energy in subtropical forest ecosystems

Frederic Gerard: Towards a predictive model of soil and rhizosphere phosphorus availability

Olga Grabczyńska: How do different earthworms species change nematode community structure?

Gera Hol: Consequences of microbial species loss for agricultural soils under different management intensities

Ingrid Lubbers: Are earthworms good or bad for the soil greenhouse gas balance?

Muhammad Imtiaz Rashid: Impact of fertilization history of grasslands on apparent nitrogen recovery from recently applied solid cattle manure

Tatiana Rittl: Land use around Atlantic forest parks (sp, Brazil)

Evgeny Shein: Hydrological and thermal regimes of complex soil cover

Jerome Tondoh: Impact of cocoa cultivation on soil health in ivory coast: a chronosequence study

Nick van Eekeren: Soil biological quality after 17 years of continuous maize cropping with and without cover crop and two levels of organic fertilisation

Rachel Creamer: Understanding how the aboveground community modulates the belowground community with regard to phosphorus incorporation and utilisation

Helene Bracht Jørgensen: Land use intensity and soil micro-organisms in agriculture

Stanislav Malý: Soil microbial biomass and activity in organic horizons of deciduous and coniferous forest soils in the Czech Republic

10.30 – 11.00 Coffee break – *Terraszaal and Wolfswaardzaal*

11.00 – 12.30 **PARALLEL SESSION**

2 workshops or masterclasses

11.00 – 12.30	*Marjel Neefjes* Readable writing: writing for the general public *Pomonazaal 1*	*Felix Bianchi and Lijbert Brussaard* Soil Management and Biodiversity workshop *Pomonazaal 2*

2 sessions with 6 oral presentations

	Session 3.1: Soil assessment, land use and ecosystem services – *Peppelzaal 1 and 2*	**Session 3.2: Soil-plant-nutrient interactions** – *Haakzaal*
	Chair: Katarina Hedlund (Lund University)	Chair: Sören Thiele-Bruhn (University of Trier)
11.00 – 11.15	*Michiel Rutgers* Ecological basis for developments in soil Ecosystem Services	*Jack Faber (replaces Jaap Bloem)* The relevance of nitrogen retention by soil biota in the rehabilitation of natural grassland communities
11.15 – 11.30	*Ute Hamer* Land-use change: consequences for soil microorganisms and soil functions	*Sören Thiele-Bruhn* The Antibiotic Sulfadiazine in Manure affects the Biodiversity of the Soil Microbial Community
11.30 – 11.45	*Céline Pelosi* Why do we need long-term trials to assess the impact of pesticides and soil tillage on earthworms?	*Karsten Kalbitz* Does changed litter input affect lignin stability and microbial communities in forest soils?

11.45 – 12.00	*Renske Landeweert* DNA barcode-based characterization of nematodes communities	*Cameron Wagg* Belowground biodiversity effects of plant symbionts supports aboveground productivity
12.00 – 12.15	*Guénola Pérès* Selection of soil bioindicators for impact assessment of land use changes and soil protection. Exemple of the "Bioindicators Programme."	*Marcel van der Heijden* Soil biodiversity and agricultural sustainability
12.15 – 12.30	*Rachel Creamer* Indicators of soil biodiversity from national perspectives to European policy	*Franciska de Vries* Plant-microbe interactions control N leaching from grassland soils

12.30 – 14.00 Lunch with postersession – *Terraszaal and Wolfswaardzaal*

THEME 4: GOVERNANCE AND POLICY

Chair: Mark Kibblewhite

14.00 – 14.25 **KEYNOTE** – *Haakzaal*
Ladislav Miko, Deputy Director-General of DG Health and Consumers at the European Commission
Soil protection as a challenge for European policy

14.25 – 14.50 **KEYNOTE** – *Haakzaal*
Luca Montanarella, JRC, European Commission
On governance and policy related to sustainable development

14.50 – 15.30 Plenary discussion - *Haakzaal*

15.30 – 16.00 One minute poster pitches – *Haakzaal*

Presented posters:

Simon Moolenaar: The SNOWMAN network: transnational programming of strategic research on soils

Anna María Ágústsdóttir: Soil conservation in Iceland and the future implications of whether Iceland will join the EU

John Bailey: Assessing the risk of nutrient loss from covered field heaps of poultry litter

Mirjam Hack-ten Broeke: EU soil thematic strategy: soil threats and priority areas

Mirjam Hack-ten Broeke: Identification of prime agricultural land

Mark Kibblewhite: Ideas for innovative 21st century field systems

Marius Heinen: Effectiveness of unfertilized grass buffer strips along ditches in the netherlands to reduce nutrient loads from intensive agriculture

Marius Heinen: Can lysimeters be used to reduce emission in soil based glasshouse horticulture?

16.00 – 16.30 Coffee break – *Terraszaal and Wolfswaardzaal*

16.30 – 18.00 **PARALLEL SESSION**

3 workshops or masterclasses

16.30 – 18.00	*Sandra Boekhold, Piet Otte and Margot de Cleen* Soil, partner in sustainable development *Pomonazaal 1*	*Lars Hein* From ecosystem services to monetary value *Pomonazaal 2*	*Mark Kibblewhite* Spatial prioritisation of soil protection actions - can meaningful priority areas be defined? *Peppelzaal 1*

2 sessions with 6 oral presentations

	Session 4.1: Soil information in support of policy making and awareness raising – *Haakzaal* Chair: Johan Bouma (Wageningen University)	**Session 4.2: Ecosystem services: a useful concept for soil policy making?** – *Peppelzaal 2* Chair: Ton Breure (RIVM, Radboud University Nijmegen)
16.30 – 16.45	*Rogier Schulte* Functional Soil Planning: can policies address global challenges with local action?	*Thomas Eglin* More policy-driven research on soil: feedback from the French GESSOL program
16.45 – 17.00	*Gabriele Broll* Soil policy in Europe - no communication - no success	*Leo Posthuma* Appraisal and governance of multiple-stressed soil systems
17.00 – 17.15	*Todd Crane* Same soils, different ideas: Comparison of Marka and Fulani agropastoralists' knowledge of soils in central Mali	*Gerlinde de Deyn* Grassland restoration: promoting biodiversity and ecosystem services
17.15 – 17.30	*Willie Towers* The Role of Soils Information in Scottish Rural policy and support	*Katarina Hedlund* Soil ecosystem services , their value and use in promoting sustainable farming
17.30 – 17.45	*Olivier Dewitte* The Soil Atlas of Africa	*Jos van Orshoven* Absolute and relative approaches for integrating soil ecosystem services in rural land use planning
17.45 – 18.00	*Ciro Gardi* Soil atlas of Latin America and Caribbean: soil science and awareness raising	*Estelle Dominati* The value of soil ecosystem services for a New Zealand dairy farm
18.00 – 19.30	Snacks with refreshments and poster session – *Terraszaal and Wolfswaardzaal*	

Thursday, September 22nd 2011

08.30 Registration desk open - *Lobby*

THEME 5: CLIMATE CHANGE
Chair: Rik Leemans

08.30 – 08.55 **KEYNOTE** – *Haakzaal*
Richard Bardgett, University of Lancester, United Kingdom
Harnessing plant-soil interactions for the enhancement of carbon sequestration in soil

08.55 – 09.20 **KEYNOTE** – *Haakzaal*
Wim van der Putten, Netherlands Institute of Ecology, The Netherlands
Climate change and range expansion

09.20 – 10.00 Plenary discussion - *Haakzaal*

10.00 – 10.30 One minute poster pitches – *Haakzaal*

Presented posters:

Franz Bender: Symbiotic soil fungi reduce n2o emissions from model grassland microcosms

Alberto Bernardi: Comparing ammonia volatilization and dry matter yield of fertilized crops with nitrogen and aluminosilicates

Karlijn Brouns: Decomposition of peat in lab experiments simulating summer drought

Timothy Cavagnaro: Using an arbuscular mycorrhiza defective tomato mutant shows increases in soil-plant nitrogen cycling

Wenfeng Cong: Soil carbon sequestration in intercropping agroecosystems

André Dias: Functional traits underpinning desiccation resistance among terrestrial isopods

Antonia Galvez: effect of the irrigation with wastewater on greenhouse gas emissions and fertility of amended soil

Cornelis-Jan van Groenigen: Soil C turnover under elevated CO_2: an integrative meta-analytic approach

Aldis Karklins: Carbon stock in 15-year-old forest stands planted on agricultural land

Roland Klefoth: Enriched 15N-N2O tracing reveals the importance of soil moisture and bulk density for N2O reduction

Imants Kukuls: The accumulation of the organic matter and the change of humification process following afforestation of abandoned farmland

Dirk Mallants: Possible impact of climate change on groundwater recharge and soil moisture budget

Francesca Bampa: The potential use of LUCAS database for the assessment of soil organic carbon

James Kinyangi: Climate variability influences soil management at household and community scales

Marianne Hoogmoed: Soil carbon sequestration potential for afforested pastures in the Mediterranean climatic zone, a meta-analysis

10.30 – 11.00 Coffee break – *Terraszaal and Wolfswaardzaal*

11.00 – 12.30 **PARALLEL SESSION**

2 workshops or masterclasses

11.00 – 12.30	*Peter Kiela, Dick Brand, Margot de Cleen, Piet Otte and Sandra Boekhold* Opportunities of subsoil use for dealing with climate change *Pomonazaal 1*	*Peter Kuikman* 'Credits for carbon care' – from soil eco-system services to monetary value *Pomonazaal 2*

2 sessions with 6 oral presentations

	Session 5.1: Carbon stocks and carbon sequestration – *Haakzaal*	**Session 5.2: Tropical peatlands, Andosols, and Biochar** – *Peppelzaal 1 and 2*
	Chair: Herman Verhoef (Free University Amsterdam)	Chair: Karsten Kalbitz (University of Amsterdam)
11.00 – 11.15	*Feike Dijkstra* The potential of agroecosystems to mitigate global warming under elevated CO2: a review	*Keizo Hirai* Soil carbon stock and their changes following forest degradation in tropical monsoon forest in Southeast Asia
11.15 – 11.30	*Zhiping Cao* Organic Carbon Sequestration Processes Driven by Agricultural Soil Food Web	*Susan Ward* Vegetation and warming effects on peatland carbon fluxes
11.30 – 11.45	*Chris van Kessel* Greenhouse Gas Emissions and Yield-Scaled Global Warming Potential of Major Cereal Crops	*Boris Jansen* Carbon stabilization mechanisms in Ecuadorian Andosols
11.45 – 12.00	*Wim de Vries* Modelling past and future impacts of changes in climate, nitrogen deposition, ozone and CO2 exposure on carbon sequestration in European forests	*Lewis Peake* Biochar amendment to improve soil properties and sequester carbon

12.00 – 12.15	*Annemieke Gärdenäs* Knowledge gaps in soil carbon and nitrogen interactions - From molecular to global scale	*Nele Ameloot* Greenhouse gas emissions from biochar amended loamy soils: a lab CO2, CH4 and N2O emission experiment
12.15 – 12.30	*Reto Meuli* Evolution of soil organic carbon content in Switzerland over the last 25 years, 1985-2009	*Henk Wosten* Peatland restoration in Indonesia to mitigate CO2 emissions

12.30 – 14.00 Lunch with postersession – *Terraszaal and Wolfswaardzaal*

14.00 – 14.30 Closing ceremony including a concluding address by *John Sadler,* co-ordinator of the research theme "The Natural Resources Challenge" of the OECD Co-operative Research Programme on Biological Resource Management for Sustainable Agricultural Systems

Workshops

Workshops

Monday, September 19th 2011

Monday morning: Theme Food Security

Workshop 1: 'Soils and the city': Risk assessment tools to assess the impact of urban soil quality on human health

Paul Römkens[1], Piet Otte[2], René Rietra[1] and Johannes Lijzen[2]

[1]Alterra, Wageningen UR, The Netherlands
[2]National Institute for Public Health and the Environment, The Netherlands

Background and aim of the workshop
Soils in and near urban areas are often under the direct influence of emission from industry or traffic. In other places, soils have been amended with waste materials like dredged sediments or even industrial waste. Infamous examples include the discovery of houses build on former industrial waste in the town of Lekkerkerk as well as housing areas on former mining areas in the southern parts of the Netherlands. Aside from such hot spots, soil quality within urban areas often is characterized by a rather heterogeneous degree of soil pollution. Levels of pollutants including lead and PAH's can vary on a rather small scale (< 10 m) from background levels to seriously polluted which hampers a regional assessment of soil quality.
Despite the varying quantity of pollutants in soil there is marked increase in the interest of people within the city to grow their own vegetables and spend time in a green environment. In many cases people rent small allotments on the edge of the city but recently also areas in between housing apartments are converted to communal gardens. Here, residents often share small pieces of land to grow special vegetables to be used for cooking. As such these activities have a high added value in view of the social interaction within city communities and often such activities are promoted by housing corporations. Unfortunately the less than optimal quality of soils often leads to unrest among residents. Elevated levels of metals like lead or organic contaminants like PAH's can lead to enhanced exposure of such unwanted compounds through consumption of home grown food. In some highly industrialized countries in Asia this even affects the quality of products from regular arable fields which are more and more affected by the growing urban an industrial areas.
To assess the possibilities and potentially also the risks of what is called *urban agriculture* risk assessment tools are needed that are capable of predicting both the transfer of metals and organic contaminants from soil to food as well as the calculation of the human exposure. In the Netherlands the model tool CSOIL is used for such assessments. CSOIL is a combined transfer and exposure model that enables the user to calculate acceptable levels of contaminants in soil depending on the use of the soil.
The aim of the workshop is to give participants insight in the concepts and functioning of CSOIL, its model concepts and applications. A special feature of the workshop is a 45 minute hands on course on working with CSOIL. Participants even can use their own data to perform a site specific risk assessment. By using a stand-alone version of CSOIL on available PC's participants can obtain inside knowledge of the functioning of different model parts within CSOIL.

Tentative programmer
The program of the workshop which is jointly organized by researchers from RIVM and ALTERRA contains 3 short (10-15 minutes including discussion) introductions:

- Background and concepts of CSOIL in risk assessment (RIVM)
- Uptake of metals by crops: model concepts (RIVM/ALTERRA)
- Case study Urban Agriculture in the Netherlands: 'Do we have a problem with lead?' (ALTERRA)

Following these introductions participants are invited to use the available PC's in the workshop room to work with CSOIL. This can be done using (soil) data provided by the organization or using own data from local or regional studies. In the latter case participants need to bring data on soil texture, pH and organic matter content as well as levels of contaminants in soil (total content).

Workshop 2: Global Soil Information Facilities

Tomislav Hengl (tom.hengl@wur.nl), Hannes I. Reuter, Gerard B.M. Heuvelink
GSIF development team, ISRIC, The Netherlands

GSIF stands for Global Soil Information Facilities - Open (publicly available) tools that can be used to enhance collation, harmonization and use of soil and covariate data to assist production of global soil information at high resolution (100 m). This global Soil Information System will become an important part of the Global Land Information System and will serve global land use planning and global environmental risk assessment activities.

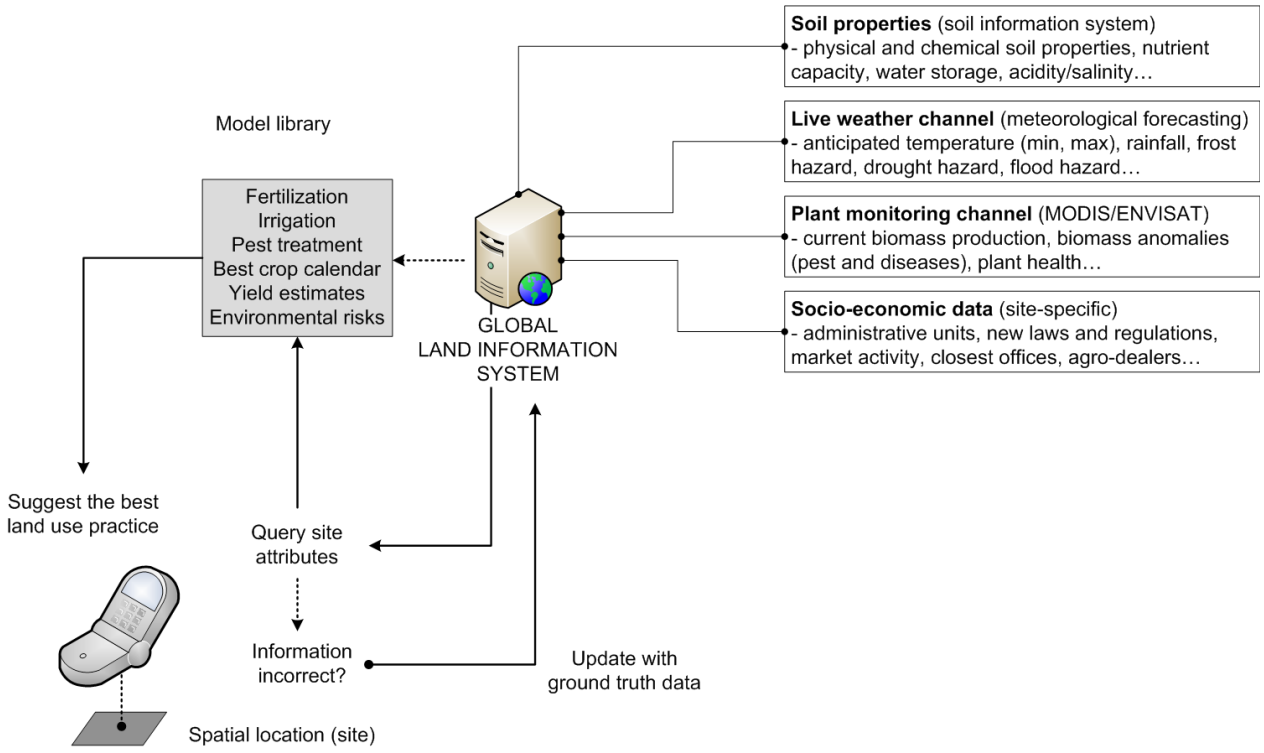
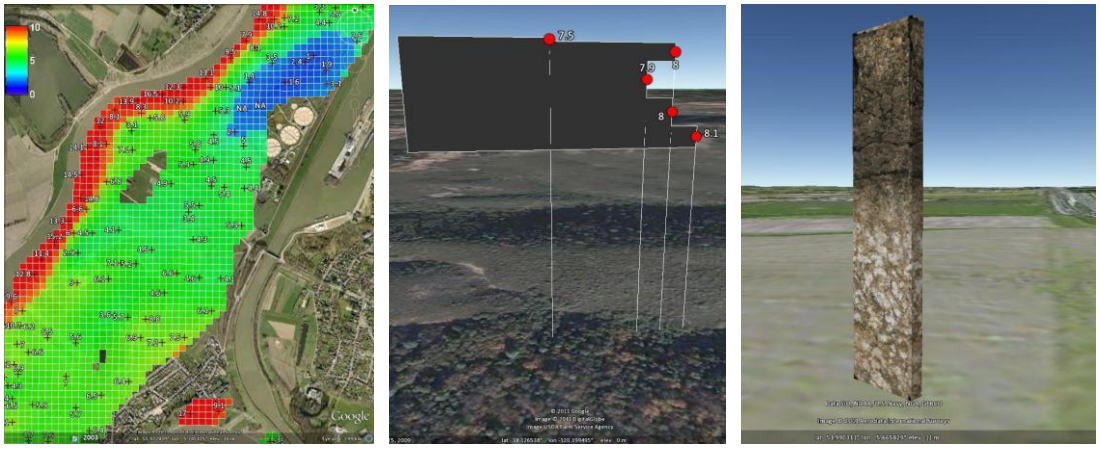


Fig. 1: Schematic example of using a Global Land Information system for site-specific decision making. The future of GSIF is in crowd-sourcing the data input to farmers, agricultural extension workers, high school pupils, ecologists and similar.

GSIF is a framework for production of open soil data. It has been inspired by global environmental data initiatives such as Global Biodiversity Information Facilities, Global Land Cover mapping, OneGeology and similar. The main practical reason for GSIF is to build cyber-infrastructure to collate all existing legacy soil data currently under threat of being lost forever (!).

The main users of GSIF will potentially be various international agencies and initiatives such as GlobalSoilMap.net and other international agricultural development and research organizations such as FAO, CIAT, USAID, Inter-American Development Bank, World Bank. We also aim at National Environmental and Soil Survey agencies, and private entities and individuals, soil surveyors and soil scientists, farmers and agriculture engineers (the public).



This workshop will present the main components of the GSIF: GlobalSoilMap.net soil property maps; Open Soil Profiles data portal (for on-line point data entry); Worldgrids geo-data service; R packages GSIF (automated analysis and mapping functionality) and plotKML (visualization of soil field data and output maps) and GSIF manual (book explaining all functionality and show cases), and then elaborate design of each component. We will also run a demo that shows how state-of-the-art mapping tools can be used to produce high resolution soil property maps of Africa (Malawi showcase).

Monday afternoon: Theme Water Resources

Workshop 1: Green water credits, Soil and Water Conservation in Africa

Hannes I. Reuter
ISRIC – World Soil Information, The Netherlands

Scope, activities and outcomes
The source of all fresh water is rainfall received and delivered by the soil. Soil properties and soil management, in combination with weather and crop type, will determine the course of rainwater as evaporation, transpiration, surface runoff, infiltration, storage in the soil and deep percolation to the groundwater. Improper soil management may result in low use as productive water, i.e. water that is transpired for plant production, and in high losses due to surface runoff or evaporation, which in turn may lead to water scarcity, land degradation, and

food insecurity. Nonetheless, farmers are paid for their crops and livestock but not for their water management, while proper management may lead to less losses and more of-farm availability of water to downstream users. In order to capture these benefits, it is necessary to develop a payment scheme for the provided water and associated services. The Green Water Credits (GWC) programme, coordinated by ISRIC – World Soil information and supported by the International Fund for Agricultural Development (IFAD) addresses this opportunity by bridging the incentive gap.

The GWC programme focusses on the beneficial effects of improved soil and water management practices on reducing destructive runoff, soil erosion and the silting of reservoirs, as well as reducing soil evaporation, while enhancing transpiration for plant production. Over the past 5 years the impact of various GWC interventions on these aspects was calculated for the Upper Tana basin, Kenya using a comprehensive agro-hydrological model that included soil, climate, hydrological, terrain and land use data. The quantitative agro-hydrological analyses are accompanied by socio-economic analyses , including institutional aspects and financial mechanisms. Knowledge of how different land management practices affect agro-ecosystem carbon stocks and greenhouse gas emissions, land degradation and sustainability remains to be studied.

In the green water credits workshop we will demonstrate the effects of implementing improved soil management practices -11 soil and water conservation practices that are common or new in Kenya – to the basin hydrology and the beneficial effects for downstream water users such as hydro-power generating companies, urban and industrial water users and irrigators.

After the presentation of results in Kenya (and Morocco) with main emphasis on the biophysical analyses, participants will have ample time to discuss the concept, the approaches, the results and the way forward in the implementation phase.

The outcome of the meeting will be an overview of ideas of how tailored soil and water conservation management can contribute to integrated water resources management, improving food security and reaping the opportunities of ecosystem services.

Workshop 2: Revitalizing Soil Science Education – how to maintain pedological literacy?

Thom Kuyper
Wageningen University, The Netherlands

Scope, activities and outcomes
In the last decade a lively debate has taken place on soil science education. In some countries soil science is facing a declining number of students, whereas in other countries a soil science renaissance is observed. Pleas to reform soil science have often included a plea to weaken the link between soil science and agriculture, and rather strengthen its link with environmental sciences. Curriculum reforms have been implemented at several universities, in order to halt declining student enrolment (BSc, MSc, PhD).

This Wageningen Soil Conference emphasises the contribution of soil science to the global challenges, rather than as a scientific discipline per se. Would such changes in focus in education really solve the underlying issues? More fundamentally, does soil science have sufficiently strong organising principles to stand as a science by itself? Whereas biologists can

use evolution as a unifying concept, as chemists have atomic theory, is Jenny's 'clorpt' model strong enough as a unifying principle in soil science? If integration in other programmes would be the solution, how can we increase visibility? How can we prevent that soil science is taught by non-soil scientists? (If that is a problem after all?) And how can we maintain a sufficient influx of new soil experts if there are no separate programmes in soil science?

In this workshop we will start with a few inspiring examples of recent reforms of soil science curricula, followed by a discussion fed by challenging propositions. The outcome will be a clearer view on how to maintain or increase pedological literacy, while maintaining an influx of students in the field(s) of soil science(s). We do not strive towards one solution – one size does not necessarily fit all countries with different education systems. However, we would like to achieve a position paper on how to best achieve pedological literacy.

Wednesday, September 21st 2011

Wednesday morning: Theme Biodiversity

Workshop 1: Readable writing: writing for the general public

Marjel Neefjes
Communication Bureau de Lynx, The Netherlands

Several topics in the communicating science to the general public will be addressed in this workshop. Short lectures will be mixed with hands-on exercises. The topics addressed will include:

1. Do you know your audience?
Who is it that you're writing for? Do you want to tell your colleagues what you've done? Do you want to convince a donor to fund your projects, or are you looking for participants for your training course?

2. Will your audience read your text?
People usually decide whether to read a text in a fraction of a second. So your headline and your first sentence are crucial! During the next few seconds they will continue to decide whether they will continue to read. So you'll have to take into account all the factors that influence these decisions. Think about headlines, subtitles, introductions, the length of you sentences and paragraphs and so forth. And content of course: why would your audience read your text? Is it of interest to them? This means you have to get to know your audience.

3. Will your audience understand your message?
It is not you who decides what's too difficult or too complicated, it is your audience! Even if they do read it, that doesn't mean they actually understand. So you have to adapt your text to their level, and try not to give too much information in one go.

4. Will your audience remember your message?
Whether your message will actually stick with your audience depends on several factors:

- The message should be relevant to your audience. There is so much information in this world, they simply can't remember everything.
- The message should be short and simple rather than long and complicated.
- Repetition of your message in different wordings helps your audience to remember it.

5. Will your audience accept your message and act upon it?
Even if you manage to convince them of the importance of your message, is your audience actually going to do something with it? Are they going to fund your proposal, or participate in your training?

Workshop 2: Soil Management and Biodiversity Workshop

Felix Bianchi and Lijbert Brussaard
Wageningen University, The Netherlands

Scope, activities and outcomes
While soil management has historically mainly focussed on increasing productivity in agriculture and forestry by manipulation of chemical and physical properties of soil, it is only more recently that the implications of soil management on the composition and diversity of soil biota have become apparent. Practices like conservation soil management and addition of organic matter may enhance the activity of soil organisms by increasing their diversity and/or density. At the same time, there is increasing awareness that interactions between soil biota and plants are ubiquitous and can have strong effects on plant growth, above-ground multitrophic interactions, and the succession of plant communities. For instance, the far majority of plant species are colonized by mycorrhiza, which can facilitate nutrient uptake and result in higher seedling survival, biomass accumulation, and improved seed quality. The community of nematodes and microorganisms in the soil have been shown to influence the nitrogen levels and phenolic concentration in plants, the population dynamics of aphids feeding on these plants, and mortality rates of aphid parasitoids. Root-feeding nematodes and larvae of click-beetles have been shown to selectively suppress plant species, thereby increasing plant species diversity and driving plant succession. These examples highlight exciting opportunities to link above- and belowground processes for managing agricultural land and natural ecosystems.

In this workshop we will explore options of implementing soil management practices (e.g. no- or minimum till, addition of compost or solid manure, planting of cover crops, introduction of plant pathogens or their antagonists) to address current challenges related to:

- sustainable agriculture
- management of invasive species
- restoration of natural habitats
- mitigation of climate change

Participants will discuss the opportunities (and risks) of implementing soil management to tackle these major challenges in breakout sessions. The outcome of the meeting will be an overview of ideas of how tailored soil management can contribute to restoring/conserving below- and above ground biodiversity and contribute to the 4 challenges indicated above.

Wednesday afternoon: Theme Governance & Policy

Workshop 1: Soil, partner in sustainable development

Sandra Boekhold[1], Piet Otte[2] and Margot de Cleen[3]

[1]Soil Protection Technical Committee, The Netherlands
[2]National Institute for Public Health and the Environment, The Netherlands
[3]Ministry of Infrastructure and the Environment, The Netherlands

Climate change, energy shortages, urbanization, health and food security are some of the societal and economic challenges for the coming decades. Soil and the subsurface are part of the answer to meet these major challenges imposed to man. Goal of the workshop is to describe the international soil research needs in this perspective. Aim is to publish the results as a follow up of the workshop.

Outline of the workshop

- An introduction film 'Terra' in English, illustrating three perspectives on soil use: soil abused as a slave, protected as does Mother Earth and sustainably used as a partner (6 minutes).
- Discussion with audience about these three perspectives in relation to the research or policy field they work in.
- Short presentations on societal challenges, sustainability issues, ecosystem services, the influence of different scales and knowledge management.
- Collaborative survey on international soil relevant sustainability issues and the role of ecosystem services, leading towards definition of the main research items for an international research agenda.

Soil plays a significant role in interregional climate effects, water balance, food production, preservation of biodiversity and human health. This makes soil a vital partner in sustainable management at all levels of our environment. An understanding of the functioning of the soil, ecosystem services and the interrelations of the different soil functions is therefore essential for planning and defining the right policy measures.

The Dutch Soil Platform initiated a research agenda for the future: soil as a partner in sustainable development. The agenda starts with a description of societal trends and challenges and ends with the definition of related knowledge questions in the field of soil science. This initiative is a partnership between several ministries and major Dutch research institutes.

Workshop 2: From Ecosystem Services to Monetary Value

Lars Hein
Wageningen University, The Netherlands

The masterclass 'Ecosystem services' (1.5 hours) will provide the participants an opportunity to engage in a basic analysis of ecosystem services provided by a national park, potential indicators for their monetary value, and the link between ecosystem services and soils. In small groups, the participants will work on a specific case study. The case study site the participants will analyse is the Hoge Veluwe national park, the destination of one of the

conference excursions. The Hoge Veluwe park offers a mix of forest and heather landscapes and provides a diverse mix of ecosystem services.

Workshop 3: Spatial prioritisation of soil protection actions - can meaningful priority areas be defined?

Mark G. Kibblewhite
Cranfield University, United Kingdom

This workshop will explore how risk assessment could be used to identify priority areas for soil protection. It will address the feasability of this for soil erosion, loss of soil organic matter, compaction and diffuse contamination. Generic approcahes will be explored as well as threat-specific ones. The relevance of achievable outputs to policy definition and implementation will be discussed.

Thursday, September 22nd 2011

Thursday morning: Theme Climate Change

Workshop 1: Opportunities of subsoil use for dealing with climate change

Peter Kiela[1], Dick Brand[1], Margot de Cleen[1], Piet Otte[2] and Sandra Boekhold[3]

[1]Ministry of Infrastructure and the Environment, The Netherlands
[2]National Institute for Public Health and the Environment, The Netherlands
[3]Soil Protection Technical Committee, The Netherlands

It is expected that climate change may result in rising sea levels, large-scale flooding, extreme rainfall and heat stress. It represents a possible risk for the well being of man . To mitigate the effects of climate change, agreements were made concerning CO_2 reduction and the use of 'green energy'. Furthermore, urban environments should be made resistant against the negative effects of climate change. Over the past decades the Dutch policy on soil quality aimed at protecting the soil quality and restoring contaminated sites. Given new societal tasks, the soil policy is shifting to an integrated approach for spatial planning and the sustainable use of the soil-water system. The potential of the soil-water system contributing to societal tasks is a promising prospect. One of these societal tasks is the mitigation and adaptation of the effects of climate change in urban and rural environment.

In this workshop the position of the Dutch soil policy in relation to climate change and recent scientific developments will be discussed. Possible opportunities or services of the soil water system to deal with the effects of climate change will be presented, e.g.:

1. Increased use and promotion of aquifer thermal energy storage.
2.. Mitigation of heat stress and extreme rainfall events in urban environments.
3. Mitigation of CO_2 emissions from peat soils by proper water management.
4. Adaptation to temporary water excess by controlled flooding and spatial renovations.

Outline of the workshop

- The presentation of the scientific, practical and policy key points of the five 'soil services'.
- A comprehensive evaluation of advantages and disadvantages, sustainability aspects and political considerations. This will be concluded with provocative questions and statements.

- Questions and statements will be discussed with the participants of the workshop in small groups. The results of the discussion in groups will be presented at the end of the workshop.

Remarks
- We will invite experts to present (in so-called flash presentations) opportunities of the soil-water system and the way soil water system can be taken into account in spatial planning instruments to participate in the discussions
- The organizers invited dr. Jacqueline Cramer (the former minister of Environment) to present the contemplative part of the workshop and to formulate questions and statements for the discussion.
- It is the objective that a discussion paper will be released prior to this session.
- After the conference the results of the workshop will be added to the paper.

Workshop 2: "Credits for Carbon Care" - from soil eco-system services to monetary value

Peter Kuikman[1] and Emiel Elferink[2]

[1]Alterra, Wageningen University and Research Centre, The Netherlands
[2]CLM – centre for agriculture and environment, The Netherlands

scope, activities and outcomes
Soil management has historically focussed on increasing productivity in agriculture and forestry. It is only more recently that the implications of soil management on soil organic matter content and emissions of greenhouse gases (source of CO_2) has become apparent. This has put emphasis on practices that conserve organic carbon in soils and on sequestration of additional organic carbon in soils as means to mitigate climate change. These actions now are proposed through international climate change mitigation policies. However, internal (knowledge and recognition) and external (economic) incentives are insufficient. Farmers and land owners may be encouraged to adopt adequate management through payments from ecosystem services buyers.

In this workshop we will explore options to define, design and develop an ecosystem service for climate mitigation through sequestration and conservation of soil carbon via targeted and additional soil management. This should contribute to effective climate change mitigation and fit other current challenges in the area of sustainable agriculture and soil and land management. We will further explore what an effective monetary system to sustain such an ecosystem service and economic benefits to farmers and land owners could be like.

The participants in the workshop will learn about recent initiatives to set up climate mitigation soil services and arrange for adequate funding of such services and have the opportunity to discuss options, challenges and risks of implementing soil management to tackle these major challenges. The outcome of the meeting will be an overview of ideas of how technology (agricultural practices) and institutional arrangements (e.g. financing, ownership, certification) will work towards implementation of such an ecosystem service on climate mitigation.

Theme 1
Global Food Security

Keynote
Hans Eenhoorn

THE FIGHT AGAINST CHRONIC HUNGER: A HOLISTIC AND ENTREPRENEURIAL APPROACH

EENHOORN, HANS (J.W.EENHOORN@INTER.NL.NET)

Associate professor (em.) for Food security and Entrepreneurship, Wageningen University and Research Centre, The Netherlands

The United Nations' "Universal Declaration of Human Rights" (1948), defines food security as a **human right** (article 25). Apparently the world did not take this "right" very serious, because the number of chronically hungry people increased, despite the success of the green revolution in Asia. In 2000 Foodsecurity became part of the Millennium Declaration, "Halving hunger by 2015", duly signed by all 189 members of the United Nations. Unfortunately the food price crises from 2008-2011 increased the number of people suffering from chronic hunger by more than 100.000.000 people to a total of about 1 billion!

It is morally unacceptable that in this world about 1 billion people live in wealth and have so much to eat that many suffer from obesity, cardiovascular disease, diabetes and food-related-cancers and at the same time another 1 billion people live in poverty, are chronically hungry and denied the very minimum requirements of human dignity. It is not only a moral issue, but also a world safety issue. The great divide between rich and poor causes the world to be unstable through food revolts (Middle East, Horn of Africa 2011), armed conflict, refugee streams and the spreading of contagious disease. Besides it is economic nonsense to exclude 1 billion people as consumers and/or producers.

Nowhere is the failure of alleviating hunger more glaring than in Sub-Saharan Africa where the number and proportion of hungry people are forecast to increase in many countries. Sub-Saharan Africa accounts for more than 200 million of the undernourished in this world. Business as usual will not achieve the Millennium Development Goal of halving Hunger by 2015. A paradigm shift has to be realised, away from the conventional macroeconomic improvements and towards an approach that places more emphasis on agricultural development, entrepreneurship, the application of science, capital investment and public commitment to achieve Food security for the poor and help them out of their **"poverty trap".** Economic growth alone is not sufficient to lift the poor and hungry out of their misery, because the poverty reducing effects of growth, largely bypass the rural poor.

Fifty percent or more of the rural poor has access to farmland, but for various reasons (like poor soil quality and water problems) are incapable to grow enough food to feed themselves adequately, let alone produce marketable surpluses. Supporting smallholder farmers to feed themselves and produce marketable surpluses is the quickest--and in the short-run the most efficient-- way to reach food-security for more than two hundred million poor and hungry people in Africa and Asia. There are virtually no examples of mass poverty reduction, that did not have their origins in sharp rises in employment and self-employment as a result of the higher productivity in small family farms.

The original Green Revolution in Latin-America and Asia, was one of the key successes of humankind in the latter third of the 20th century. But the success of this approach in Africa has been very limited. The contribution of improved crop varieties to crop yield increases has been 70-90% in Asia, Latin America and the Middle East, but only 28% in Sub-Saharan Africa.

One of the main reasons is that unlike in other developing regions, soil nutrient depletion is extreme in Africa and therefore the key entry point is replenishing soil fertility at the lowest possible cost rather than improved varieties. But even in terms of native soil fertility, Sub-Saharan Africa is simply less endowed than Europe because of unfavorable climate and geology. Decomposition of biomass takes place rapidly in consistently warm temperatures, leaving little time for the accumulation of humus. As a result, extensive layers of deep fertile topsoil are rare in Africa. Also, Africa is the world's oldest land mass. Nutrient-impoverished granites, basement sediments and sands cover about 90% of Africa's land surface. These kinds of proven adverse natural conditions in Africa are brushed under the carpet or are deemed irrelevant when macro-economists take the floor.[1] Similarly, the need to better manage available water in rain-fed systems is another fundamental problem. Both nutrients and water are biological imperatives that transcend socio-economic and political ones.

The studies of the United Nations Taskforce on Hunger and many other institutions, provide a range of technical means that can reduce hunger for most groups and in diverse contexts. Apart from necessary policy reform, the recommendations of the UN Hunger taskforce focus on:

Increasing the agricultural productivity of food-insecure farmers; improving soil health, improve and expand small-scale water management, improve access to better seeds, establish effective agricultural extension services.

Increasing rural incomes and making markets work for the poor.

It can be concluded that in the short run, sustainable food security can be best enhanced by concentrating on the (sub-) subsistence smallholder. This implies looking for enabling mechanisms to increase agricultural productivity and market development at the local level. Farmers, even smallholder farmers, are entrepreneurs, who are only willing to take risks if profit incentives are apparent.

The question: "what is holding smallholders back, to move from (sub) subsistence farming as a way of life, towards a more entrepreneurial attitude?" was investigated by the department of Food security and Entrepreneurship of Wageningen University and Research Centre (WUR).[2]

This research indicated that the most important constraints to overcome are:

Capital: with money, soils can be improved, better seeds bought, water-harvesting projects financed, efficient tools bought, knowledge and technology provided and labor and extension services paid.

Good Governance: with reliable governance and law and order, risk and uncertainty will be mitigated and efficient farmer based organizations (FBO's) can emerge.

Infrastructure: better roads and communication will be an enormous incentive for entrepreneurship.

Mindset: understanding the mindset of smallholders will be essential for effective support.

[1] Smaling E, 2005. Harvest for the world, Enschede
[2] Eenhoorn J, Becx G, 2009. Constrain constraints, Wageningen

The overall conclusion is thus, that considerable capital injections and technical assistance (soil, seeds, water, markets) are required for a prolonged period, to overcome the constraints smallholders face to improve productivity and move towards an economic position above subsistence level. However many constraints cannot be solved by capital injections but require a mindset change and structural reforms at governance and infrastructural level. Thus there should be **understanding** that a holistic approach to solving the constraints is required, including the understanding of cultural and religious habits, attitudes, norms and values of poor farming communities, which is necessary to enhance a mindset change.

4 areas for high priority solutions are recommended:

- Agricultural **research and knowledge transfer** is essential to stimulate productivity increase. It is strongly recommended to enable renowned knowledge institutions like WUR to make their skills and competencies available for smallholder development, in close cooperation with National institutions in the South.
- It is essential for **smallholder farmers to organize themselves** and create countervailing power on in-and output markets and become respected partners in negotiations with the Governments. It is recommended to dramatically increase the support for farmers to organize themselves properly.
- An **adequate infrastructure** is a precondition for successful marketing of agricultural products. It is recommended to place rural infrastructure improvements very high on every development agenda.
- **Good Governance** at National, Regional and Local level, that facilitates an enabling environment and a positive business climate for smallholders is at present more exception than the rule. It is therefore recommended that in bi-and multilateral discussions and negotiations, a lot of emphasis be placed on measures to provide incentives for smallholder farmers.

Any action plan must take the constraints in their **holistic** context into account; an integrated approach is a must. An entrepreneurial approach, addressing constraints in their holistic context and defining realistic operational action criteria is necessary to help the real poor out of their "poverty traps".

Keynote
Bruce Campbell

ENSURING FOOD SECURITY IN THE FACE OF CLIMATE CHANGE

CAMPBELL, BRUCE (BRCA@LIFE.KU.DK); ZOUGMORE, ROBERT; KINYANGI, JAMES; AGGARWAL, PRAMOD; VERMEULEN, SONJA

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Denmark

This paper looks at three of the greatest challenges of the 21st century – ensuring food security, adapting agriculture to climate change and reducing the ecological footprint of agriculture (with a particular focus here on mitigating climate change). Using some recently published data it proposes five key messages, some of which relate to soil management.

Feeding the world sustainably and equitably is one of the greatest challenges of our time. Today about one billion people are food insecure and about two billion suffer micro-nutrient deficiencies. It is estimated that more than a 60% rise in food production is required by 2050 to feed the growing population with its changing diet. While market forces and continued investment in science and technology are likely to be sufficient to satisfy the food needs of wealthier countries and wealthier members of society, it will be the poorer members of society, and developing nations, that will struggle to achieve food security.

Agriculture performance has to improve in the face of climate change. The expectation is for more frequent and more severe extreme weather events globally. This could contribute to greater price volatility, and in some jurisdictions, food export restrictions, food riots and humanitarian disasters. Over the longer term, higher temperatures, shorter growing seasons and sea level rise are likely to have severe impacts in many developing countries. For example, in large parts of South Asia and parts of sub-Saharan Africa (SSA) there are a quarter of a billion food-insecure people living in agriculture-intensive areas that are between now and 2050, highly exposed to a potential five percent decrease in the length of the growing period . Many parts of SSA will see declines in length of growing period of up to 20% by the turn of the century, if the global temperature rises by four degrees. Even at the optimistic end of the range of possible temperature rises (two degrees), the impact at low latitudes will be relatively significant. For instance, in low-income developing countries wheat yield is predicted to decline by between 13 and 18% by 2050, and irrigated rice by about 9%. The impacts of climate change are already being felt. Using data from the last few decades, scientists found that a temperature rise of a single degree Celsius would cause yield losses in more than half of the present maize-growing region in Africa – provided the crops received the optimal amount of rainfall. As a result of climate change, it is estimated that developing countries' agricultural imports are expected to double by 2050.

Agriculture's global footprint is large, agriculture being one of the drivers, if not the major driver, that is pushing the world beyond the so-called safe planetary boundaries. Greenhouse gas emissions from agriculture are up to 30% of the total global emissions, agriculture is the largest driver of biodiversity loss and land cover change, is depleting phosphorus reserves, is the largest driver of the nitrogen cycle, is one of the major causes of ocean acidification, and is the largest user of global freshwater supplies. At a local level it is causing a multitude of negative impacts, from groundwater decline to dead zones in lakes and seas.

Thus, agriculture sits at the interface of a "trilemma": a food security challenge, an adaptation challenge and an ecological challenge. **The first key message is that we need much greater understanding of the trade-offs and synergies amongst the three objectives of food security, adaptation and reducing the ecological footprint; and that this must lead to new incentives and institutional arrangements for farmers and others involved in food systems to deliver on these objectives.** Part of this understanding must relate to cross-scale effects, where solving a problem at one scale may well lead to problems at another scale – a global, regional and landscape perspective is needed – solving production problems at the field scale is insufficient. The term "climate-smart agriculture" is emerging to characterize the attempt to deliver on food security, adaptation and mitigation objectives.

Many argue that the key to global food security is reducing over-consumption, reducing meat consumption and reducing waste, particularly in developed countries. While these are some important ingredients, they are by no means sufficient (and may be very difficult patterns to change). For instance, even in this globalizing world, many food systems in developing countries are poorly linked into global markets, and thus measures taken in developed countries will have little impact in developing countries. To illustrate how important local and national markets are we take the case of milk and maize in Kenya. About 95% of milk production for Nairobi comes from small producer-consumers, and only 3% of maize consumption in Kenya comes from imports. Thus food security challenges have to be tackled through improved agricultural production, rural development and wider poverty alleviaition measures. . Yield gaps in several parts of the developing world are exceptionally high – reducing the yield gaps will be an important step for food security. In many intensive agricultural areas (such as Punjab of India and Pakistan), yield gaps are small and climate change will reduce yield potential. In these regions there is a need to increase yield potential over time (while also giving attention to the agricultural footprint of agriculture). Climate risk management, for more uncertain weather events, must become increasingly important. **The second key message is that the agricultural production, rural development, poverty alleviation and climate change agendas must be closely aligned.**

Achieving food security without harming the environment will require sustainable intensification or ecological intensification, with consideration to multiple factors – land, nutrients, water, energy, biodiversity, and pests and diseases. However, in many other contexts, diversification – such as displayed in complex home gardens – will be more important, e.g. to stabilize incomes, provide risk insurance etc. It is apparent that what will be needed will vary dramatically across the globe and even within countries. And yet these local solutions will often be insufficient to address global problems. In the context of climate change, a global framework is needed, perhaps involving global standards on agricultural emissions, to ensure that emission targets are met without compromising food security, and without disadvantaging countries unfairly. For this reason, it is essential that agriculture is addressed in the UNFCCC negotiations. To date, the agricultural text has been excluded from the global agreement. **The third key message is that an agricultural work program is needed under the UNFCCC so that a framework for agricultural mitigation and adaptation can be developed, with appropriate funding.** This work program needs to address the complex synergies and trade-offs amongst food security, adaptation and mitigation, to examine how issue of trade can be resolved (or at least agreeing that some of the contentious trade issues will be dealt with in the global trade negotiations) and to determine how co-benefits (e.g. biodiversity conservation) can be achieved.

Soil management is at the centre of nexus amongst food security, adaptation and reducing the ecological footprint. Soils get particular mention in the mitigation discussions. It has been widely observed that long term cultivation has a caused severe decline in soil carbon stocks. Accelerated mineralization of organic matter following land clearing and continuous cropping has been reported to decrease soil carbon content by up to 30 %. Soil carbon sequestration is often touted as a key means to meeting global mitigation targets. In addition, the benefits of soil carbon to maintaining soil fertility, water holding capacity and ultimately crop yields means that management of soil carbon can help address the trilemma. However, there is controversy in this area and some non-governmental organisations have used the uncertainties as a means to forward an agenda that argues against agriculture and soils being included in existing carbon offset schemes. One contentious issue relates to the degree to which soil carbon stocks can be increased globally, with some arguing that large amounts can be sequestered while others focus on the high costs (including labour) of practices that mitigate soil carbon loss. A contentious issue relates to the degree to which soil carbon can be subject to MRV (Measurement, Verification and Reporting), in order for it to be included in market and non-market schemes to mitigate emissions. As an example of the measurement problem, estimates of soil carbon content varied by up to ten fold in the fields of farmers in Burkina Faso, with much of that variation occurring within the fields of a single household rather than between households. Another issue relates to smallholder farmers – even if the problems of measurement can be solved will such schemes be opportunities for smallholder farmers, or will they only benefit large producers? There are also controversies around specific practices – biochar, conservation agricultural practices based on GMOs etc. **The fourth key message then is that science and technology has a key role to play if soil carbon sequestration is to be become a cornerstone of climate change mitigation.**

Agriculture is often regarded as "too complex" by the climate change negotiators, and thus a stumbling block to progress in the negotiations: balancing the multiple objectives, measuring emissions and soil carbon across diverse practices and landscapes, and dealing with trade-related issues. This is one of the reasons why there has been such slow progress in getting agriculture on the climate change agenda. **The fifth key message is that we need early action (i.e. while the negotiations continue) to expand the evidence base for climate-smart agricultural technologies, practices, and policies.** This will help build confidence that agriculture can be part of the solution to climate change adaptation and mitigation. This early action must include the testing of simple methods to estimate soil carbon, developing appropriate incentives to implement practices at scale, enhancing institutional arrangements to reduce transaction costs in landscapes with many smallholders, etc. Twelve cases are highlighted in a recent booklet on climate-smart agriculture, six of them featuring soil management (involving soil carbon sequestration; as part of conservation farming; sustainable land management; rehabilitation of degraded areas; and erosion control). Thus soil management will be important in this early action.

In conclusion, agriculture is rather special in that it is at the centre of three major global challenges that have to be solved simultaneously. Very simple adaptation strategies, already available today, such as change in crop variety or planting date, can address short -term changes in climate. However, we should expect, and work towards, a relatively major transformation of agriculture. In some countries this transformation will center on resource use efficiency, while in others it will focus on increasing productivity, while in others it will focus on transformational adaptation to meet the challenges of new climates. Thus far, agriculture has been sidelined in international climate change negotiations. Much effort in science and technology will be needed to fill knowledge gaps, help resolve trade-offs, and clarify

controversies. Early action is needed to expand the evidence base and build confidence that agriculture can be part of a global agreement. Soil management has a particular niche to play in this agenda of transformation and early action.

Session 1.1
Nutrient management for food security

POTENTIAL IMPACTS OF RESOURCE EFFICIENCY STRATEGIES ON GLOBAL AGRICULTURAL LAND AND PHOSPHORUS USE

VAN DEN BERG, MAURITS (MAURITS.VANDENBERG@PBL.NL); NEUMANN, KATHLEEN; VAN VUUREN, DETLEF; BOUWMAN, LEX; KRAM, TOM

PBL Netherlands Environmental Assessment Agency, The Netherlands

Increasing population and wealth are resulting in growing demands for key resources. Continued physical, economic and geopolitical accessibility of these resources are of paramount concern. Resource efficiency is understood as making the best possible use of natural resources, using them wisely and sustainably throughout their lifecycle. This study explores the practical meaning and potential of resource efficiency. Results on two distinct, yet strongly interlinked resources are presented: agricultural land and phosphorous (P). The study is geographically explicit, has a global scope, and a time horizon up to 2050. Starting from an authoritative baseline, scenarios were developed using ambitious, yet realistic and coherent resource efficiency assumptions regarding future agricultural yield increase, livestock husbandry practices, phosphorous recycling, consumer habits etc. The TIMER/IMAGE modelling suite was used, together with a P supply, demand and trade model, to explore global land use dynamics, P use and the depletion of P resources in each of the scenarios. Results suggest an expansion of agricultural area, globally, until 2020/2030, followed by stabilization. This can be curbed to a contraction if resource efficiency assumptions are implemented. Such measures would be most effective in regions such as sub-Saharan Africa, where (in the baseline) pressure on land resources is building up most rapidly and persistently, while the potential for eco-efficient yield improvements is much greater than elsewhere. With regard to P, taking all resource efficiency strategies together, savings of some 30% could be achieved compared to the baseline projection. Strategies aiming to recycle P (from livestock and humans) seem to have the bigger potential. Even with these savings, the exploitation of P-reserves will inevitably accelerate to sustain increasing food and feed demands, especially in developing countries. Physical depletion of extractable phosphate rock is not likely in the near-term, but production costs are likely to rise and phosphate supply will be more-and-more geographically concentrated.

MAIZE NUTRIENT RESPONSE IN TROPICAL AND SUBTROPICAL REGIONS AS EVIDENCED FROM HISTORIC CROP TRIALS

VAN DER VELDE, MARIJN (VELDE@IIASA.AC.AT); KHABAROV, NIKOLAY; OBERSTEINER, MICHAEL

International Institute for Applied Systems Analysis (IIASA), Austria

Over the last century, fertilizers have been essential in increasing and improving global crop productivity and food security status. Population projections and food demand assessments clearly indicate that current agricultural productivity growth is not sufficient to feed the 9 billion people inhabiting the world in 2050. Dramatic improvements in crop production levels will be a necessity. In the industrialized countries oversupply of fertilizers has lead to detrimental environmental consequences for water quality and biodiversity, and attendant financial losses. Increasingly, precision farming practices and optimal nutrient supply are promoted to bring these agricultural systems on a pathway of sustainable intensification while maintaining the world's highest yields.

By contrast, crop yields in the developing world, especially in Africa, are still very low and suffer from a shortage of nutrient supply. Evidence exist that increasing fertilizer use through e.g. subsidized agricultural inputs can lead to cost effective yield improvements. Importantly, improved crop productivity will not only increase yields, but also income and livelihoods. To analyze comprehensively the response of maize to nitrogen and phosphorus fertilization in subtropical and tropical regions of Africa, Latin America and SE Asia, we analyzed experimental data from historic maize field trials and demonstrations carried out under the FAO Fertilizer Programme from the 1970’s through the 1990’s using the Mitscherlich-Baule crop response function. Crop response functions capture crop nutrient response, and allow deducing attainable crop production levels provided that local socio-economic constraints are known.

In many maize field trials a strong response to P-fertilizer was seen confirming that many soils in subtropical and tropical regions often suffer from P supply problems. This highlights the need to provide the crop with a balanced supply of nutrients which is essential for optimal nutrient use efficiency.

UNDERSTANDING THE IMPORTANCE OF THE DIVERSITY OF SITES AND FERTILIZATIONS PRACTICES ON SOIL FERTILITY AND LETTUCE PRODUCTION IN URBAN AREAS OF BURKINA FASO

KIBA, DELWENDÉ INNOCENT (INNOKIBA@YAHOO.FR)

ETH Zurich, Switzerland; INERA, Burkina Faso

Keywords: urban agriculture, vegetable gardens, lettuce, phosphates, heavy metals, Burkina Faso

The production of vegetables in urban areas of West Africa is facilitated by the availability of solid wastes and waste waters which are used as fertilizers. Whereas nutrients balances as well as the risk of soil and crop pollution by pathogens and heavy metals in these urban vegetables gardens (UVG) have been largely investigated, there is little information on how the diversity of farmer's practices and sites conditions affects soil and crop quality in these UVG. In four vegetables sites in Ouagadougou called Boulmiougou, Hopital, Tanghin, Wayalguin, we sampled soils on the horizons 0-15 and 15-30 cm in farmer's plots. We determined their texture, pH, total C, N, P, inorganic P, available P and heavy metals (Cd, Cu, Pb, Cr, Zn, Ni) contents. We evaluated on the same plots the lettuce yields and we analyzed the lettuce for N, P, K, Ca, Mg, Na and Cd, Cu, and Zn. Farmers were then questioned about their fertilization habits. Results showed that solid wastes and waste waters are the main sources of nutrients in sites located inside the city (Hopital, Tanguin and Wayalguin) leading to an accumulation of soil available metals while in site Boulmiougou located in the periphery, manure and mineral fertilizers are the preferred source of nutrients leading to high soil available P. The high soil available Pb observed in Tanguin was attributed to atmospheric pollution as this site is close to a major road. Lettuce dry matter yields reached 1.85, 1.10, 1.16, and 1.16 T/ha respectively for site Boulmiougou, Hopital, Tanghin, Wayalguin and were not statistically different. It appeared that organic matter added to these urban soils is stabilized by clay leading to nutrients and metals accumulation while inputs of mineral fertilizers lead to increased soil P availability and N, P and Cd accumulation in lettuce.

ASSESSING THE ROLE OF ATMOSPHERIC FERTILIZATION IN CONCEALING THE SEVERITY OF LAND DEGRADATION IN WEST AFRICA

TAMENE, LULSEGED[1] (LDESTA@AFRICASOILS.NET); LE, QUANG BAO[2]; VLEK, PAUL[3]

[1]International Center for Tropical Agriculture (CIAT), Malawi
[2]Swiss Federal Institute of Technology (ETH) Zurich, Switzerland
[3]Center for Development Research (ZEF), University of Bonn, Germany

Keywords: NDVI, long-term biomass productivity trend, land degradation, soil erosion, multi-scale approach, Volta basin, West Africa

Assessing the role of atmospheric fertilization in concealing the severity of land degradation in West Africa Lulseged Tamene, Quang Bao Le, Paul, L.G. Vlek Abstract Separating human-induced land degradation from that caused by natural processes is important for developing mitigation strategies. However, achieving this is a challenging task especially in the world of global climate and atmospheric change. Current remote-sensing data and spatio-temporal analyses allow the distinction of climate and human-induced land degradation on a sub-continental scale, but the underlying processes cannot be discerned at this scale. This study is conducted at a river-basin scale to (1) identify land degradation hotspots using long-term satellite data and soil erosion models, and (2) assess the correspondence and divergence of land degradation assessed by normalized difference vegetation index (NDVI) shifts with and without accounting for atmospheric fertilization with that based on soil erosion assessment at different scales. Long-term remote sensing (NDVI) and rainfall data were used to identify human-induced land degradation hotspot areas in the Volta basin. The results were compared with critical zone of soil loss delineated based on spatially distributed soil erosion model in the White Volta sub-basin. A spatial comparison of the land degradation hotspots derived from the above approaches revealed that the biomass productivity (NDVI)-based land degradation assessment grossly underestimated the extent to which soil is being degraded, unless a correction was included to account for atmospheric fertilization. The study demonstrates the need for using a multi-pronged assessment strategy in land degradation assessment in order to gain a better insight of the processes involved.

DEVELOPMENT OF SOIL SUSTAINABILITY INDICATORS

RAGNARSDOTTIR, KRISTIN VALA (VALA@HI.IS); JÓNSDÓTTIR, EYDÍS MARY; DAVÍÐSDÓTTIR, BRYNHILDUR

University of Iceland, Iceland

Soil sustainability indicators (SSI) are presented here within a framework that takes three dimensions of sustainability into account: Nature, economy and society and wellbeing. The BellagioSTAMP was used as an overarching guideline in the development of the SSI. We developed a conceptual, theme-based framework, using the ISIS Compass of Sustainability, the United Nations Commission on Sustainable Development sustainability indicator framework and the DPSIR (Drivers–Pressures–State–Impacts–Responses) indicator framework. Preliminary results the nature dimension are: Net emission of greenhouse gases, extreme events, pedodiversity, aggregate size and stability, bulk density, soil sealing, cation exchange capacity, contamination, pH, microbial biomass, potential N mineralization, soil protective cover, total soil organic matter, natural disasters, nutritional quality of crop and potential erosion risk. For the economy dimension we have chosen the following indicators: Economic value of soil ecosystem services, economic loss of soil degradation, land use changes, fossil energy intensity, waste generation intensity, organic waste composted, yield, return on equity, debt to asset ratio, energy returns on investment, return on investment, fertilizer use intensity, pesticide use intensity, irrigation intensity, cultivation index, crop residual removal rate, genetically modified crops, intensity in the use of heavy machinery. For the society and wellbeing dimension the following indicators have been adopted: Access to information and justice, government policies that encourage land degradation, government policies that encourage sustainability, land tenure security, soil in the city, expenditure on soil related research development, literacy, education on sustainable agriculture, public awareness of the value of soil, public participation, recognition programs, human health, exposure to landfills and polluted soils, suicide rate among farmers, elderly dependency rate, population growth and armed conflicts. The aim of this work is to provide a basis for determining the most important soil sustainability indicators so that land-owners and other stake-holders can manage soil sustainably for future generations.

EVALUATION OF NUTRIENT MANAGEMENT STRATEGIES AT FARM LEVEL IN ETHIOPIA FOR IMPROVED FOOD PRODUCTION

VAN BEEK, CHRISTY[1] (CHRISTY.VANBEEK@WUR.NL); AGEGNEHU, GETACHEW[2]; DEBELE, TOLESSA[2]; TERANO, YUSUKE[3]; HEESMANS, HANNEKE[1]; ELIAS, EYASU[3]

[1]Wageningen University and Research Centre, Alterra, The Netherlands
[2]EIAR, Ethiopia
[3]Wageningen University and Research Centre, The Netherlands

Soil fertility is a key driver for food production in Africa and despite major efforts to overcome this issue through large scale fertilizer supply programmes, the adoption by farmers is still low. In Ethiopia the majority (65%) of the farmers do not use fertilizer at all and the remainder apply only at very low rates. There are several reasons for the poor adoption by farmers which include: 1. Apparent low value to cost ratios of fertilizers because of high costs and low fertilizer recovery in crops due to low organic matter contents, acidity, erosion, erratic rainfalls, etc. 2. Ill performing supply chains and lack of timely delivery of fertilizer. To understand current farm management strategies and its implication for soil fertility and food production detailed surveys were performed on 18 farms distributed over 2 sites (Holetta and Melkassa) in Ethiopia. Nutrient management strategies were classified according to its ratios between the three main driving mechanisms: 1) crop – market interactions, 2) crop – livestock interaction and 3) livestock-market interactions. Also value to cost ratios (VCR) were calculated for maize, teff and potato. Our results showed negative nitrogen balances for all farms, but large differences were observed between the two sites and between crops. The VCRs were high, indicating large profits of fertilizer application. Nutrient management strategies were dominated by market-crop interactions, but differed in main directions of flows. Nutrient management strategies were positively related to net farm income, indicating that with improved nutrient management strategies farm profitability can be increased, even without additional inputs. In this presentation a methodology to evaluate different nutrient management strategies is presented together with quantitative information on nutrient balances, flows, VCRs and yield response curves for 18 farms in Ethiopia. Consequences of diverse nutrient management strategies for sustainable food production in developing countries are discussed.

Session 1.2
Assessing physical, chemical and biological soil functioning for food security

THE NEWSTART ECO-GARDEN: AN INNOVATIVE FOOD PRODUCTION SYSTEM FOR SMALLHOLDER FARMERS WITH LIMITED RESOURCES

MATERECHERA, SIMEON ALBERT[1]; SWANEPOL, H.R.[2]

[1]Crop Science Department, North West University (Mafikeng Campus), Mmabatho, South Africa
[2]Kei Apple Eco-Farm, Buhrmannsdrift, Mmabatho, South Africa

Keywords: Agroforestry, water use efficiency, food security, manure, permaculture, sustainability, vermicomposting

Smallholder farmers in the Southern African region, and indeed much of the sub-Saharan Africa, faces the challenge of increasing food production with multiple constraints associated with land degradation, climate change, water scarcity and resource allocation. The eco-garden system is a unique innovative and cost effective food production technology developed to create opportunities for financial independence and sustainable food production. It was designed to produce more healthy foods, especially vegetables and fruits, using less land, water and energy. The system enhances ecosystem health, including biological activity and minimises the use of external inputs such as synthetic fertilizers and pesticides. A single unit consists of one 100 litre drum supplying 28 crop circles for planting giving 2800 circles per hectare. It consists of an irrigation watering-ring, poly pipe, central water ring, mainline with water filter and tank outlet, compost as an organic fertilizer, and a plastic drum which serves as an easy and economical water reservoir. Irrigation water is released directly at the root zone in circular beds on which different vegetables are grown. The eco-garden system uses mainly compost and manure, or a combination of the two, as the source of plant nutrients. The integration of vermin-composting into the eco-gardening system is considered an excellent solution for waste disposal especially in urban and peri-urban areas where large amounts of organic wastes are available for recycling.

The practice of growing a series of dissimilar types of crops in the same space in sequential seasons for various benefits including the build up of pathogens and pests that often occur when one species is continuously cropped is recommended for the eco-gardening system. Both pests and diseases are managed using integrated biological approaches. The socio-economic benefits of the eco-garden system are related to its contribution to improvement in the livelihoods of the people through its potential to reduce poverty, creating employment opportunities and increasing the food and nutritional security. The system does not only generate profit, but also supports healthy diets and create employment to producers and sellers of the products and thus contribute to local economy. The integration of fruit trees such as Kei apple into the cropping sequence of the eco-gardens enhances ecosystem health through benefits of agro forestry. The system provides a viable proposition for the production of health food on a sustainable basis under many conditions of rural and urban communities. It was concluded that the eco-garden system is an appropriate technology for the resource-poor households since it optimised the use of water, nutrients, labour and solar energy.

THE EFFECTIVENESS OF CHELATES IN PREVENTING IRON DEFICIENCY IN CROPS

TEMMINGHOFF, ERWIN J.M.; SCHENKEVELD, WALTER D.C.
(WALTER.SCHENKEVELD@WUR.NL); VAN RIEMSDIJK, WILLEM H.

Wageningen University, Department of Soil Quality, The Netherlands

Iron is an essential micronutrient for plants, humans and other animals. An adequate uptake of iron is needed to ensure proper growth and development, as well as good health of organisms. When provided with insufficient quantities of iron, organisms will suffer from iron deficiency symptoms. Iron deficiency is a worldwide problem in crop production, affecting yield both qualitatively and quantitatively; plants do not reach their full growth potential, and the nutritional value is compromised, leading to economic losses and limitations in crop selection. In extreme cases, iron deficiency may result in complete crop failure. The list of plant species affected is vast and includes apple, citrus, grapevine, peanut, soybean, sorghum and dry land rice.

Iron deficiency is typically found in crops grown on calcareous or alkaline soils, in arid and semi-arid regions of the world; these soils cover over 30% of the earths' land surface. Iron is abundantly present in all soils including calcareous ones; in mineral soils the average iron content amounts approximately 2%. Most agricultural crops require less than 0.5 μg/g in the plough layer. The occurrence of iron deficiency in plants grown on calcareous soils, despite the excessive soil-iron pool, is caused by the limited bioavailability of iron in such soils.

Chelate based Fe fertilizers are commonly applied to increase the solubility, and thereby the bioavailability of Fe. The synthetic chelate FeEDDHA (iron (3+) ethylene diamine-N,N'-bis(hydroxy phenyl acetic acid)) is among the most effective in preventing and remedying iron deficiency chlorosis in plants grown on calcareous soils. However, the composition of commercially available chelates varies, and so does the effectiveness of individual components in delivering Fe to soil-grown plants. To realize a more efficient use of these chelates, the fate and effectiveness of these chelates in the soil-plant system need to be better understood. During the presentation different aspects of the behavior of the chelates in soils and uptake by plants will be shown and discussed.

A THEORETICAL FRAMEWORK FOR ASSESSING FOOD SECURITY AND FOOD POLICY EFFECTIVENESS IN CHINA

YE, LIMING[1] (LIMINGYE@CAAS.NET.CN); YANG, GUIXIA[1]; VERDOODT, ANN[2]; TANG, HUAJUN[1]; MOUSSADEK, RACHID[3]; FU, YIJIANG[4]; VAN RANST, ERIC[2]

[1]Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, China
[2]Department of Geology and Soil Science, Ghent University, Belgium
[3]National Institute of Agricultural Research, Morocco
[4]College of Continuation Education, Renmin University of China, China

The effectiveness of food security policy in China affects the livelihood and welfare for over one-fifth of the world's population. We present a theoretical framework to assess food security in China by 2030/2050 based on an integrated analysis of the food production and consumption system involving the most likely scenarios of soil degradation, cropland area, cropping intensity, population size, urbanization rate and biofuels production. The soil's productive capacity of food was simulated using a Web-based land evaluation system and grid datasets of climatic, crop, soil and management parameters. Soil and degradation data were extracted, converted and quantified from the ISRIC-WISE and ASSOD databases, respectively, in combination with published field observations across the country. Our results predict that the food supply-demand relationship will turn from an 18% surplus in 2005 to 3-5%, 14-18% and 22-32% deficits by 2030-2050 under the zero-degradation (0xSD), business-as-usual (BAU) and double-degradation (2xSD) scenarios, respectively, if no harvests are to be diverted to produce biofuels, while this relationship will turn from a 17% surplus in 2005 to 14-17%, 22-32% and 30-46% deficits by 2030-2050, respectively, should 10-15% of the total harvests be used for biofuels production. Our results advise the following policy options: (1) Biofuels should be produced from non-food crops on marginal lands. The impact of second-generation biofuels is largely controllable if produced on marginal lands; (2) Agricultural investment is essential to boost food security and thus should receive more emphasis. The food supply-demand relationship will turn from a 46% deficit under, e.g., 2xSD in 2050 to a 10% surplus should a steady yield improvement at 0.8%/yr during 2005-2030 and 0.5%/yr during 2030-2050 be implemented; (3) Institutional changes in, e.g., selection and extension of locally suitable soil and water conservation techniques are needed to control the environmental damages caused by production intensification.

IMPROVEMENT AND MONITORING SOIL HEALTH

KORTHALS, GERARD (GERARD.KORTHALS@WUR.NL); MOLENDIJK, LEENDERT; VISSER, JOHNNY; THODEN, TIM

Wageningen University and Research Centre, The Netherlands

Since the application of pesticides and artificial fertilizers the appreciation for the soil as the foundation for agricultural production diminished. Recently attention is paid to the possible negative influences of these aspects on the microbial population in the soil. The withdrawal of most soil fumigants enhanced the interest for soil aspects like root disease incidence, soil resistance and plant health. Recently PPO has started a long-term field experiment to develop strategies to achieve and establish soil health. Methods applied are crop frequency, crop rotation, use of resistant varieties of economic and green manure crops, anaerobic biological soil disinfestation, the application of compost or chitine. The effect of these measurements will be established by monitoring changes in nematode community structure and the effects upon arable crops, such as yield and disease incidence. Results showed that anaerobic biological soil disinfestation is effective in decreasing the nematode populations of free living Trichodorid nematodes and root lesion nematodes Pratylenchus penetrans. The green manure crop Tagetes patula decreased Pratylenchus penetrans, but increased Trichodorids. Chitine application resulted in a lower count of Trichodorids. The development of crops after the different treatments was inversely proportional to the nematode counts. Within this project bio assays with the root knot nematode Meloidogyne and the fungi Verticillium dahliae and Rhizoctonia solani were performed. Furthermore the effect of the treatments on several soil parameters was measured. Nematodes proved to be very good bioindicators of soil health.

CROP YIELD GAP AND GAP IN SOIL INFORMATION

JONGSCHAAP, RAYMOND[1,2] (RAYMOND.JONGSCHAAP@WUR.NL); BINDRABAN, PREM S.[1]; CONIJN, SJAAK[2]; BATJES, NIELS[1]; REUTER, HANNES[1]

[1]ISRIC - World Soil Information, The Netherlands
[2]Wageningen University and Research Centre, Agrosystem Research - Plant Research International, The Netherlands

Rising volumes of food and non-food commodities needed in the coming decades call for increasing productivity of agro-ecological systems because of an ever-declining base of natural resources per person. Closing the yield gap, i.e. the gap between current crop yields and yield that can be obtained under optimal crop growth conditions, has been presented as a key solution to this aim, for decades. Progress in closing the gap has, however, been slow.

Proper soil management is known to be essential to close the yield gap and to enhance the use efficiency of the natural resources of land and water while simultaneously reducing undesired environmental side effects. There is sufficient understanding for instance that fertilizers should be applied smartly; i.e. precise amounts should be applied in time and space with a balanced composition for the prevailing soil, crop and climatic conditions. Yet soil scientists have only recently taken initiatives to fill this information gap and provide appropriate soil data.

Soil scientists and agronomists (crop modellers) should join their expertise to define the soil data needed for proper evaluation of the productivity of soils. Conventional soil surveys, lead primarily to soil classification maps and qualitative land evaluation. Moreover, available data need harmonization and primary data are often not available for many regions at required resolutions, in particular for soil physical analyses. (Pedo)transfer functions and expert judgment, and more sophisticated techniques today are being tested to fill the gaps, including information on accuracy levels. This paper will reflect on soil data requirements from the plant growth perspective to assess soil suitability and input requirement for food production, at defined scale levels.

CAN FOOD SECURITY BE ACHIEVED IN AFRICA WITHOUT TILLAGE?

HOOGMOED, WILLEM[1] (WILLEM.HOOGMOED@WUR.NL); HOOGMOED, MARIANNE[2]

[1]Farm Technology Group, Wageningen University, The Netherlands
[2]School of Biological Sciences, Monash University, Australia

Tillage, the practice of cultivating or manipulating the soil is performed since the beginning of arable farming. Yet, particularly with respect to African agriculture, its role has become the subject of fierce debate. Wide differences in view exist in the circles of scientists, policy makers, extensionists on the pros and cons of tillage, often leaving the farmers in the dark and not assisting them in taking decisions. The strong attention given to the concept of Conservation Agriculture seems to overlook the magnitude of the sphere of influence tillage has on factors that are decisive for crop production on short term and conservation of the resource base on the long term. This paper presents a review of research findings on the role of tillage in Africa in its widest sense, taking into consideration the soil physical aspects, its importance for the control of wind and water erosion, agronomic aspects (weed control!), the fertility aspects in its interaction with nutrients, organic matter, soil biodiversity. The issue of labour requirements, energy, and the need for appropriate equipment will also be addressed. Results of the review will be classified according to the most relevant agro-ecological zones, representing important food production areas. We will show that although sustainable agriculture by applying ecological principles to agricultural production systems is commendable, these (and also economic) principles are often completely overruled by the practical constraints. Especially in Africa, soil tillage is linked to the diversity in soils, climate, crops, and soil biological activity. and its choice and application must be guided in the first place by site-specific requirements. This does not at all mean that valuable principles and concepts leading to long term conservation of the most precious production potential, the soil, should be put aside, but it emphasizes the need for a careful consideration of options; and tillage may be the only one available to the farmer.

Theme 2
Water Resources

Keynote
Victor Jetten

USING SOILS INFORMATION IN NATURAL DISASTER ANALYSIS: VALUE FOR MONEY

JETTEN, VICTOR (JETTEN@ITC.NL)

Faculty of Geoinformation Science and Earth Observation, Twente University, The Netherlands

In many parts of the world people run a daily risk from natural hazards. Risk is defined here as the 'potential damage or losses' that a natural hazard can cause, where a disaster is the risk materialized. There are three main factors in this: the hazard, which is the process that potentially causes damage, the so called elements at risk (usually people and property, or for instance natural reserves), and their value or vulnerability. These definitions are (somewhat loosely) based on the descriptions of the International Strategy for Disaster Reduction (ISDR, 2009). In this paper the links between natural hazards and disaster risk management on the one side, and soil science on the other will be explored. Hazards can be classified in meteorological hazards, hydrological hazards such as a droughts, floods and landslides, and geophysical hazards such as earthquakes (and tsunamis) and volcanism. Often the risk is a result of a combined effect of hazards that occur as a chain of events. Hurricanes trigger, besides direct damage, also floods and landslides, earthquakes trigger landslides, and even floods because of e.g. dam breaches. When we think of disasters we naturally see them disasters as not our fault, they are a sudden onslaught of extremes in the weather or trembling of the earth. First we tend to forget that there is a category of disasters related to desertification and land degradation that are slow processes and trends, although with sudden manifestations (massive loss of cattle for instance). Second, disasters are by definition the effect of these natural processes on our society, so population growth and our behaviour and actions (e.g. living in cities below the sea level) increases the risk. Although we do not always cause hazards, we can certainly mitigate their effects.

What has this got to do with soil science? There are a few obvious links. Hydrological hazards are a part of hydrology, focusing on extremes. Their analysis is done with the same tools as catchment water balance studies: models using spatial information from the earth surface from field studies and remote sensing. Soil science provides a considerable amount of information in these models. Also the prediction of the effects of geophysical hazards may use soil information, to calculate wave propagation near the surface (so called shake maps). A special case is formed by landslides, which may have a combined geophysical and hydrological trigger and can take the form of anything between fast debris flows or deep seated slow rock movements. Obviously the properties of the material moving are needed for spatial analysis of hazard and risk. Below will be explored how soil science is used in the assessment of such hazards, what is readily available currently and what is still needed. In contrast to these sudden hazards is land degradation, manifesting in drought, erosion and salinisation. Here the link with soil science is (traditionally) much closer as it is one of the main factors determining these hazards. Nevertheless a vital piece of information is missing, which has caused the world to take "rapid" hazards more seriously and invest a great deal more effort and money to deal with them: the fact that the consequences are directly visible and immediately felt as loss of lives and damage to housing and infrastructure. In "slow" disasters related to land degradation the effects caused by drought are felt immediately as loss of agricultural products and lack of household water, but the loss and degradation of soil is not seen/felt immediately. Thus we (i.e. society) do not see the soil as one of our great natural resources and we still ignore the fact that this resource is not unending for granted. In terms of Natural Hazard and Disaster

Risk Management, the value of the soil and the damages to ecosystem functioning caused by its loss is not quantified. In this paper I will explore the role of soil science in the various natural hazards, and attempt to define what is needed to include soils as a resource in the international political discussions.

Keynote
Neil McKenzie

SOIL KNOWLEDGE AND THE GLOBAL WATER CHALLENGE

MCKENZIE, NEIL (NEIL.MCKENZIE@CSIRO.AU)

CSIRO Land and Water, Australia

Soil scientists and technologists can play a far more effective role in efforts to address a wide range of water resource challenges. The most obvious contributions relate to improving the water-use efficiency of rain-fed and irrigated agriculture, refining the measurement and prediction of landscape water-balance, and anticipating the impacts of climate change. The rapid evolution of systems for water resource observation and forecasting is outlined. The utility of these sophisticated systems depends heavily on how they are used in decision making whether at the local, regional or global scale. The key test is whether the information reduces the uncertainty for decision makers. This frame of reference is used to identify opportunities and constraints relating to the use of soil knowledge. Seven priorities for soil science are identified.

1. Develop a coherent and widely accepted framework for defining control volumes in soils for measurement and estimation so that material fluxes can be computed and mass balance preserved.
2. Develop measurement technologies with characteristic length-scales ranging from tens to hundreds of metres to bridge the critical scale-gap between the plot and hill-slope scales
3. Establish effective partnerships between simulation modellers and providers of soil data.
4. Agree on a services-oriented architecture for soil information that is consistent with new web-based standards in water resources.
5. Agree on operational systems for estimating uncertainty.
6. Ensure soil information can be supplied to the schemes for model-data assimilation that now form the basis for forecasting and prediction of weather, climate and water resources.
7. Revitalise survey and monitoring to ensure quantitative soil data are available via GlobalSoilMap.net for key landscape processes in priority regions.

Addressing these priorities requires us to create new scientific and technical capability. A much greater degree of planning and coordination is necessary if we are to build operational systems for observing and forecasting stores and fluxes of water, carbon, nutrients, solutes and contaminants. We need to move from meeting together to working together. The response by scientists and engineers to the millennium drought in Australia is presented as a positive example on how to deal with a national water crisis.

Most countries have a weather service and operational systems for flood forecasting and river management. The complementary services relating to landscape hydrology and soils are less common. However, they are a prerequisite for ensuring soil knowledge is used to address global water challenges.

Session 2.1
Water use efficiency and water harvesting in dry lands

THE WATER REUSE PROJECT: OPTIMIZATION OF WATER USE EFFICIENCY AND USE OF TREATED WASTE WATER IN DIFFERENT EUROPEAN AGRICULTURAL SETTINGS

VAN DEN ELSEN, ERIK (ERIK.VANDENELSEN@WUR.NL); MOORE, DEMIE; VERZANDVOORT, SIMONE

Wageningen University and Research Centre, Alterra, The Netherlands

Agriculture is the major water using sector in many countries, with a global average share of 63% in total fresh water use in 2010 compared to domestic, electricity and manufacturing. Irrigation water is massively wasted through inadequate water conservation, losses in distribution and inappropriate times and rates of irrigation. These losses can amount to 70-85% of the total volume of water applied. The EU financed project Water Reuse (2005-2011) focussed on the reduction of irrigation water loss by applying a number of strategies: irrigation scheduling, application of soil surfactants, application of claying amendments and mulching. Additionally, irrigation with treated wastewater was applied as a substitute to fresh water . Organic compounds in the treated waste water can induce the development of water repellency in the soil. This may induce preferential flow and uneven wetting in soils, thereby reducing water use efficiency dramatically. On the other hand they can serve as useful additional nutrients for the crops grown on the fields being irrigated. After evaluating the effects of the selected strategies using the SWAP model, the most appropriate strategies per test site were selected and subsequently installed and evaluated in the field in Russia, Ukraine, Spain and Greece. All five water saving strategies field tested, showed positive effects for direct or indirect water savings in at least one test site. Adjustment of irrigation practices to match real time agronomic conditions was considered the top ranking water saving strategy as it can, with minimal investment, be immediately applied wherever irrigation is presently practiced. Other solutions involve additional costs and are less likely to be adopted without policy elements. Also a socio-political-economic analysis was conducted to identify critical factors for and/or limitations to adoption of new strategies. The biggest obstacles to implementation of water saving strategies seem to be a lack of socio-political-economic structures and policies that encourage their adoption, and/or structures and policies that are counter to their adoption.

AN INNOVATIVE APPROACH FOR ANALYZING WATER BALANCE OF A LIMAN SYSTEM IN THE NORTHERN NEGEV DESERT, ISRAEL

ARGAMAN, ELI[1] (ELI.ARGAMAN@GMAIL.COM); EGOZI, ROEY[1]; GOLDSHLAGER, NAFTALI[1]; AUINAAT, SHAHEEN[1]; YITZHAK, YEHONATAN[2]

[1]Soil Erosion Research Station, Ministry of Agriculture & Rural Development, Israel
[2]Dept. of Soil & Water, Faculty of Agriculture Food & Environmental Sciences. The Hebrew University of Jerusalem, Israel

Water availability in arid and semi-arid regions is a major limiting factor, which affect vegetation growth. Therefore, knowledge about the preliminary and the ongoing spatio-temporal conditions (e.g. land surface properties, hydrological regime and vegetation dynamics) can improve greatly afforestation practice which eventually results in preventing or limiting desertification processes. The Ambassadors forest, which is located at the northern Negev region in Israel, is a sustainable forest that relies on water harvesting techniques (e.g. Limans and contour ridge terraces). The sustainability of the vegetation within the Liman system depends to a great extent on the quantity of runoff water that is harvested from the adjacent hillslopes, under given surface & climatic conditions (e.g. surface storage, rainfall intensity and infiltration capacity, evapotranspiration). Consequently, a key issue that must be modeled in order to provide a sustainable approach for decision makers is Liman water balance. We modeled the key parameters of surface and subsurface water regime before, during and following a flood experiment made in two Liman systems (planted and bare). We surveyed each of the Limans and generated water surface elevation - volume rating curves. In addition, soil chemical and physical properties were analyzed before and after the experiment in order to learn the initial & final conditions under various manipulations. The subsurface soil water profile of each Liman was monitored throughout the whole experiment duration and scanned by FDEM at four phases of the flood test in order to link subsurface Electrical Conductivity (EC) to soil water content. During the flood test we monitored the water surface elevation utilizing pressure gauge (Diver) and Ultrasonic sensor. Surface energy balance analysis was analyzed to provide vertical as well as horizontal above ground surface fluxes. All data layers were integrated to produce 3-D model of a Liman system. Results show that the total water balance limiting parameters are vegetation cover, soil hydraulic properties and micro-climatic conditions. Combination of surface and subsurface knowledge layer provide a detailed view on the temporal trends of a Liman system which enhance potential data-mining utilizing inter-disciplinary knowledge.

THE EFFECT OF MULCHING ON THE SURFACE ENERGY BALANCE AND KEY SOIL PHYSICAL VARIABLES, UNDER SUB-HUMID AND SEMI-ARID CONDITIONS

ALHARBI, ABDULAZIZ (AABANIALHARBY@HOTMAIL.COM); VERHOEF, ANNE

Department of Soil Science, University of Reading, United Kingdom

The evaporation from soil is a function of soil and atmospheric physical variables. Soil mulching is generally considered an effective way to reduce soil evaporation and is therefore widely used as an agricutural practice. One of two field experiments was conducted at the University of Reading (UK) Plant Science Unit, under semi-humid climatic conditions, between June-October 2008, to investigate the effect of mulching on soil evaporation. On part of the experimental plot, a hardwood chips mulch was used to reduce evaporation from bare soil. Alongside, bare soil was used as a reference plot. The other field experiment took place at Qassim University farm in Saudi Arabia (arid climate), between March-July 2009; in this case dry date palm leaves were employed to create a mulch, to reduce evaporation from bare soil. For both experiments microlysimeters were installed in each treatment (mulch/no mulch) and weighed every day to determine evaporation. Meteorological variables were measured, such as long wave and shortwave (incoming, reflected and emitted) radiation components, air temperature and humidity, and wind speed. Profiles of soil moisture content and temperatures were also determined in each experiment for both treatments. The mulch reduced evaporation from the soil compared to bare soil by breaking up the hydraulic connectivity. Furthermore, it affected the other fluxes in the energy budget, i.e. net radiation, sensible heat flux, and soil heat flux. The mulch overall reduced temperatures and increased soil moisture contents.

SOIL KNOWLEDGE FOR IMPROVING URBAN ENVIRONMENTS AND REGREENING CITIES

PAVAO-ZUCKERMAN, MITCHELL (MZUCKER@EMAIL.ARIZONA.EDU); LIVINGSTON, MARGARET; SMITH, STEVEN; STOLTZ, RON; TEPLER, SARAH

University of Arizona, The United States

Despite their seeming 'separateness' from nature, cities are at the forefront of many environmental and global change processes. A recent UN report poses cities as the primary battleground in the fight against climate change, as they are dominant contributors to greenhouse gas emissions and also dense population centers who's well-being will be impacted by climate change. Management and land-use decisions in cities often are key control points for biogeochemical cycles and hydrologic flows. Here I discuss several projects undertaken in the Sonoran desert to improve the urban environment and link to climate change and water resources: (1) rain garden basins to harvest storm water runoff, and (2) model-scale green roofs to reduce energy fluxes and the urban heat island effect. Results from these projects suggest that knowledge of soils is a key element to success in using green infrastructure in cities. In the rain basins, management decisions linked to soil quality are important for impacting rates of nutrient cycling as well as mitigating the stress of urban soils, providing an important link between soil quality and water resources in urban landscapes. Soils in the green roof were designed to meet weight requirements for buildings and to help retain water for plants in a harsh arid environment. The type of mix selected (texture, organic content) plays an important role in water retention, which translates to plant performance and green roof function with respect to modified energy balances. I will discuss how these small-scale green infrastructure approaches can be integrates at larger city-wide and regional scales. Through a recognition of our role in ecosystems as soil ecosystem engineers we can utilize green infrastructure to design new soils and new ecosystem components that help mitigate environmental changes in cities and help transform urban ecology to result in more resilient and sustainable landscapes.

PARTICIPATORY DEVELOPMENT OF IN-SITU RAINWATER HARVESTING TECHNIQUES THROUGH FIELD EXPERIMENTATION AND MODELING WITH THE FAO'S AQUACROP MODEL

STROOSNIJDER, LEO; TEMESGEN, BIRHANU (BIRHANU.TEMESGEN@WUR.NL)

Wageningen University, The Netherlands

Keywords: In-situ rainwater harvesting, tied-ridges, aquacrop, Ethiopia

Recurrent drought, long dry-spells during the the rainy seasons and non-productive water losses via runoff and soil evaporation are perceived problems limiting maize water productivity in the Rift Valley drylands of Ethiopia. On the other hand, despite the burgeoning land cover change from acacia-based woodlands to crop cultivation, long-term Maresha ploughing could impede the soil physical properties. During the 2009 and 2010 maize growing seasons, field experimentation was conducted to examine the potential of in-situ rainwater harvesting through improved tillage and manure applications for crop productivity and rainwater use efficiency. Accordingly, the soil water and crop productivity modeling through the FAO's aquacrop model was made to develop a participatory rainwater harvesting tool. Based on long-term rainfall analysis and considering June 10 as the latest onset for maize farming, 63% of the years were suitable to sow maize in time. Depending on the rainfall intensity between 18 and 30% of the rainfall events greater than 12 mm could be lost in the form of runoff from traditionally tilled and sub-soiled plots while a maximum of 12% of runoff was observed when tied-ridges were applied. The use of the Maresha-modified ted-ridging improved the soil water content by up to 13% during wet rainy seasons while the effect was negligible during very dry season. Aqua crop could simulate the soil water and maize yield quite well during normal and above-average rainfall seasons. Hence, the model can be used as a participatory development tool for further development of in-situ rainwater harvesting and management in the vast drylands of Ethiopia.

OPTIMIZING SOIL AND WATER PRODUCTIVITY THROUGH MANAGEMENT OF SOIL WATER REPELLENCY

MOORE, DEMIE (DEMIE.MOORE@AQUATROLS.COM); KOSTKA, STANLEY; MCMILLAN, MICA; GADD, NICK

Aquatrols, The United States

Water's ability to infiltrate and disperse in soils, and soil's ability to receive, transport, retain, filter and release water are important factors in the efficient use of water in agriculture. Deteriorating soil conditions, including development of soil water repellency which reduces soil wettability, negatively impact hydrological processes and, consequently, the efficiency of rainfall and irrigation. Soil water repellency is increasingly being identified in diverse soils and cropping systems. Even low levels of water repellency in soils, or water resistance, can reduce soil and water productivity. Recently research has been conducted on the use of novel soil surfactants (co-formulations of alkyl polyglycoside and block copolymer surfactants) to avoid or overcome soil water repellency and enhance distribution of water and other inputs in soils. Results indicate that this is an effective and affordable approach to maintaining or restoring soil wettability in cropping systems in order to optimize growing conditions. Results from studies conducted in Australia, the Netherlands and the United States to determine how this technology modifies soil hydrological behavior and crop yields will be presented. A range of soils and various crops, including potatoes, corn, apples and grapes, were included. Several rates were compared to controls for effect on soil moisture levels, soil water distribution, and crop yield. Treatments improved rootzone water status, significantly increased crop yield and quality, and in some cases allowed significant reductions in water requirements. In some trials, an economic analysis was also conducted. Where assessed, the economic return generated was positive. Managing soil water repellency and soil wettability is a conservation strategy for optimizing water and soil productivity.

Session 2.2
Soil as a filter

EFFECTS OF COMMERCIAL BANANA PRODUCTION ON WATER QUALITY: AN EXAMPLE FROM TROPICAL MEXICO

GEISSEN, VIOLETTE (VIOLETTE.GEISSEN@WUR.NL)[1]; ARYAL, DEB R.[2]; SUAREZ, LUZ E.[2]

[1]Wageningen University, The Netherlands
[2]El Colegio de la Frontera Sur, Mexico

We studied the effects of commercial banana production on water quality in a lowland region of tropical Mexico. As typical for tropical banana production, high amount of fertilizers is applied; soil analysis prior to fertilizer application is not practiced. The fungicide Mancozeb is applied over a period of 10 years in a weekly dose of 2.5 kg ha-1.

We monitored concentrations of nitrate, nitrite, phosphate and ethylenethiourea (ETU), the main metabolite of Mancozeb, in different water bodies to estimate the risk for aquatic life and human health. We took samples from groundwater (80 m depth), subsurface (5 m depth) and surface water in the years 2007 and 2008. The nutrient concentrations were measured monthly, whereas the ETU concentrations were only estimated in the rainy reason.

Nitrate concentrations in all water bodies were lower than the threshold value for drinking water and aquatic life. In contrary, the nitrite concentrations in all water bodies exceeded the safety thresholds for drinking water of 1.0 mgL-1 (WHO 2006) and aquatic ecosystems of 0.2 m gL-1 (OATA 2008). Phosphate concentrations found in banana plantation surface water bodies were above or near the hyper-eutrophic level.

Surface and subsurface water was highly polluted with ETU (22.5 and 4.3 mg L-1, respectively). In ground water, no ethylenethiourea was detected. The level of pollution in the region presents a worrisome risk for aquatic life and for human health and it is highly recommended to apply more sustainable techniques for banana production.

EFFECTS OF WINERY WASTEWATER APPLICATION ON SOIL PHYSICOCHEMICAL AND BIOLOGICAL PROPERTIES

MOSSE, KIM[1] (KIM.MOSSE@MONASH.EDU); PATTI, ANTONIO[1]; PARIKH, SANJAI[2]; STEENWERTH, KERRI[3]; CHRISTEN, EVAN[4]; BUELOW, MAYA[2]; CAVAGNARO, TIMOTHY[1]

[1]Monash University, Australia
[2]UC Davis, The United States
[3]USDA-ARS, The United States
[4]CSIRO, Australia

The ability to reuse winery wastewater (WWW) has potential benefits both with respect to treatment of a waste stream, as well as providing a beneficial water resource in water limited regions such as south-eastern Australia, California and South Africa. Our studies in south-eastern Australia and California have focused on determining the effects of WWW application on vineyard soils, with respect to both physicochemical and microbiological properties. Studies in south eastern Australia have focussed on the impacts of long terms application of winery wastes to soils (paired sites), as well as the effects of a single application of an industrially generated WWW and treated WWW. These studies have shown that there are significant changes to soil physicochemical properties as well as microbiological properties with long term waste application. The single application of WWW was shown to significantly increase soil respiration rates, and impact upon microbial nitrogen cycling, as well as microbial community composition. In California, studies have shown that irrigation with semi-synthetic WWW (ssWWW) over the course of the growing period have had significant effects on plant nutrition and berry quality parameters. Soil physicochemical properties were shown to be affected, although it is yet to be determined whether these changes persist after winter rainfall. Soil microbial activity was also impacted upon by the application of ssWWW, as evidenced by changes to microbial respiration rates.

DO FORESTRY OPERATIONS DECREASE THE GROUND WATER QUALITY FOR HOUSEHOLD USE?

PIIRAINEN, SIRPA (SIRPA.PIIRAINEN@METLA.FI); FINÉR, LEENA; JUNTUNEN, MARJA-LIISA

Finnish Forest Research Institute, Finland

Groundwater is the main source (60 %) of water distributed by waterworks to households and industry in Finland and 89% of households are served by waterworks. However, the groundwater resources are abundant in Finland and use of groundwater is much smaller (0.7 Mm3 d-1) than replenishment (2.82 Mm3 d-1). Due to shallow soils, groundwater is vulnerable to anthropogenic pollution. Groundwater aquifers are mainly located on forest land, thus forest fertilization and intensive soil preparation are not allowed on aquifers to maintain the good quality of groundwater. High nitrate leaching to groundwater after clear-cuttings has been observed in studies done in N-rich soils in southern Sweden and central Europe (Wiklander et al. 1991, Weis et al. 2001). However, the effects of different forestry operations on groundwater quality are not systematically studied. A monitoring study on the effects of forest cutting on the quality of groundwater in large aquifers (5.2-15.4 km2) showed that both thinning and clear-cutting (27-66 % of the recharge zone) increase nitrate concentrations for several years (Rusanen et al., 2004). However, even the maximum annual average concentrations remained very small < 2 mg L-1, well below the upper level (50 mg L-1) set for drinking water. In 2000 we started a new study to find out what is the effect of forest regeneration and soil harrowing on the quality of groundwater in the Class I groundwater recharge area. The area, called Silkunharju esker (2.47 km2), locates in eastern Finland and the soil is glacial deposit with a texture of gravel. The main tree species was Scots pine and final cutting was done in 2001. We have monitored the groundwater quality, groundwater table level and climatic variables in the area. We will show the results from the Silkunharju study, which indicate that the effects of forest operations are small on groundwater quality and quantity and also short lasting.

References

- Rusanen, K., Finér, L., Antikainen, M., Korkka-Niemi, K., Backman, B. & Britschgi, R. 2004. The effects of forest cutting on the quality of groundwater in large aquifers in Finland. Boreal Environment Research 9(3): 253-261.
- Weis, W., Huber, C. & Göttlein, A. 2001. Regeneration of mature Norway spruce stands: early effects of selective cutting on seepage water quality and soil fertility. The Scientific World Journal 1(2): 493-499.
- Wiklander, G., Nordlander, G. & Andersson, R. 1991. Leaching of nitrogen from a forest catchment at Söderåsen in southern Sweden. Water Air and Soil Pollution 55: 263-282.

EXPLICIT PARAMETERIZATION OF MACROPORE FLOW BASED ON EARTHWORM SPECIES DISTRIBUTION MODELS

VAN SCHAIK, LOES[1] (SCHAIK@UNI-POTSDAM.DE); PALM, JULIANE[1]; KLAUS, JULIAN[2]; ZEHE, ERWIN[3]; SCHROEDER, BORIS[1]

[1]Institute of Earth and Environmental Sciences, Potsdam, Germany
[2]Technical University of Munich, Institute of Water and Environment, Germany
[3]Karlsruhe Institute for Technologie, Karlsruhe, Germany

Earthworms are known as important ecosystem engineers, meaning that through their burrowing activity they regulate their own physical environment. The macropores created by earthworms are a common origin for preferential flow under high rainfall intensities. The distribution of rainfall to matrix or macropores depends strongly on the matrix infiltration capacity. Then the geometry of the macroporous network and the interaction between macropores and matrix determine the effectivity of macropore flow over larger depths or distances. Thus explicit parameterization of the soil matrix and macropores separately is important to correctly simulate the transient distribution of infiltration to the different domains. Therefore, we use species distribution models and knowledge on burrowing patterns of different ecological earthworm types to parameterize the macropore spatial distribution and geometry in the hydrological model Catflow. Earthworms can be divided into three ecological types with varying burrowing behavior: endogeic, epigeic and anecic earthworms. Due to difference in depth and orientation of the burrows the infiltration can be mainly distributed diffusely in the topsoil or flow rapidly into deeper layers. Therefore the species distribution modeling is performed for different earthworm ecological types to create maps of earthworm occurrence and abundance throughout the studied Weiherbach catchment (Baden-Württemberg, Germany). The occurrence of the earthworm ecological types is then related to the corresponding macropore size and expected depth distribution. The hydrological effectivity of macropores depends on the infiltration at soil surface. Therefore, the correct characterization of the matrix hydrological parameters, which determine the initiation of macropore flow is very important. The bulk soil infiltration capacity can be used to determine the maximum inflow to macropores. Furthermore the infiltration from macropores to soil matrix is influenced by macropore side wall characteristics, which in turn depend on age of the macropores.

SALTWATER CONTAMINATION IN THE VENICE LAGOON MARGIN, ITALY. 2: THE INFLUENCE ON THE SOIL PRODUCTIVITY. FIRST RESULTS

SCUDIERO, ELIA[1] (ELIA.SCUDIERO@STUDENTI.UNIPD.IT); BRAGA, FEDERICA[2]; TEATINI, PIETRO[3]; PIRAGNOLO, DAVIDE[1]; BERTI, ANTONIO[1]; MORARI, FRANCESCO[1]

[1]Dept. Environmental Agronomy, University of Padova, Italy
[2]Institute of Marine Science (ISMAR), Italy
[3]Dept. Mathematical Methods and Models for Scientific Applications, University of Padova, Italy

Salt accumulation in coastal soils is strongly affected by water dynamics in unsaturated and saturated zones. Rainfall and irrigation promote salt leaching contrasting the effect of upward flux from saline groundwater. Salinization degree and soil productivity depend by the final equilibrium between these two contrasting processes. This dynamic has been investigated in a farmland close to the Venice Lagoon. Indeed, the Venice watershed includes a very precarious coastal environment subject to both natural and anthropogenic changes with a significant and economically important fraction of the coastal farmland presently below mean sea level. In the hydrogeological context of the Venice coastland, a large risk of saltwater contamination characterizes the southernmost area because of the geomorphological setting of the coastal plain. Salt contamination is influenced also by the activity of several pumping stations used to keep drained the area, groundwater withdrawals, irrigation and freshwater releases during summer dry months. A 3-years project was started in 2010 to evaluate the impact of salt intrusion from the salty water bodies on soil productivity. In a 25 ha basin cultivated with maize crop, soil salinity (electrical conductance 1:2) and the main physical-chemical properties (e.g. texture, organic carbon and exchangeable cations) were measured along the 1.5 m soil profile in 120 positions. Maps of apparent electrical conductivity (ECa) at three different investigation depths (0 - 0.75 m; 0-1.50 m; 0- 6.00 m) were also obtained in April 2010 with a CMD electromagnetic conductivity meter (GF Instruments) associated to a DGPS. During 2010 some physiological crop parameters, in particular leaf potential, SPAD, reflectance (i.e. Spectrascan, Photoresearch), leaf ions content were monitored in 13 scattered positions. Moreover, maps of NDVI were obtained by proximal sensing (three dates) using an active spectral radiometer (Crop Circle, Holland Scientific) and remote sensing acquiring a WorldView 2 satellite image at the end of July. Finally, a map of the crop production was obtained by a yield mapping system mounted on a combine harvester. Relationships existing between soil and crop factors and crop yield were identified applying a multivariate spatial model, proving also the risk of salinization of the coastal area.

HOW UNIFORM ARE WATER FLOW AND PESTICIDE TRANSPORT IN CULTIVATED SANDY SOILS?

LEISTRA, MINZE (MINZE.LEISTRA@WUR.NL); BOESTEN, JOS

Wageningen University and research Centre, Alterra, The Netherlands

Water flow and pesticide transport in cultivated sandy soils are often assumed to be rather uniform. However, measurements in the soil profile by replicated coring resulted in a wide range of concentrations per depth. Published studies indicate that preferential transport of pesticides can be easily missed by soil samplng alone. Only in a few studies, the pesticide concentrations in the upper groundwater were also measured. These concentrations also showed a wide range of variation. Collection of leachate from sandy-soil monoliths by a grid of suctions cells showed hot spots of local transport. A literature study revealed that there are various possible causes of non-uniform water flow in cultivated sandy soils. Interception of water by the crop followed by stemflow and leaf drip lead to peaks in the water load at the soil surface. Water infiltration at the soil surface can be highly irregular, e.g. due to differences in soil structure, presence of micro-depressions and water repellency. Water flow within the soil profile is affected by sedimentation pattern, soil forming features, differences in soil structure and antecedent water content (and thus hydraulic conductivity). In a few field studies for sandy soils, both pesticide concentrations in the soil profile and in the upper groundwater were measured. The relationship between these concentrations is investigated further to estimate the extent of preferential transport of pesticides in sandy soils. Such transport would be apparent from the groundwater concentrations to be higher than those expected from the concentrations in the lower part of the vadose zone. The results of these investigations will be presented and discussed.

Theme 3
Biodiversity

Keynote
Diana Wall

BIODIVERSITY IS KEY TO SUSTAINING SOILS

WALL, DIANA H. (DIANA.WALL@COLOSTATE.EDU)

University Distinguished Professor and Director, School of Global Environmental Sustainability, Colorado State University, The United States

Knowledge about soil biodiversity and the ecosystem services they provide will help us sustain ecosystems for the world's growing populations. But we can no longer afford to study and manage soils and their biodiversity as isolated components if we are to reach this goal.

Soils are the surface we live on and the basis for all life on land, while ecological processes occurring in soil affect terrestrial, aquatic and marine ecosystems. Nevertheless, soils are possibly the least understood of the planet's ecosystems, and the most fragile. Soils are being degraded and under threat due to land use change resulting in desertification, erosion, pollution, urbanization and deforestation. Fertile soils are diminishing as land is cultivated and urbanized, affecting food production, water quality, human health and other services necessary to sustain populations. These changes to soils and new management strategies such as soil carbon sequestration to mitigate CO_2-induced climate change are raising global attention on efforts to sustain soils.

There is growing recognition that soil biodiversity provides ecosystem services (i.e. food, fiber, stable soils, clean air and water) for human well-being. Moreover, scientists and policy makers are increasingly recognizing the benefit of including ecosystem services in decision-making for global sustainability. However, despite the increasing awareness of the crucial role of soil in food production, hydrology and greenhouse gas fluxes, soils and their ecosystem services are often considered without including the biotic component that is integral to the provision of ecosystem services.

Soils are among the most biologically diverse habitats on earth. They rival coral reefs and tropical rainforests in biological complexity: a handful of rich organic soil may contain millions of organisms representing hundreds of species from most of the lineages in the Tree of Life. The majority of species are hidden to our eye, primarily microscopic and less than a millimeter in size. As a consequence, few of these are named and described, and their ecology is mostly estimated. Soil biodiversity is structured into food webs that are composed of organisms ranging from bacteria, Archaea and fungi, to larger invertebrates such as ants and earthworms. Their distribution is poorly mapped across soil types and orders and thus, soil biodiversity is often not considered in local and national management decisions. All sub-surface and above-ground organisms depend on this biodiversity for food and habitat. Disturbances to soil impact ecosystem functioning, soil physical and chemical factors that comprise habitat for soil organisms, alter soil biodiversity, and appear to be associated with the loss of ecosystem services such as control of pathogen-predator outbreaks. Soil biodiversity in less disturbed systems is determined by multiple factors over evolutionary time, such as vegetation (resource quality and quantity), soil physical and chemical properties, and climate.

Environmental factors leading to a higher incidence of soil borne organisms that are linked to human disease, such as disturbance to soil, climate change, urbanization, and result in impacts on soil food webs should be integrated in research agendas to better predict disease occurrence.

Frameworks such as the Millennium Ecosystem Assessment (MEA, 2005) brought attention to the value of ecosystem services for human well-being, but focused largely on aboveground biota and their interactions, and less on soils and their biodiversity that support national economies and human health. Soils provide habitats for the diversity and activities of soil biota that in turn are key for several types of services. Supporting services include nutrient cycling, plant production, and hydrologic cycling, all of which are interactive and critical for the formation, functioning and maintenance of soils over time. Provisioning services, such as food, biochemicals and genetic resources, and regulating services, such as climate regulation, disease regulation and water purification are a result of complex interactions between micro- and macro-organisms and soil habitats. Technologies and ecosystem management frameworks are being developed to characterize services across spatial scales, such as whether soils are degraded or fertile or sequester soil carbon or not. These frameworks will benefit from inclusion of information on soil biodiversity to improve and maintain soil habitat and ecosystem services. For example, the role of biota in aerating, aggregating and moving soil particles and elements will affect biotic habitat on the short term and assure soil formation over longer time scales.

The degree to which multiple global change drivers will alter ecosystem services will depend on the rates of change, the ecosystem and the vulnerability of species. For example, the largest changes may be expected in low diversity, less-resilient ecosystems. In order to anticipate such changes, we will need to develop tools to quantitatively assess ecosystem services, based on factors such as the vulnerability and resilience of sub-surface species and the individual species' or food web's contribution to a particular component of a service. These tools can be used for comparative studies across local to global spatial scales, and for building scenarios of how subsurface species will contribute to ecosystem services in the future, as well as increase recognition of their benefit to human health and human well-being. A coordinated effort is needed to bring soil sciences, geology and biological sciences to the center of collaborations in order to promote management decisions furthering the long-term sustainability of soils.

Keynote
Louise Jackson

NITROGEN CYCLING, SOIL BIOTA AND AGRICULTURAL INTENSIFICATION

JACKSON, LOUISE (LEJACKSON@UCDAVIS.EDU)

Dept. of Land, Air and Water Resources, University of California Davis, The United States

Agricultural systems must become more productive to meet world food demand, but this must also support environmental quality, rural livelihoods, and biodiversity conservation. The intensification of agriculture through high inputs of non-renewable resources, such as synthetic fertilizers and pesticides, has increased food supply, but also the contamination of waters, eutrophication, atmospheric N deposition, and emissions of nitrous oxide (N_2O), a potent greenhouse gas. Another concern is the loss of biodiversity in agricultural landscapes (Tscharntke et al., 2005) and its 'functional homogenization' (Clavel et al., 2011).

Local decisions about N management have global ramifications for environmental quality, food security, and the loss of biodiversity and ecosystem integrity. Human interference has pushed the N cycle beyond a safe planetary boundary (along with the rate of biodiversity loss and climate change) (Rockström et al., 2010). At present, conversion of unreactive N_2 to more reactive forms of N by anthropogenic activities is ten-fold higher than in 1860, compared to only a four-fold increase in global population (Galloway et al., 2004). A recent meta-analysis of studies that documented ecosystem N processes after N additions showed that N losses far exceeded increases in N retention (Lu et al., 2011). Mean accumulation of N increased by ~50% in plants and by ~6% in soil, whereas leaching of soil inorganic N and N_2O emissions increased by >400% and >100%, respectively.

Increased N inputs have increased crop yields, reducing the land needed for agriculture. Segregating land for nature from land for high-input agricultural production (land sparing) is one view to support biodiversity conservation and food security (Phalan et al., 2011). But proponents of land sparing rarely address the non-target effects of high use of fertilizers and other agrochemicals. Another view is that increased reliance on ecological processes in agroecosystems is more feasible when integration of agricultural production and conservation occurs on the same land (land sharing) (Perfecto and Vandermeer, 2010). Greater dependence on ecological processes for N supply through innovative management of soil biota and root processes can potentially achieve high yields while minimizing other tradeoffs for environmental quality at the landscape level (Jackson et al., 2008).

In the second half of the talk, I will present a specific example of agricultural intensification, and the challenges of transitioning to ecologically-based production systems from high-input conventional systems. In the Sacramento Valley of California, savannas and wetlands were the main vegetation types before European settlement 150 years ago. Today, most of the high quality soils are in intensive, irrigated agricultural production of fruits and vegetables, which relies heavily on synthetic fertilizers and pesticides, resulting in serious problems associated with movement of agricultural chemicals through riparian corridors to the San Francisco Bay Delta. There has been a a concomitant loss of soil quality and diversity in the soil biota (Culman et al., 2010; Young-Mathews et al., 2010).

Organic agriculture relies on ecological processes to provide an adequate and reliable N supply, but in this situation, the transition to organic management builds on a soil assemblage of low biodiversity. On organic farms, we have found that nematode communities tend to lack

complexity and that phospholipid fatty acid (PLFA) profiles are dominated by bacterial biomarkers with relatively low contribution by fungal and protozoa biomarkers (Cavagnaro et al., 2006; Smukler et al., 2010).

One functional group, arbuscular mycorrhizae (AM), however, increases rapidly during the transition from high-input conventional to organic management, and organic crops are typically well-colonized, with crop N and phosphorus (P) levels meeting sufficiency criteria (Smukler et al., 2008). Experiments have been conducted in an organic farm soil to determine how AM contribute to N processes using a wild-type mycorrhizal tomato (MYC+) and a mutant (*rmc*) with highly reduced mycorrhizal colonization (Barker et al., 1998). High microbial biomass and nematode counts were present in the rootzones of both mycorrhizal and non-mycorrhizal tomatoes (Cavagnaro et al., 2006), and soil ammonia-oxidizing bacteria were also not different between the genotypes, based on RT-PCR and DGGE (Cavagnaro et al., 2008). From an experimental viewpoint, the similarity in soil biota between genotypes improves the capacity to isolate the N responses of the AM symbiosis.

In an on-farm study, transcriptome profiling of tomato root RNA after injection of water or ammonium into an enriched soil patch was performed using the Tomato Genome Array Chip (Ruzicka et al., in press). The primary response to an enriched N patch was mediated by mycorrhiza-independent root processes, but when inorganic N concentrations in the soil were low, differential regulation of key tomato N uptake and assimilation genes showed a shift to mycorrhiza-mediated N uptake over direct root inorganic N uptake. In addition, mycorrhizal specific phosphate transporters were more highly expressed in mycorrhizal roots compared to *rmc*. These pathways help to explain the higher N and P concentrations and contents in the mycorrhizal plants. Currently underway is an analysis of 454 Next Generation sequencing from the root RNA (Schachtman et al., in progress). Comparison of the genotypes with this high-throughput sequencing method is showing many fungal transcripts and additional tomato transcripts not found on the Gene Chip, and provides new possibilities for studying the fungal side of the symbiosis. Overall, this work is demonstrating the mechanistic basis for reliance on the AM symbiosis in an ecologically-based production system, and suggests that there may be new opportunities for more specific biodiversity management to enhance the AM symbiosis to increase crop nutrient uptake and minimize N losses.

As one example of agriculture that depends on ecological processes, organic vegetable production in California is characterized by high and dependable yields, but considerable variation exists in strategies for soil amendments, cover cropping, and rotations between farms. We have begun a landscape-level study to compare farming methods, biogeochemical processes, soil biota, and expression of root nutrient assimilation genes in tomato fields (Bowles et al., in progress). In addition to further understanding of the AM symbiosis, we hope to be able to identify situations in which nematode and microbial communities are more complex, and the ecological processes associated with higher soil quality and soil biodiversity. This will increase the capacity to compensate for high non-renewable inputs in specific farming situations, and thus promote the ability for other types of farmers to adopt practices that enhance 'ecological intensification' of agriculture.

References:

Barker, S.J., Stummer, B., Gao, L., Dispain, I., O'Connor, P.J. and Smith, S.E. 1998 A mutant in *Lycopersicon esculentum* Mill. with highly reduced VA mycorrhizal colonization: Isolation and preliminary characterisation. *Plant Journal* 15:791-797

Cavagnaro, T., Jackson, L.E., Six, J., Ferris, H., Goyal, S., Asami, D., and Scow, K.M. 2006. Arbuscular mycorrhizas, microbial communities, nutrient availability, and soil aggregates in organic tomato production. *Plant and Soil* 282:209-225.

Cavagnaro, T.R., Jackson, L.E., Hristova, K., and Scow, K.M. 2008. Short-term population dynamics of ammonia oxidizing bacteria in an agricultural soil. .*Applied Soil Ecology* 40:13-18.

Clavel, J., Julliard, R., and Devictor, V. 2011. Worldwide decline of specialist species: toward a global functional homogenization. *Frontiers in Ecology and the Environment* 9:222-228.

Culman, S.W., Young-Mathews, A., Hollander, A.D., Ferris, H., Sánchez-Moreno, S., O'Geen, A.T., and Jackson L.E. 2010. Biodiversity and soil ecosystem functions over a landscape gradient of agricultural intensification in California. *Landscape Ecology* 25:1333-1348.

Galloway, J.N., Dentener, F.J., Capone, D.G., Boyer, E.W., Howarth, R.W., et al. 2004. Nitrogen cycles: past, present, and future. *Biogeochemistry* 70:153-226

Jackson, L.E., Burger, M. and Cavagnaro, T.R. 2008. Roots, nitrogen transformations, and ecosystem services. *Annual Review of Plant Biology* 59:341-363.

Lu, M., Yang, Y., Luo, Y., Fang, C., Zhou, X., Chen, J., Yang, X., and Li, B. 2011. Responses of ecosystem nitrogen cycle to nitrogen addition: a meta-analysis. *New Phytologist* 189:1040-1050.

Perfecto, I. and Vandermeer, J. 2010. The agroecological matrix as alternative to the land sparing/agriculture intensification model. *Proceedings of the National Academy of Sciences of the United States of America* 197: 5786-5791.

Phalan, B., Balmford, A., Green, R.E. and Scharlemann, J.P.W. 2011. Minimising harm to biodiversity of producing more food globally. *Food Policy* 36:S62-S71.

Rockström, J., Steffen, W., Noone, K., Persson, A., Chapin, F.S., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., De Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., and Foley, J.A. 2009. A safe operating space for humanity. *Nature* 461:472-475.

Ruzicka, D.R., Hausmann, N.T., Barrios-Masias, F.H., Jackson, L.E., and Schachtman, D.P. Transcriptomic and metabolic responses of mycorrhizal roots to nitrogen patches under field conditions. In press, *Plant and Soil*.

Smukler, S.M., Jackson, L.E., Murphree, L., Yokota, R., Koike, S.T., and Smith, R.F. 2008. Transition to large-scale organic vegetable production in the Salinas Valley, California. *Agriculture, Ecosystems and Environment* 126:168-188.

Smukler, S.M., Sánchez-Moreno, S., Fonte, S.J., Ferris, H., Klonsky, K., O'Geen, A.T., Scow, K.M., Steenwerth, K.L. and Jackson, L.E. 2010. Biodiversity and multiple ecosystem functions in an organic farmscape. *Agriculture, Ecosystems and Environment* 139:80-97.

Tscharntke, T., Klein, A.M., Kruess, A., Steffan-Dewenter, I., and Thies, C. 2005. Landscape perspectives on agricultural intensification and biodiversity-ecosystem service management. *Ecology Letters* 8:857-874.

Young-Mathews, A., Culman, S.W., Sánchez-Moreno, S., O'Geen, A.T., Ferris, H., Hollander, A.D., and Jackson, L.E. 2010. Plant-soil biodiversity relationships and nutrient retention in agricultural riparian zones of the Sacramento Valley, California. *Agroforestry Systems* 80:41–60.

Session 3.1
Soil assessment, land use and ecosystem services

ECOLOGICAL BASIS FOR DEVELOPMENTS IN SOIL ECOSYSTEM SERVICES

RUTGERS, MICHIEL (MICHIEL.RUTGERS@RIVM.NL); MULDER, CHRISTIAN; POSTHUMA, LEO; SCHOUTEN, TON; VAN WIJNEN, HARM; BOGTE, JAAP; DEN HOLLANDER, HENRI; DE ZWART, DICK; BREURE, TON

RIVM-Lab for Ecological Risk Assessment, The Netherlands

Ecosystem Services (ES) as introduced by the United Nations Millennium Ecosystem Assessment boosted ongoing strategic research and paved the actual pathway to current applications – especially for soil. ES are services from ecosystem "outdoors" and should lean heavily on available terrestrial (bio)monitoring data and ecological analyses thereof. Two decades of sampling have resulted in a substantial database of soil organisms and their habitat characteristics. Extensive additions from ecological literature have expanded our data set to become a very rich source for both fundamental and practical applications. Fundamentally, our data allowed for the initiation of the development of three concepts, which are: allometry (the science of size-abundance relationships amongst soil organisms in natural food webs), ecological stoichiometry (the science of biotic (inter)relationships in terms of chemical compositions and food preference), and the association of structural and functional aspects of food webs – what directly links our data set to soil ES. Amongst others, a main finding was the definition of the stability of food webs in the field, which is key for any service being provided on the long term. The data have not only been used to derive fundamental new theories, but also to apply those already to rural and societal questions. When spatially presented, the fundamental models as derived have been used to demonstrate that several options in land-use planning and land management resulted in highly different impacts on the biodiversity of soil organisms, including differences in functional attributes as well as food-web stability. This paper will provide an overview of recent developments, aiming to illustrate the depth and width of soil biodiversity and Ecosystem Services that can be reached today.

LAND-USE CHANGE: CONSEQUENCES FOR SOIL MICROORGANISMS AND SOIL FUNCTIONS

HAMER, UTE (UTE.HAMER@TU-DRESDEN.DE)

Dresden University of Technology, Germany

Soil microorganisms are central for manifold functions of soils. They regulate soil forming and nutrient cycling processes and contribute to carbon sequestration and biomass production. So far consequences of land-use change for microbial community structure and soil functionality are only poorly understood. Data obtained on structure and activity of microbial communities in soils originating from different ecoregions (China, Germany, Ecuador) were analysed using multivariate analysis. The soil types examined have been classified according to WRB as Cambisols (Germany and Ecuador) and Calcaric Regosols (China). In addition to geological and climatic differences between the study areas soil properties were influenced at all sites by land-use change. The pH(H2O) of the soils ranged from 4.5 (Ecuador) to 9.0 (China). Distinct microbial communities with a characteristic phospholipid fatty acid (PLFA) fingerprint developed at all sites. Interestingly, the PLFA fingerprint of the Chinese arable soils was more similar to the examined agricultural soils in Germany than to the Chinese forest soils. In all ecoregions considered land-use change induced a more or less pronounced shift in the soil microbial community structure. After deforestation a changed microbial community structure seemed to be essential in the Chinese soils for the maintenance of N and C cycling rates independent of erosion intensity. The most important driver of the shift in the microbial community structure was the decrease in nutrient and substrate availability. In contrast, in the Ecuadorian mountain soils a disconnect between microbial structure and function was observed. Here, microbial community structure was mainly regulated by soil pH whereas microbial activity was predominantly driven by availability of nutrients and substrates.

WHY DO WE NEED LONG-TERM TRIALS TO ASSESS THE IMPACT OF PESTICIDES AND SOIL TILLAGE ON EARTHWORMS?

PELOSI, CÉLINE[1] (CELINE.PELOSI@VERSAILLES.INRA.FR); BERTRAND, MICHEL[2]

[1]INRA, France
[2]INRA-AgroParis Tech, France

Restoration of biodiversity loss due to intensification of agricultural practices is a major environmental issue that calls for the design of new cropping systems. Earthworms perform important agro-ecological functions since they influence organic matter dynamics and soil structure. They are taken to be biodiversity and soil quality indicators. In a long-term trial, initiated in 1997 (15 km southwest of Paris), three cropping systems are studied: a direct seeding living mulch-based cropping system (DMC), a conventional system (CONV), and an organic system (ORG). They differ mainly by soil tillage, crop biomass production, and pesticide and nitrogen use. Density, biomass and diversity of earthworms were studied in 2005, 2006, 2007, and 2011 thus after 8, 9, 10 and 13 of differentiation. In 2005-2007, total densities do not differ between the three cropping systems. However, anecic and epigeic abundances, diversity, and biomass are better in the DMC system than in the two others. No difference in density, biomass and diversity is found between BIO and CONV systems. In 2011, compared with 2005-2007, total densities were multiplied by 3 and 4 in DMC and BIO systems, respectively, but changed lightly in CONV system. Epigeic earthworms, poorly represented in cultivated systems because of their high exposure to pesticides and the lack of surface organic matter, have greatly increased in BIO and DMC systems (up to 21% and 47% of population). Thus, ploughing strongly affects the survival of earthworms, which explains that its abandonment (SCV system) has a measurable effect in the short term (8 years). Pesticides may increase earthworm mortality but they mainly affect other life-parameters such as fecundity and growth, over several generations. The effects of giving up using pesticides (BIO system) are measurable in the medium term (13 years) and then rejoin, at least in terms of abundance, the effects of ploughing abandonment.

DNA BARCODE-BASED CHARACTERIZATION OF NEMATODES COMMUNITIES

HELDER, JOHANNES[1]; LANDEWEERT, RENSKE[2]
(RENSKE.LANDEWEERT@BLGG.AGROXPERTUS.COM)

[1]Wageningen University, The Netherlands
[2]BLGG AgroXpertus, The Netherlands

Nematodes constitute one of most numerous and speciose groups of animals in marine, freshwater and terrestrial habitats. Nematodes include economically important plant, animal and human parasites and are used as bio-indicators for soil and sediment health. Nematodes are diverse, abundant, trophically diverse, and easily extractable from soil. Nematode assemblages not only reflect their own fate, but also the condition of the bacterial, fungal and protozoan communities. The conserved morphology of nematodes means that identification is time consuming and requires expert knowledge, and this is the main reason for their under-exploitation as soil health indicators. Therefore a user-friendly bio-sensor system should be based on non-morphological traits. Previous studies demonstrated that the small subunit ribosomal DNA (SSU rDNA) gene harbors enough phylogenetic signal to distinguish between nematode families, genera and often even species (Holterman et al., 2006, Van Megen et al., 2009). On the basis of an alignment of ≈ 2,400 full-length SSU rDNA sequences, we conclude that rDNA offers enough signal to detect target taxa even in high complex backgrounds such as soil and fresh water sediments. Currently, over 20.000 soil samples are analyzed yearly with molecular tools for detection of plant pathogenic nematodes at BLGG AgroXpertus. We will give an update on the development of a robust & affordable quantitative PCR-based nematode detection tool for agricultural and scientific purposes, as well as on comparable tools in the pipeline for the assessment of the ecological condition of soils and fresh water sediments.

References

- Holterman M., van der Wurff A., van den Elsen S., van Megen H., Bongers T., Holovachov O., Bakker J. and Helder J. 2006. Phylum-wide analysis of SSU rDNA reveals deep phylogenetic relationships among nematodes and accelerated evolution toward crown clades. Mol. Biol. Evol. 23, 1792-1800.
- Van Megen, Hanny; Van den Elsen, Sven; Holterman, Martijn; Karssen, Gerrit; Mooyman, Paul; Bongers, Tom; Holovachov, Oleksandr; Bakker, Jaap; Helder, Johannes. 2009. A phylogenetic tree of nematodes based on about 1200 full-length small subunit ribosomal DNA sequences, Nematologica 11 (6), 927-950

SELECTION OF SOIL BIOINDICATORS FOR IMPACT ASSESSMENT OF LAND USE CHANGES AND SOIL PROTECTION. EXEMPLE OF THE "BIOINDICATORS PROGRAMME."

PÉRÈS, GUÉNOLA[1] (GUENOLA.PERES@UNIV-RENNES1.FR); BISPO, ANTONIO[2]; GRAND, CÉCILE[2]; GATTIN, ISABELLE[3]; HEDDE, MICKAËL[4]; LEGUEDARD, MARINA[5]; RUIZ, NURIA[6]; DUR, JEANNE-CHANTAL[4]; ALALAPHILIPPE, AUDE[7]; BEGUIRISTAIN, THIERRY[8]; DOUAY, FRANCIS[9]; FAURE, OLIVIER[10]; HOUOT, SABINE[11]; HITMI, ADNANE[12]; VIAN, JEAN-FRANÇOIS[13]; ROUGÉ, LAURENCE[1]; CLUZEAU, DANIEL[1]

[1]University Rennes 1, France
[2]ADEME, France
[3]ESITPA ROUEN, France
[4]INRA PESSAC, France
[5]Université Victor Segalen Bordeaux, France
[6]IRD Bondy, France
[7]INRA Avignon, France
[8]LIMOS, France
[9]Groupe ISA, France
[10]ENS des Mines de St-Etienne, France
[11]INRA Versailles-Grignon, France
[12]IUT Clermont-ferrand - Université d'Auvergne, France
[13]ISARA-Lyon, France

Protecting and managing soils require a set of indicators able to judge about the impact of land use changes and the degradation of soil properties and functions. Considering the lack of biological indicators (bioindicators) to describe the quality of soil, a national research programme has been set up to develop such indicators (2006-20012). The main objectives of this "BioIndicator programme" are to (i) develop methods for measuring soil biodiversity and soil functions, (ii) use soil bioindicators to monitor soil quality and (iii) identify relevant bioindicators or endpoints for soil ecological assessment. For the first phase (2006-2009), 80 biological parameters were tested from microorganisms to soil Fauna and Plants. This phase, due to multivariate analysis approaches, ended with the selection of 47 relevant indicators. The 2nd phase (2009-2012), which involved 70 partners, aims to calibrate the different selected bioindicators, to compare them each together (relevance in terms of sensitivity, accessibility, applicability) and to validate these bioindicators. These 47 biological parameters correspond to microorganisms (e.g.genetical structure, enzymatic activities) micro-meso and macrofauna (e.g. nematodes, collembola and mites, earthworms, total macrofauna, metal accumulation in snails) and flora (e.g. lipid biomarkers in the leaves, Amino acid content, Metalic element bioaccumulation). The strengths of Bioindicator programme, which is unique at European scale, are (i) to test a large number of bioindicators (47), in a large panel of situations (47 situations differing by land use and agricultural practices and contamination origin), (ii) to apply standardised sampling protocols managed by only one sampling team, thus ensures a high quality of biological data acquisition, iii) to manage high number of data (200.000) by using a common database thus facilitates the data analysis. This presentation will present in details the Bioindicator programme (bioindicators, sampling protocols and procedures, sites, database structuration, data-mining involved) illustrated by the first results.

INDICATORS OF SOIL BIODIVERSITY FROM NATIONAL PERSPECTIVES TO EUROPEAN POLICY

CREAMER, RACHEL[1] (RACHEL.CREAMER@TEAGASC.IE); BLACK, HELAINA[2]; RITZ, KARL[3]; GRIFFITHS, BRYAN[1]

Teagasc, Ireland
James Hutton Institute, United Kingdom
National Soil Resources Institute, Cranfield University, United Kingdom

The development of biological indicators for the assessment of change to soil quality has become an increasingly important research agenda item. This emphasis is logical since the soil biota is the driving force behind many soil functions including nutrient transformations, water purification, C-sequestration and soil structural dynamics. There is a substantial amount of information available concerning the measurement and implementation of soil biological indicators for the assessment of soil quality; from small-scale field trials up to national-scale studies (Black et al., 2003; Rutgers et al., 2009). At a European level (Bispo et al., 2009) initiatives have been taken to promote the use and standardisation of such indicators. Currently there are over 15 European Member States which have collected soil biological data as part of a monitoring programme. However, this information has been derived from specific environmental situations using a wide range of methods, which challenges effective comparison and integration of such data. The European Union are increasingly prescribing the need for standardised information to provide the foundation for integrated assessments of soil biodiversity and soil quality. To achieve this, measurement of biological indicators need to be consistently applied, with standardised methodologies which can be validated across a range of environmental and climatic conditions. Approaches and results from four large-scale research projects are here reviewed in this context, viz. (i) the SQID project (UK) which investigated the sensitivity and discrimination power of 9 biological indicators across a range of land-uses; (ii) the ENVASSO project which proposed a set of suitable indicators for monitoring the decline in soil biodiversity across Europe; (iii) the Ecofinders project which is assessing the standardisation of biological indicator methodologies, to be implemented and tested in several counties across Europe; (iv) a soil respiration study which assessed the ISO basal respiration methodology across a range of climatic zones within Europe.

Session 3.2
Soil-plant-nutrient interactions

THE RELEVANCE OF NITROGEN RETENTION BY SOIL BIOTA IN THE REHABILITATION OF NATURAL GRASSLAND COMMUNITIES

KEMMERS, ROLF[1]; BLOEM, JAAP[1] (JAAP.BLOEM@WUR.NL); FABER, JACK[2]

[1]Wageningen University and Research Centre, Centre of Soil Sciences, The Netherlands
[2]Wageningen University and Research Centre, Centre for Ecosystem studies, The Netherlands

In conservation management efforts to restore deteriorated fen meadows the re-establishment of a biodiverse flora stays away in many cases. On observations of unexpected increases in biomass production upon acidification in several fens we founded our hypothesis that unsuccessful efforts are due the ignorance of the soil food web as an important nitrogen sink by N-immobilization depriving the vegetation of mineral nitrogen for biomass production at the cost of species diversity. We examined sound and deteriorated natural sites as well as successfully and unsuccessfully restored sites with plant communities of poor and rich fen meadows. We determined soil chemical properties, nitrogen pools in soil biota, carbon and nitrogen mineralization rates, nitrogen flows, and we assessed which of these variables correlated with the variation in plant species composition. In sound rich fen meadows nitrogen was poorly available for biomass production due to an active soil life, immobilizing nitrogen and transferring it to higher levels of the soil food web. Earthworms constituted the major nitrogen sink. In sound poor fen meadows less nitrogen was immobilized by soil life. Microbes were the main nitrogen sink whereas mesofauna nearly failed. Our results showed that soil acidification depressed soil activity, causing the internal nitrogen balance to shift from N-immobilization to net N-mineralization in favor of biomass production but a decreased plant species diversity. Nitrogen retention, driven by an active soil biological community appeared a decisive process for successful recovery. We propose that restoration techniques may benefit from stimulating a functional diverse soil fauna resulting in an enhanced storage of available nutrients in the soil food web.

THE ANTIBIOTIC SULFADIAZINE IN MANURE AFFECTS THE BIODIVERSITY OF THE SOIL MICROBIAL COMMUNITY

THIELE-BRUHN, SÖREN (THIELE@UNI-TRIER.DE); HAMMESFAHR, UTE; REICHEL, RÜDIGER

Soil Science, University of Trier, Germany

Pharmaceutical antibiotics reach agricultural soils with contaminated manure used as fertilizer. Most antibiotics tend to persist in soil for month. Hence, being bioactive agents, antibiotics exert adverse effects on the functional and structural diversity and resistance level of soil microbial communities. To elucidate the effect of the sulfonamide sulfadiazine (SDZ) on soil microorganisms, microcosm, mesocosm and field experiments have been conducted using contaminated manure for soil spiking. Phospholipid fatty acids (PLFA) and 16S rDNA genes were analyzed as markers of the soil community structure and enzymatic activities were determined. Manure had a strong influence on functional and structural parameters, increasing the activity of selected enzymes, basal respiration, microbial biomass and PLFA parameters. Effects of SDZ on the functional parameters were small and not related to the SDZ concentration. However, clear effects of SDZ on microbial biomass and PLFA pattern were determined, which effects interacted with the manure application rate. SDZ decreased the soil microbial biomass and bacteria:fungi ratio. The influences of manure and SDZ on the bacterial community structure were also revealed by DGGE analysis. Both manure and SDZ induced shifts in the community structure, making communities of different soils more similar. Results indicated that SDZ changed the structural diversity of gram-positive bacteria and especially influenced the ratio of gram+:gram– bacteria. Sequencing showed that manure-borne bacteria, designated as sulfonamide- and tetracycline-resistant, survived several weeks in soil treated with SDZ contaminated manure. The effects of SDZ on soil microorganisms were significant for several months and observed for up to 120 d although the bioavailable SDZ fraction (CaCl2-extractable) rapidly declined. Also conventional manure storage for 6 months did not eliminate the antimicrobial activity of SDZ. Effects were less pronounced in the rhizosphere compared to bulk soil, which was mirrored by a stronger dissipation, and thus lower bioaccessibility of SDZ in the rhizosphere.

DOES CHANGED LITTER INPUT AFFECT LIGNIN STABILITY AND MICROBIAL COMMUNITIES IN FOREST SOILS?

KLOTZBÜCHER, THIMO[1]; STROHMEIER, STEFAN[2]; KAISER, KLAUS[3]; BOWDEN, RICHARD[4]; KALBITZ, KARSTEN[1] (K.KALBITZ@UVA.NL)

University of Amsterdam, Institute for Biodiversity and Ecosystem Dynamics, Earth Surface Science, The Netherlands
University of Bayreuth, Soil Ecology, Germany
Martin Luther University Halle-Wittenberg, Soil Sciences, Germany
Allegheny College, Meadville, Department of Environmental Science, The United States

Global change scenarios predict increasing productivity of temperate forests. The response of soil organic matter (SOM), with lignin being an important component, is critical for future carbon balances of these ecosystems. Lignin composition was analyzed with the CuO method in mineral topsoils (0–20 cm depth) of two temperate forest sites with manipulated litter inputs (doubling/ exclusion of litter and/or roots) for either 8 or 16 years. Data on soil carbon contents and distribution over density fractions, traits of the microbial community, and fluxes of dissolved organic matter (DOM), was used to unravel effects on lignin caused by changed input of recent lignin and/or lignin degradation. It seems that type of forest floor determines the relationship between litter input and lignin turnover. For moder-type forest floors, litter exclusion changed the major pathway of organic matter input into topsoils from DOM to forest floor-derived organic particles. This resulted in increasing fungi-to-bacteria ratios and lignin degradation (higher acid-to-aldehyde ratios of lignin phenols) in topsoils. Increased DOM input by doubling litter input did not affect lignin properties and fungi-to-bacteria ratios. Thus, the form of organic matter input and the microbial community seemed to control lignin degradation in topsoils. Both factors were closely linked and determine the share of energy-rich organic matter fuelling lignin degradation. The general input patterns did not change upon litter exclusion for topsoils under thin non-permanent mull-type forest floor. Fungi-to-bacteria ratios were not affected and the decreased input of organic particles resulted in lignin being more oxidized. For topsoils under mull-type forest floors, doubling litter input may result in increased input of organic particles, which degrade rapidly, without effects on lignin. Overall, our results suggest that increasing litter production due to global change will hardly affect degradation of lignin stored in mineral soils.

BELOWGROUND BIODIVERSITY EFFECTS OF PLANT SYMBIONTS SUPPORTS ABOVEGROUND PRODUCTIVITY

WAGG, CAMERON[1] (CAMERON.WAGG@ART.ADMIN.CH); JANSA, JAN[2]; SCHMID, BERNHARD[3]; VAN DER HEIJDEN, MARCEL[1]

[1]Ecological Farming Systems, Agroscope Reckenholz Tänikon, Research Station ART, Switzerland
[2]Institute of Plant, Animal and Agroecosystem Sciences, ETH Zürich, Switzerland
[3]Institute of Evolutionary Biology and Environmental Studies, University of Zürich, Switzerland

Soil microbes play key roles in ecosystems, yet the impact of their diversity on plant communities is still poorly understood. Here we demonstrate the diversity of belowground plant associated soil fungi promotes plant community productivity. Using additive partitioning of biodiversity effects developed in plant biodiversity studies, we demonstrate for the first time, that this positive relationship was driven by complementary interactions among soil fungi in one soil type, and by selection for the fungal species that stimulated plant productivity the most in another soil type. Both selection and complementarity effects among belowground species contributed to improving plant productivity up to 82 % and 85 %, respectively, above the average of any of the species alone. Our results demonstrate belowground diversity can act as insurance for maintaining plant productivity under differing environmental conditions.

SOIL BIODIVERSITY AND AGRICULTURAL SUSTAINABILITY

VAN DER HEIJDEN, MARCEL[1] (MARCEL.VANDERHEIJDEN@ART.ADMIN.CH); WAGG, CAMERON; VERBRUGGEN, ERIK; BENDER, FRANZ; OLBRECHT, LUISE; VEIGA, RITA; OEHL, FRITZ

[1]Ecological Farming Systems Group, Agroscope Reckenholz Tänikon, Switzerland

Soil microbes represent the unseen majority of life on Earth and are essential for the functioning of terrestrial ecosystems as they catalyse unique and indispensable transformations in the biogeochemical cycles of the biosphere. The significance of soil microbial biodiversity for the functioning of agricultural and natural ecosystems is still poorly understood and communities of soil biota can be considered as a black box. This talk highlights the importance of soil microbial diversity, for a number of important ecosystem processes including plant productivity, plant diversity, nutrient capture, reduction of nutrient losses and nutrient retention (as proxy for ecosystem sustainability). Specific attention will be given to arbuscular mycorrhizal fungi and rhizobia, underground symbionts that form associations with a wide range of plants including many agricultural crops. Overall this talk highlights the role of soil micro-organisms as ecosystem engineers.

PLANT-MICROBE INTERACTIONS CONTROL N LEACHING FROM GRASSLAND SOILS

DE VRIES, FRANCISKA[1] (F.DEVRIES@LANCASTER.AC.UK); BLOEM, JAAP[2]; QUIRK, HELEN[1]; BARDGETT, RICHARD[1]

[1]Lancaster University, United Kingdom
[2]Wageningen University and Research Centre, Alterra, The Netherlands

Nitrogen (N) leaching from agricultural soils is a major problem. It has resulted in widespread changes in plant community composition and loss of grassland species diversity, hypoxia in aqueous systems, and increased levels of nitrate in drinking water with consequences for human health. Evidence is culminating that extensively managed grasslands with fungal-based soil food webs are less leaky of N than their intensively managed, bacterial-based counterparts. Extensively managed grasslands have lower N availability, supposedly because fungi slow down rates of N cycling and immobilize added N. However, because of the strong links between plant communities and soil microbes it is not clear which of the two is a stronger control of N leaching. Here, we explored how grassland management affects N leaching in a field sampling across 22 mesotrophic grasslands in northern England. Leaching losses of inorganic N were lower from extensively managed, plant species rich grasslands than from intensively managed, species-poor grasslands. We found that N leaching was best predicted by shoot C/N ratio of the plant community. In turn, the fungal/bacterial ratio, measured by microscopy, was best explained by the C/N ratio of roots. We tested the mechanisms for differences in N leaching in a linked greenhouse experiment with soils from a subset of these grasslands, to which we added 15N. We found that extensively managed grassland soils also retained added 15N better; further analysis will show whether this was because of increased uptake of 15N by microbes or plants. These results show that interactions between plants and microbes control N leaching from grasslands, and might help to improve management for N retention in soils, which is central to 'sustainable intensification' of agriculture.

Theme 4
Governance and Policy

Keynote
Ladislav Miko

SOIL PROTECTION AS A CHALLENGE FOR EUROPEAN POLICY

MIKO, LADISLAV (LADISLAV.MIKO@EC.EUROPA.EU)

Deputy Director-General of DG Health and Consumers at the European Commission

The importance of soil and soil protection was repeatedly discussed at the level of European Union. In September 2006, the European Commission adopted a new thematic strategy for soil protection. Based on a very comprehensive assessment and very broad scientific consensus, the situation of European soils was evaluated as alarmingly degrading and requiring remedial action. The main instrument proposed, the Soil Framework Directive, was however not adopted yet, due to the absence of support of a blocking minority of member states – namely Germany, France, Netherlands, United Kingdom and Austria. This position seems to be very striking, as among those, opposing the directive are the very states which proposed ca.10 years ago to start works on the development of a European Soil Protection Policy, and which have developed until now quite comprehensive national policies to protect their soils. This position means at the same time, that the alleged additional burden for farmers and other subjects, caused by the proposed framework directive, is in fact only present in those countries which developed their national frameworks of soil protection, and will not be balanced in countries where national legislation does not exist, and will not be adopted without a European framework directive in the foreseeable future.

The adopted European thematic strategy for soil protection aims to protect soil functions across the European Union and sets out the four pillars of EU soil policy: legislation, integration into other policies, research and awareness raising. The strategy recognises soil as a practically non-renewable natural resource, performing crucial functions both for human and ecosystem benefit and survival. The costs of vast soil degradation are very high and mainly borne by society, not by the land users. As the trends clearly signal that European soils are increasingly degrading or even irreversibly lost across the whole territory of the European Union, the present Community acquis is clearly not sufficient. The problems can only be addressed by a broad and comprehensive approach, therefore the soil framework directive was proposed, building on experience with the water framework directive. Nevertheless, the proposed directive respects extremely high variability of local conditions and historical socio-economic developments, so it remains very flexible and in many aspects only indicative. The proposed directive aims to protect soil for the following functions: (a) biomass production, (b) storing, filtering and transforming nutrients, substances and water, (c) biodiversity pool function as a habitat, species and gene source, (d) physical and cultural environment for humans and human activities, (e) source of raw materials, (f) carbon pool, and (g) archive of geological and archaeological heritage. The proposal covers all major soil threats (sealing, erosion, organic matter decline and soil biodiversity, compaction, salinisation, landslides and contamination) and it is structured into three major parts, covering prevention (precautionary measures, integration into sectoral policies, prevention of contamination), identification of problems (identification of contaminated sites within 25 years, identification of other risk areas within 5 years) and action (programmes of measures, sealing mitigation/limitation and National remediation strategy).

Despite the presence of national measures in some countries, the soil problem cannot be addressed without coordinated and comprehensive action at higher than national level. While the mechanism of some soil threats is self-evident (eg. sealing, compaction, salinisation, toxic or other contamination), very complex challenges remain to be addressed regarding functions

linked to biotic elements of soils and ecological processes backing the delivery of ecosystem services. Some of them may have in medium or longer term perspective a principal, strategic importance (soil nutrients, soil fertility and productivity), among others for water regime and food/feed production.

I would like to highlight some of these challenges, which may help to support the idea of coordinated action at (at least) European level.

Even if research of biological and ecological properties of soils advanced dramatically in recent decades, we still have very limited knowledge about the basic structure and functions of biotic elements of soils. Some elements are more developed (eg. soil microbiology) than others, but the extremely high complexity of soil functions and their relationships remains to be fully understood. Even with all available knowledge it is difficult to predict further developments, provide clear recommendations for soil ecological restoration etc. Many elements of soil life are yet unknown or poorly described, eg. there is very limited knowledge at the species level.

Ecological trade-offs linked to favoring certain soil functions over others (eg. production function in highly intensive farming or intensive horticultures) are not well described in medium and longer-term perspective. Negative impacts are usually compensated by human actions (fertilising, pH-management, irrigation etc.), but these are highly dependent on still relatively cheap (fossil) energy input.

Some of the lost qualities, as eg. simplified soil organism communities, resulting in losses of soil structure and consequently decreased soil ability to keep and preserve both water and nutrients, cannot be easily compensated. Highly intensified approaches in farming and forestry seem to be responsible for lowered organic matter input back into soil, stipulating potentially a dangerous positive feedback: lower input of organic matter causes degradation of soil biota communities (by simplification, and selection of just several species able to adapt), resulting in decreased ability to build and/or keep appropriate soil structure. As a consequence, even more scarce nutrients are easier lost, resulting in further simplification and further loss of soil structure. Addition of industrial/mineral fertilizers by humans mitigates only temporarily the availability for crops or other plants, but cannot stop soil structure degradation. Moreover, species (microflora) able to utilise energy of soil organic matter with normally very slow turnover, may be favored and attack also longer term organic reserves of the soils. This process may be potentiated also by effects of climate change and management methods (increased average temperatures, opening soil to sun irradiation at vegetation-free or clear-cut areas etc.).

There are many indications, that presence and input of soil organic matter are crucial for healthy soils. Still, the amount of production removed from the soil is very high, and in many areas still increasing. There is no clear indication about thresholds leading to abovementioned feedbacks and to significant soil degradation. Neither is it clear, if and to what extent simple addition of organic matter can help to restore soils. I would like to propose, that more attention is given to the overall energy flow throughout the soil ecosystem. Apparently, human activities simplify the energy sources available in the soil system and, instead of energy dissipation in very small steps via a highly diverse soil community, install "shortcuts". This results in less efficient energy use, loss of nutrients including carbon, contributing also to production of greenhouse gasses. Lower amounts of available energy and its utilisation in larger 'steps' is perhaps a reason for the observed decrease of abundance and diversity of soil biota communities. However, restoration of soil functions may be dependent not only on the

simple addition of organic matter, but also on availability of a species pool and time for re-establishing more complex food-webs.

Clearly, addressing some of the challenges mentioned above may play crucial role in establishing efficient responses to soil degradation. More clarity about the links between long-term ability of soils to deliver their basic functions, related to the highly political demand to feed the growing human population and ensure the availability of water, and availability of energy for both soil processes and human interventions may help to convince member states to proceed with Europe-wide coordinated action, resulting not only in stopping further degradation, but also in restoring soil structure and functioning.

Keynote
Luca Montanarella

ON GOVERNANCE AND POLICY RELATED TO SUSTAINABLE DEVELOPMENT

MONTANARELLA, LUCA (LUCA.MONTANARELLA@JRC.EC.EUROPA.EU)

European Commission, Italy

Keywords: Soil Protection, Sustainability, Natural Resource Management, Environmental Policies

In the current era of multiple crises, from food price, through climate change to economic failure, policy makers around the world are exploring opportunities to make a shift to a green economy. The international community is seeking new ways of developing the concept of sustainable development up to and beyond the Earth Summit in 2012, mainly with regards to practical ways for the coherent implementation of the three pillars of sustainability, moving away from trade-offs to synergies between the economic, social and environmental dimensions of development.

The UN General Assembly at its 64th Session agreed to convene a UN Conference on Sustainable Development in Brazil in 2012. The objectives are: to secure renewed political commitment to sustainable development; to assess progress and gaps in implementation of the major summits; and to address new and emerging challenges including food, fuel, climate, finance and employment. The two main themes of the Conference are: a green economy in the context of sustainable development and poverty eradication; and the institutional framework for sustainable development. Within that context special attention to global soil resources should be paid, given that global soil resources are limited and currently under pressure by various threats. Future food security for a growing population can only be assured if sufficient fertile soils and water will be available for food production. The limited available soil resources for food production are currently under increasing pressure by competing land uses, like energy production, housing and infrastructure, nature protection, mining and industrial activities. Available legal frameworks for soil protection at National and regional level seem not to be able to regulate the current use of soil resources in order to assure long-term sustainability. A new framework is needed based on partnership and participatory approaches at all levels, from the local scale to the global scale, enabling sustainable soil management and land use. A new Global Soil Partnership (GSP), as proposed by the FAO and the EU, could be the way forward for a renaissance of soil protection activities assuring the necessary availability of soil resources also for future generations.

Maintaining the needed minimum amount of soils for feeding the growing population of the world and meeting their needs for biomass (energy), fiber, fodder and other products should be one of the guiding principles of the GSP. As should be maintaining soil/land uses that allow to also sustaining the other ecosystem services on which our livelihoods and societies depend including water regulation and supply, climate regulation as well as biodiversity conservation and other cultural services. Increasing soil degradation processes due to land use changes are threatening this resource and urgent action is needed to reverse this trend if we want to assure the necessary food production for future generations. The sustainable and productive use of the soil resources of the world should therefore be the ultimate twinned goal of the GSP.

In order to achieve this goal, the GSP will address four main pillars of action:

1. Harmonization and establishment of guidelines and standards of methods, measurements and indicators;
2. Soil data and information: data collection, validation, reporting, monitoring and integration of data with other disciplines;
3. Soil research and development focusing on synergies with related productive, environmental and social development actions.
4. Sustainable management of soil resources and improved global governance for soil protection.

Following the successful launch event of the Global Soil Partnership 7-9 September 2011 in FAO, Rome, Italy, the detailed terms of reference and implementation plan will be submitted to the FAO governing bodies for endorsement and for being presented at the Rio+20 Earth Summit as a major contribution to a new approach to sustainable development based on green economy and a new institutional framework based on partnership and participatory approaches.

Session 4.1
Soil information in support of policy making and awareness raising

FUNCTIONAL SOIL PLANNING: CAN POLICIES ADDRESS GLOBAL CHALLENGES WITH LOCAL ACTION?

SCHULTE, ROGIER (ROGIER.SCHULTE@TEAGASC.IE); CREAMER, RACHEL; FEALY, REAMONN; ET AL.

Teagasc - the Irish Agriculture and Food Development Authority, Ireland

Food security and environmental sustainability are no longer contradicting goals; both are reliant on maximising the efficient use of natural resources. Soils and soil science are at the heart of this resource use efficiency, as soils are the interface between farming and the environment; most agronomic and environmental processes take place within the soil. Whilst heretofore soil policies have largely focussed on defining and combating "threats" to soils, this approach has inadvertently led to significant resistance amongst stakeholders. In this presentation, we propose an alternative approach to soil policies, which is based on maximising soil functions at national and international scale by customising soil management at local level. First, we propose approaches to quantify both the "supply" and the "demand" for the multitude of functions we require from our soils, including food, fibre and fuel production, carbon sequestration, water purification and providing a habitat for biodiversity. We explore the extent to which each of these functions are "synergistic", and can be maximised simultaneously, or "antagonistic" and subject to mutual trade-offs. We discuss differences between soil types in performing each of the soil functions, and we assess whether the total "demand" for soil functions at national level can be met by the total "supply", or whether supply is ultimately restricted by land availability. In this light, we introduce the concept of Functional Soil Planning: this entails the planned, spatial management of soil functions, in which soils are managed to perform a specific function at local level, with a view to maximising combined suite of soil functions at national and international level. Finally, we assess the extent to which current policies (including the Nitrates Directive, Kyoto Agreement and Water Framework Directive) facilitate such an approach, in which the global challenge of sustainable food security is addressed by tailor-made actions at local level.

SOIL POLICY IN EUROPE - NO COMMUNICATION - NO SUCCESS

BROLL, GABRIELE (GABRIELE.BROLL@UNI-OSNABRUECK.DE)

German Soil Association, University of Osnabrueck, Germany

After long discussion, the soil framework directive is still up in the air. There is no doubt, politicians of some countries will continue opposition against the soil framework directive and will operate with strong lobbyists also in the future. Many people including some EU politicians suppose that raising soil awareness can help to change this situation. These activities are very useful, but will not be very effective in the short term. Raising soil awareness cannot be done within a few years but will take decades like in case of water protection. Moreover, it will never work with a top down approach only. One bottom up approach to raise soil awareness can be, for example, encouragement of local initiatives, people dealing with soil and soil protection in administration, in school etc. The European Network on Soil Awareness ENSA tries to link all these local initiatives. Moreover, it is not very promising to take only soil scientists into consideration when looking for people to become involved in raising soil awareness. Many of them are interested in this topic but most soil scientists do not want to spend time for these activities. Thus, communication with the society to raise soil awareness, which will hopefully change the behavior of many people including politicians, is a long-term process and needs the right dissemination strategy. Additionally, short term communication is necessary between all those stakeholders involved in soil protection in Brussels and in those European countries where politicians still oppose against the soil framework directive. Without a common strategy all single efforts will probably fail. In Germany, the "Aktionsplattform Bodenschutz" (ABo), a consortium of the German Soil Association (BVB), the German Soil Science Society (DBG) and the German Association for Environmental Remediation and Brownfield Redevelopment (ITVA), would be one partner for cooperation,www.bvboden.de.

SAME SOILS, DIFFERENT IDEAS: COMPARISON OF MARKA AND FULANI AGROPASTORALISTS' KNOWLEDGE OF SOILS IN CENTRAL MALI

CRANE, TODD (TODD.CRANE@WUR.NL)

Wageningen University, Technology and Agrarian Development Group, The Netherlands

Innovation in sustainable management of agricultural soils requires co-production of knowledge and technologies involving both research scientists and farmers themselves. While a great deal of knowledge has been produced about soil management techniques by research scientists, there is often a disconnect with application in farmers fields. The study of local knowledge of soils, ethnopedology, has been identified as a promising research approach to documenting and understanding farmers' knowledge of soil dynamics, as well as bridging farmers' and scientists perspectives on soil management. Local knowledge of soil types and fertility management strategies was documented between two groups of agro-pastoralists in central Mali. One group has a long history of farming with animal keeping having been integrated into livelihoods in living memory. The other group has a long history of cattle herding, and have only integrated farming into their livelihood portfolio in recent decades. Comparisons between the two data sets indicate that while the groups have fairly similar knowledge of biophysical soil processes, their ideas of how to manage those processes differ substantially. These difference are most robustly explained by the groups' distinct cultural values and modes of access to land resources which have been shaped by regional political history. The fact that farmers' technical knowledge of soils and their management is embedded within normative cultural positions has major implications for scientific experimentation with soil improvement. It emphasizes that technical innovations or interventions are infused with implications of political and cultural transformation. Collaboration with farmers in the development of soil technologies requires that research scientists take farmers' knowledge seriously, both in terms of technical and normative aspects. Furthermore, research scientists must substantively grapple with the political and cultural implications of technical changes they explore.

THE ROLE OF SOILS INFORMATION IN SCOTTISH RURAL POLICY AND SUPPORT

TOWERS, WILLIE[1] (W.TOWERS@MACAULAY.AC.UK); DONNELLY, DAVID[1]; CONDLIFFE, IAN[2]

[1]The James Hutton Institute, United Kingdom
[2]Ingleby, United Kingdom

This paper describes how soil information has been used to inform the debate in a key area of EU Rural Policy within a Scottish context. The Less Favoured Area (LFA) support scheme was heavily criticised by the EU Court of Auditors in 2003 with respect to the lack of transparency in its delineation and implementation in some countries. As a result, the EU recommended that delineation of the LFA (renamed Areas of Natural Handicap (ANH)) be based solely on biophysical criteria with no socio-economic assessment. The Land Capability for Agriculture (LCA) system is a long established classification system for determining the inherent agricultural capability of land in the UK. It was assessed as a mechanism for re-delineation, and although there was a clear and logical relationship between the existing LFA boundary and LCA class, the EU did not favour country-specific solutions and developed a uniform system to be applied across Europe. Eight criteria were proposed – temperature, heat stress, drainage, soil texture and stoniness, soil rooting depth, soil chemical properties, soil moisture balance and slope. These have been tested in the Scottish context and the potential impact on the LFA boundary assessed. Alternative criteria such as Field Capacity Days and different thresholds for temperature have also been tested as the thresholds originally proposed by the EU did not produce realistic solutions for Scotland. Some highly productive arable land was being wrongly classified as ANH; one explanation is that the long day length in summer and lack of drought conditions in Scotland compensate for the relatively low temperatures.

THE SOIL ATLAS OF AFRICA

DEWITTE, OLIVIER[1] (OLIVIER.DEWITTE@JRC.EC.EUROPA.EU); JONES, ARWYN[1]; SPAARGAREN, OTTO[2]; BREUNING-MADSEN, HENRIK[3]; BROSSARD, MICHEL[4]; DAMPHA, ALMAMI[5]; GALLALI, TAHAR[6]; JONES, ROBERT[7]; KILASARA, METHOD[8]; LE ROUX, PIETER[9]; MICHÉLI, ERIKA[10]; THIOMBIANO, LAMOURDIA[11]; VAN RANST, ERIC[12]; YEMEFACK, MARTIN[13]; ZOUGMORE, ROBERT[14]; BOSCO, CLAUDIO[1]; MONTANARELLA, LUCA[1]

[1]European Commission, DG Joint Research Centre, Institute of Environment and Sustainability, Land Management and Natural Hazards Unit
[2]former ISRIC - World Soil Information, Wageningen, The Netherlands
[3]University of Copenhagen, Denmakr
[4]Institut de Recherche pour le Développement (IRD), France
[5]African Union Commission
[6]University of Tunis El Manar, Tunis
[7]Cranfield University, United Kingdom
[8]Sokoine University of Agriculture, Tanzania
[9]University of the Free State, South Africa
[10]Szent István University, Hungary
[11]Food and Agriculture Organization of the United Nations
[12]Ghent University, Belgium
[13]Institute of Agricultural Research for Development (IRAD), Cameroon
[14]International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Niger

To raise the awareness of the general public, policy makers and other scientists to the importance of soil in Africa, the Joint Research Centre of the European Commission is to produce the first ever Soil Atlas of Africa. The Atlas compiles existing information on different soil types as easily understandable maps (both at regional and continental scale) covering the African continent. The Soil Atlas of Africa produces derived maps at continental scale with descriptive text (e.g. vulnerability to desertification, soil nutrient status, carbon stocks and sequestration potential, irrigable areas and water resources) as well as specific maps to illustrate threats such as soil erosion for instance. For each regional overview, large scale examples of soil maps and derived products are presented too. Together with the publication of the Atlas, associated datasets on soil characteristics for Africa will be made available. These datasets will be useful for making broad distinction among soil types and provide general trends at the global and regional scales. The datasets will be made accessible for free downloading from the portals of the SOIL Action (http://eusoils.jrc.ec.europa.eu/) and the ACP Observatory for Sustainable Development (http://acpobservatory.jrc.ec.europa.eu). The Atlas links the theme of soil with rural development and, at the same time, supports the goals of the EU Thematic Strategy for Soil Protection in conserving a threatened natural resource that is vital to human existence. Not only climate change, but also desertification and loss of biodiversity are strongly affecting soils globally, making the "Soil Atlas of Africa" relevant to a much larger community of stakeholders involved in the implementation of the three "Rio-Conventions" and allowing to explore possible synergies among international multilateral agreements towards global soil protection.

SOIL ATLAS OF LATIN AMERICA AND CARIBBEAN: SOIL SCIENCE AND AWARENESS RAISING

GARDI, CIRO[1] (CIRO.GARDI@JRC.EC.EUROPA.EU); BARCELO CORDON, SARA[1]; ARWYN, JONES[1]; MONTANARELLA, LUCA[1]; CASTILLA, CARLOS; COMERMA, JUAN; ENCINA ROJAS, ARNULFO; KRASILNIKOV, PAVEL; MENDONCA, MARIA LOURDES; MUNIZ, OLEGARIO; ORTEGA BLU, RODRIGO; SCHAD, PETER; VARGAS, RONALD; GHYOOT, CATHERINE; GONZALEZ CHANSON, SILVIA

Joint Research Centre, European Commission

Communication to civil society and awareness raising are important tasks for science and development actions. Today, soils have been acknowledged again to be the key resource when dealing with global issues such as food insecurity and climate change adaptation and mitigation. Yet, communication of soil information was not fully achieved. With the objective of filling the gap in communication between science and society, the European Commission's Joint Research Centre (JRC) launched a series of thematic atlases on soil. The latest in this series is the Soil Atlas of Latin America and the Caribbean (LAC). This publication will be a cooperative effort between the European Commission, the Food and Agriculture Organization of the United Nations (FAO) and a wide representation of the soil science community from over 19 Latin America and Caribbean countries, Europe, United States and other International Organizations. The project is financially supported by the European Commission's Development and Cooperation Directorate-General through EUROCLIMA regional cooperation program between the EU and Latin America on climate change issues. The Atlas will present the geographic distribution of the major soil types in LAC using the World Reference Base system, highlighting the key soil forming processes as well as drawing attention to the potentiality of and the threats to these soils; a specific focus will be on the links between climate change and soil in the region. The relevance and richness of ethnopedology in the region will be also shown in the publication. Some of the maps shown in the Atlas will be produced using modern digital soil mapping approaches and techniques. The collaboration with LAC soil scientists and Soil Science Societies will contribute to the reinforcement of scientific collaboration between Europe and Latin America and a strengthening of the knowledge base on soils in the region.

Session 4.2
Ecosystem services: a useful concept for soil policy making?

MORE POLICY-DRIVEN RESEARCH ON SOIL: FEEDBACK FROM THE FRENCH GESSOL PROGRAM

EGLIN, THOMAS[1] (THOMAS.EGLIN@ADEME.FR); BISPO, ANTONIO[1]; BARDY, MARION[2]; CHENU, CLAIRE[3]; KING, DOMINIQUE[4]

[1]ADEME, France
[2]MEDDTL/CGDD/DRI/SR, France
[3]AgroParisTech - UMR BioEMCo, France
[4]INRA, France

Soil provides human societies with food and other biomass production, environmental interactions, raw materials, physical support for human activities, cultural heritage. It also hosts more than 25% of the known biodiversity. Still, soil is currently threatened by numerous natural and human-induced degradation processes. In 2006, European Commission has adopted a Soil Thematic Strategy aimed at preserving the soil capacity to perform its functions, including a proposal for a Soil Framework Directive. Simultaneously, during the last decade, there was an increased concern with the integration of ecosystem services and with the assessment of their economic and/or social value in environmental policies. However, implementation of such policies faces a lack of knowledge: (i) on real causes upstream of soil functions degradation and (ii) on ways to valuate and manage soil services. Indeed, few research programs have focused on these questions. Anticipating these issues, the French Ministry for Ecology has been funding the applied research program GESSOL since 1998. It aims at providing scientific basis and appropriate tools to decision makers and environmental managers to improve the consideration of multi-functionality of soils and reduce risks of degradation. To date, the program has funded 46 projects. We will analyze how the program and the scopes of the funded projects have evolved since the first call for proposal and have responded to political and societal demands concerning soils and their environmental roles. For instance, GESSOL has switched from the funding of bio-technical projects characterizing soil degradation, to the funding of trans-disciplinary projects in order to point out socioeconomic causes and to provide a framework optimization of soil services. These latter projects bring together natural sciences, engineering sciences, social sciences and humanities. Thus, actions on soil and their acceptability are evaluated in terms of environmental, economical, legal and sociological terms.

APPRAISAL AND GOVERNANCE OF MULTIPLE-STRESSED SOIL SYSTEMS

POSTHUMA, LEO (LEO.POSTHUMA@RIVM.NL); LIJZEN, JOHANNES; MULDER, CHRISTIAN; OTTE, PIET; RUTGERS, MICHIEL; SWARTJES, FRANK; WINTERSEN, ARJEN; BREURE, TON

RIVM-Lab for Ecological Risk Assessment, The Netherlands

In a Nature Feature article, Rockström et al. (2009) discussed planetary boundaries, and considered complex (soil) contamination a relevant threat amongst eight other major ones, especially from the perspective of biodiversity. Ecosystem Services (UN Millennium Ecosystem Assessment 2005) might be threatened. Rockström et al. however considered complex (soil) contamination a problem, because of open issues on 'how to quantify' and 'how to assess planetary boundaries'. In a strategic research program, the Dutch National Institute for Public Health and the Environment has developed some fundamental methods that may be of use for these issues. Due to their role in current soil policies, various of these methods have been implemented and are considered useful. This presentation shows various of these methods: their scientific basics, their use, their validity, and their potential for further use, especially in the fields of soil policies, biodiversity and Ecosystem Services and threats. Attention focuses first on a method to quantify impacts of contaminant mixtures. This method is used in environmental appraisals, followed by risk reduction actions. Further focus will be on instrumentation for daily use – when soil remediation is considered due to high risks. In the Netherlands, the web-based Toolbox for Site-Specific Risk Assessment compacts the available knowledge for daily use. Detailed insights in the kinds and magnitudes of contamination effects can be obtained, addressing the missing link identified by Rockström et al.. When these methods are used on a (regional) landscape scale, diagnosis of multiple stressor impacts on soil and water systems is possible. Such eco-epidemiological analysis methodologies have been developed to signal where in a landscape, and to which extent, multiple stressors affect the quality of the environment. Enriched diagnostic methods address fundamental ecological issues, superimposed on the (bio)monitoring data used so far. Diagnosis of major stressors can then help to focus management attention on (cost)effective management solutions.

GRASSLAND RESTORATION: PROMOTING BIODIVERSITY AND ECOSYSTEM SERVICES

DE DEYN, GERLINDE B.[1,2] (GERLINDEDE@GMAIL.COM); SHIEL, ROBERT S.[3]; OSTLE, NICK J.[4]; MCNAMARA, NIALL P.[4]; OAKLEY, SIMON[4]; YOUNG, IAIN[5,6]; FREEMAN, CHRISTOPHER[7]; FENNER, NATHALIE[7]; QUIRK, HELEN[2]; BARDGETT, RICHARD D.[2]

[1]Wageningen University, The Netherlands
[2]Lancaster University, United Kingdom
[3]Newcastle University, United Kingdom
[4]CEH Lancaster, United Kingdom
[5]SYMBIOS Dundee, Australia
[6]University of New England, Australia
[7]University of Wales Bangor, United Kingdom

Grassland agriculture is an important form of land use in Europe. Grassland systems are important not only in terms of their productivity but also with respect to their diversity. This is reflected at the level of agri-environment policy in Europe which aims at grassland management that promotes botanical diversity, together with the delivery of ecosystem services such as storage of soil carbon (C). In this study we tested if management that enhances biodiversity restoration also promotes soil C and nitrogen (N) storage. To test this we used a long-term experiment in which fertiliser use and plant seeding were manipulated for 16 years and where Trifolium pratense densities were altered for the last 2 years in factorial combination with the long-term treatments. In this experiment we investigated the accumulation rates of C and N in soil and the C and N pools in vegetation. In addition we explored the effects of diversity restoration management on ecosystem respiration, soil enzyme activities and soil structure in order to unravel the mechanisms underlying changes in soil C and N accumulation rates. We found that the long-term biodiversity restoration practices of cessation of fertiliser use and sowing of species mixtures increased soil C and N accumulation, especially when these treatments were combined with the recent promotion of the legume Trifolium pratense. The increased accumulation rates of soil C and N were associated with increased soil organic matter content, reduced rates of ecosystem respiration, and enhanced soil structure. Cessation of mineral fertiliser use, however, reduced the pool of C and N stored in vegetation. These results show that long-term diversity restoration practices can yield significant benefits for soil C storage when they are combined with increased abundance of a key species. In addition we found that these diversity restoration management practices delivered additional ecosystem benefits such as soil N storage, increased organic matter content and improved soil structure.

SOIL ECOSYSTEM SERVICES, THEIR VALUE AND USE IN PROMOTING SUSTAINABLE FARMING

HEDLUND, KATARINA (KATARINA.HEDLUND@EKOL.LU.SE)

Lund university, Dept Biology, Sweden

The FP7 research project SOILSERVICE brings together natural scientists and economists in an transdisciplinary approach to understand how human-induced competition for land use influences soil biodiversity, sustainable provision of ecosystem goods (biofuel, food, nature) and ecosystem services (clean water, control of greenhouse gases and control of pests). The project aims at promoting strategies for achieving sustainable management of soil resources on a European scale and to mitigate degradation of agricultural soils that are under pressure from intensive land use, climate change and urbanisation. In SOILSERVICE we have identified economic production drivers that will change current and future use of soil-related ecosystem services in agriculture and is evaluating how they will affect the resilience and resistance of ecological-economic systems. Soil biodiversity and production of ecosystem services are studied at different intensities of agricultural land usage at regions in four European countries. These regions are used for valuing ecosystem services by extending an economic model of farmers' economy with generation of ecosystem services. This creates an ecological-economic valuation tool that can be used for evaluating agricultural and environmental. This presentation will describe how ecosystem services can be valued and how we can use its value to promote sustainable use of soils.

ABSOLUTE AND RELATIVE APPROACHES FOR INTEGRATING SOIL ECOSYSTEM SERVICES IN RURAL LAND USE PLANNING

VAN ORSHOVEN, JOS (JOS.VANORSHOVEN@SADL.KULEUVEN.BE); JACXSENS, PAUL; DE MEYER, ANNELIES

Catholic University of Leuven, Belgium

Land evaluation can be considered as the go-between between land resources survey and land use planning. In a first stage of a land evaluation project, georeferenced land resources data are interpreted in terms of land qualities, performance attributes or, for this study, ecosystem services related to the considered land utilisation types (LUT). In the more common absolute approach service levels are next confronted with predefined requirements to classify the land units as recommendable or not recommendable for a given LUT or to discriminate between LUTs which are recommendable or not recommendable for a given land unit. This confrontation between service levels and requirements is not applicable in a relative approach where the land units are rather ranked from best to worst without the setting of absolute threshold levels for their services. Classification and ranking are usually done based on the service levels under the actual or potential LUTs. By substituting these absolute values by change values (change in service levels after transition from initial LUT to target LUT), another element of relativity is brought in. In this study we compared four cases, presenting a gradient of increasing 'relativity', in order to illustrate, assess and discuss the pertinence of the absolute and relative approaches for integrating soil ecosystem services into rural land use planning, in line with the EU's water framework directive and soil thematic strategy. To this end we generated a specific spatial decision support system by integrating available data about six soil system services (biomass production potential, buffering capacity, soil organic carbon storage, resistance against soil compaction, water and wind erosion) for land units and major rural land use types in the region of Flanders in Belgium, in the OSMOSE data model and toolbox (De Meyer et al., 2011) . The paper will introduce the absolute and relative approaches for spatial decision support, will present and discuss the four cases and elaborate the scientific and policy relevant conclusions. We anticipate that the choice for one of the possible approaches will be conditioned by (i) the level of available prior knowledge of the decision makers and the desired outcome of the decision support process (ranking of alternatives, predefined number of hectares to be identified) and that the pertinence will be enhanced by making provision for integrating the effect of climate change on service levels and for dealing with off-site and off-time services.

THE VALUE OF SOIL ECOSYSTEM SERVICES FOR A NEW ZEALAND DAIRY FARM

DOMINATI, ESTELLE[1,2] (E.J.DOMINATI@MASSEY.AC.NZ); MACKAY, ALEC[1]; GREEN, STEVE[3]; PATTERSON, MURRAY[2]

[1]Agresearch, New Zealand
[2]Massey university, New Zealand
[3]Plant and Food Research, New Zealand

The full range of ecosystem services provided by soils is often not recognised and generally not well understood, nor is the link between soil natural capital and these services. Despite this lack of recognition, they are more important than ever if we are to meet the food and fibre demands of a growing global population. This paper addresses this issue by drawing on scientific understanding of pedogenesis, soil classification and functioning and on current thinking about ecosystem services to present how a new framework for classifying and quantifying soil natural capital and ecosystem services was implemented to model and value the ecosystem services provided by soils under a typical New Zealand dairy farm operation. The services quantified included the provision of food, including the supply of water, nutrients and physical support to plants, the provision of support for human infrastructures and animals, flood mitigation, the filtering of nutrients and contaminants, detoxification and the recycling of wastes, carbon storage and greenhouse gases regulation, and the regulation of pests and diseases populations. A process-based model was customised and used to explore the dynamics of soil properties and processes regulating each of the soil services provided every year by a volcanic soil, for 35 years using climate records, and to quantify each service, focusing at the farm scale. The model illustrates how contrasting natural capital, farming practises and soil management impact on the provision of soil services. The quantitative information on each service was valued using a range of neo-classical economic valuation techniques. The average value of the ecosystem services provided by a volcanic soil was NZD14,899/ha/yr. The framework provides for the first time economists and policy makers with an approach for quantifying and valuing the country's soil ecosystem services under a range of land uses and new tools to inform land valuation.

Theme 5
Climate Change

Keynote
Richard Bardgett

HARNESSING PLANT-SOIL INTERACTIONS FOR THE ENHANCEMENT OF CARBON SEQUESTRATION IN SOIL

BARDGETT, RICHARD D. (R.BARDGETT@LANCASTER.AC.UK)[1]; DE DEYN, GERLINDE[2]; ORWIN, KATE[1]; FORNARA, DARIO A.[3]; WARD, SUSAN[1]; DE VRIES, FRANCISKA T.[1]; TURNER, CATHERINE[1]; QUIRK, HELEN[1]; OAKLEY, SIMON[4];OSTLE, NICK[4]

[1]Soil and Ecosystem Ecology Laboratory, Lancaster Environment Centre, Lancaster University, United Kingdom

[2]Department of Soil Quality, Wageningen University and Research Centre, The Netherlands

[3]School of Environmental Sciences, University of Ulster, Northern Ireland

[4]Centre for Ecology and Hydrology, Lancaster Environment Centre, Lancaster University, United Kingdom

There has been an explosion of interest in the topic of soil carbon cycling in recent years. The source of this interest is the fact that soils absorb and release greenhouse gases, including carbon dioxide and methane, and act as a major global store of carbon. Indeed, the soil is the third largest global pool of carbon, after the oceanic and geological pools, and together with vegetation, it holds 2.7 times more carbon than the atmosphere. Despite the importance of soils for the carbon cycle, very little is known about the factors that regulate the fluxes of carbon to and from soil, or about the role that interactions between plants and soil microbes play in regulating soil carbon sequestration. In this talk, we will use examples from recent research done on British grasslands to illustrate some of the routes by which plants and their functional traits influence soil biological properties and carbon dynamics at different spatial and temporal scales. We will also show how this understanding might be harnessed to achieve the goal of enhancing soil carbon sequestration in farmed grassland systems. A particular focus will be the belowground transfer and sequestration of recent photosynthetic carbon through roots, which, as we will show, plays a major role in the carbon cycle. Finally, we will touch on how climate change might influence these plant-soil interactions and identify some challenges for the future.

Various land management practices have been proposed to increase carbon sequestration in agricultural soils. These include no-tillage agriculture, which reduces soil disturbance and decomposition of crop residues, the conversion of arable lands to perennial grassland, which leads to a build-up of organic matter at the soil surface, and the use of cover crops in crop rotations, especially legumes. Another route for soil carbon sequestration involves management of grasslands, which cover a huge area of the Earth's surface and represent a considerable, and often neglected, carbon store. In the United Kingdom alone, for example, grasslands cover 36% of the land surface and contain about 32% of our soil carbon store. Here, an area that has attracted attention is the potential for high-diversity grassland to build-up soil carbon while also reaping benefits for wildlife conservation and other ecosystem services, such as soil nitrogen retention. For example, recent work has shown that increasing grassland plant diversity can enhance the uptake of carbon dioxide by the plant community, and also the belowground allocation of this carbon to roots and mycorrhizal fungi, which is a key mechanism governing soil carbon sequestration. These effects, however, are mostly due to the presence of certain plants, especially legumes, in high diversity mixtures rather than the species richness per se. Consistent with this, our recent studies in the Yorkshire Dales, northern England have shown that the sowing of legumes into species-rich grassland can

enhance soil carbon and nitrogen sequestration, which we think is mostly down to an increased input of carbon and nitrogen to soil and the suppression of extracellular enzyme activities involved in organic matter breakdown. These findings, combined with those of studies done on grasslands in other parts of the world, point to the potential for using diverse grasslands to deliver a range of ecosystem services, including climate mitigation. More research is needed to exploit this approach, especially since restoration of high-diversity grassland on degraded and formerly arable land is a key policy objective for sustainable agriculture in many parts of the world.

The mechanisms involved in plant manipulation of soil carbon sequestration involve many different biotic interactions between plants, their symbionts, and decomposers whose activities determine decomposition of organic matter and carbon loss from soil. Recent studies, which we will touch on in this talk, suggest that plant functional traits, such as leaf-litter nitrogen content and relative growth rate, can act as major drivers of belowground nutrient and carbon cycling, and can favor particular groups of soil organisms that play key roles in these processes. For instance, recent studies done in grassland in southern Scotland show that root traits of grassland plants, such as their nitrogen content and root density, are correlated with soil properties, including the biomass and composition of the surrounding microbial community and some measures related to soil carbon cycling. Also, specific plant traits, such as differences in the quantity and chemical composition of root exudates, are likely to affect the mineralization of soil carbon by altering microbial activity. Moreover, such plant-microbe interactions might affect the incorporation of carbon into more recalcitrant soil organic fractions, thereby affecting their stability. These studies suggests that plant traits, and especially those of roots, represent tools for understanding the mechanisms behind plant-microbial-soil interactions and ecosystem functions. Moreover, given the importance of root traits for soil microbial processes related to carbon cycling, understanding of root interactions could offer potential for modification of plant communities and the root traits of crops for carbon sequestration.

A central message of this talk is that understanding soil carbon dynamics and its response to climate change requires consideration of linkages between plants, microbes, and soil processes. Of particular note here is the transfer of carbon to soil via plant roots and the resulting carbon cascades through the plant–microbial–soil system, which play a primary role in driving carbon-cycle feedbacks and in regulating ecosystem responses to climate change. A major challenge is to integrate such understanding into land management strategies in order to enhance soil carbon sequestration, which also yields benefits for soil fertility, food production and biodiversity conservation. A new age of research is needed to meet these challenges and to develop future land-management and climate change mitigation strategies.

Keynote
Wim van der Putten

CLIMATE CHANGE AND RANGE EXPANSION

VAN DER PUTTEN, WIM H. (W.VANDERPUTTEN@NIOO.KNAW.NL)

Netherlands Institute of Ecology, The Netherlands

A major challenge for ecology is to predict the possible consequences of climate change and, based on this, propose adaptation and mitigation measures in order to sustain natural and production systems. Thus far, effects of climate change on soil-vegetation systems have been predominantly studied by changing ambient conditions (mainly temperature, drought and CO_2) related to anticipated future climate conditions and determining the responses of the local soil organisms, plants and ecosystem processes. However, recent studies have shown that species may shift their ranges as a consequence of climate warming, so that the composition of local communities of plants and soil organisms will change as well. Ecosystems of the future will, therefore, not only experience different climate and environmental conditions, but they also will harbor other species assemblages. I will discuss work where we have considered that both the abiotic environmental conditions and the belowground and aboveground species assemblages will change and how this may influence community composition and species abundance as a consequences of climate warming.

One of the key factors that constrain the reliability of the predictions so far is that climate change may not only affect species performances, but also species interactions, which can result in non-linear and non-gradual changes in community composition and ecosystem processes. A main reason for this is that species interact within complex multi-level food webs, and that these different trophic levels do not necessarily react to climate change in a similar way. Especially range expansion can differ strongly between plants and soil organisms. These different responses make it difficult to predict how, for example, plant species that originate from lower latitudes may perform in their new high latitude range, which further complicates predictions on consequences for vegetation characteristics and ecosystem processes.

There are two major types of interactions between plants and soil biota. These are interactions between plant roots and the decomposer subsystem, and interactions between living plant roots, herbivores and pathogens, and symbiotic mutualists. The decomposer food web is the major energy channel in the soil subsystem and receives its resources from dead plant material (detritus). The majority of the interactions between plant roots and the decomposer organisms are indirect. The decomposer food web converts dead plant tissues into mineral nutrients and the nutrient availability determines the outcome of competition between and within plant species. Root herbivores and pathogens have direct effects on plant community composition through selective growth reduction or killing of specific plant species, and indirect effects by changing the outcome of interspecific plant competition. Symbiotic mutualists (mycorrhizal fungi, N_2 fixing microorganisms) influence the availability and uptake of resources and they also have the potential to change the outcome of interspecific plant competition, mostly in favour of their host.

The decomposer food web and the herbivores, pathogens and symbionts are not independent of each other. The effectiveness of symbioses depends on the nutrient availability in the soil and root herbivory has a stronger impact on plant competition when nutrients are limited. Many of the higher trophic level organisms in soil food webs are omnivorous and a number of the omnivores feed on microorganisms, small invertebrates, as well as plant roots. Plants, therefore, are exposed to a range of soil biota and the ecological consequences of these

interactions result into a net effect on plant community development, influence vegetation succession, diversity, and invasiveness of ecosystems by alien species. Plants also influence the composition of the soil community, and these reciprocal interactions are called 'plant-soil feedback'. Feedback effects can be negative, neutral or positive, but the recent examples in literature point at a predominance of negative effects indicating at a profound role of root herbivores and pathogens in structuring natural plant communities.

Plant exposure to aboveground-belowground biodiversity varies with latitude. The high insect diversity in Tropical and Mediterranean ecosystems probably has contributed to the selection of a high diversity and high levels of secondary plant compounds. Below ground, biodiversity probably peaks in temperate regions. However, the contribution of soil organisms to ecosystem processes, such as decomposition, may not necessarily depend on soil biodiversity alone. For example, decomposition strongly depends on plant traits, and the contribution of soil fauna to decomposition strongly depends on abiotic environmental conditions. High and low temperatures, as well as drought are the major limitations for soil mesofauna to contribute to decomposition of plant litter. Root herbivores and soil pathogens have been found to influence plant community dynamics in a wide range of ecosystems, ranging from arid savannas to tropical forests. It is not known whether levels of belowground herbivory and pathogenicity, or plant adaptations to these influences, varies along latitudinal gradients.

When low latitude plants expand their range towards former colder regions, this will go along with a number of changes. Successful range expanding plants may have less negative feedback interactions with the soil community from the new range than related species that are native in that range, which results in an enemy release effect. Whether this is due to reduced exposure to soil pathogens and root herbivores, or to enhanced effectiveness of symbionts, still needs to be tested. Interactions between range expanding plants and mycorrhizal fungi and other symbionts have not yet been tested, but given the reported specificity in host-symbiont interactions, some effects might be expected as well in plant-mutualism interactions. Also, the different traits of lower latitude plants could influence decomposition of the leaf material, thereby changing nutrient cycling-related processes. Plant-decomposer interactions may also be more specific than previously supposed, but also this issue has not yet been studied from an explicit range shift perspective.

In conclusion, climate warming-induced range expansion of plants can profoundly change plant-soil biota interactions and this can have substantial consequences for local biodiversity, ecosystem functioning and the delivery of ecosystem services. Current studies aiming at enhancing insight in these processes are in progress. These results will improve our predictions on consequences of climate change scenarios and this area is wide open for soil ecology with important possibilities for understanding the functional consequences of belowground-aboveground interactions.

Session 5.1
Carbon stocks and carbon sequestration

THE POTENTIAL OF AGROECOSYSTEMS TO MITIGATE GLOBAL WARMING UNDER ELEVATED CO2: A REVIEW

DIJKSTRA, FEIKE (FEIKE.DIJKSTRA@SYDNEY.EDU.AU)

The University of Sydney, Faculty of Agriculture, Food and Natural Resources, Australia

A rise in atmospheric CO2 concentration (eCO2) often results in increased plant and plant litter production that could potentially increase soil carbon storage. In recent reviews it was suggested that soil C storage under eCO2 can particularly increase in combination with the addition of N fertilizers. Thus, in many agroecosystems where N fertilizers are frequently applied, eCO2 appears to have considerable potential to mitigate global warming. However, to fully account for the eCO2 effect on global warming in agroecosystems, eCO2 effects on the exchange of the greenhouse gases N2O and CH4 also need to be assessed. Here I reviewed 32 field experiments conducted in agroecosystems where the effect of eCO2 on soil C sequestration, soil respiration, N2O emission, and/or CH4 exchange was examined. As found be others, soil C increased under eCO2, particularly in combination with N fertilization. However, on average, N2O emissions also increased under eCO2 with N fertilization, and expressed in CO2 equivalents, more than offset the gain in soil C. The effect of eCO2 on soil C and GHG exchange was highly variable among studies and I tested whether this variability among studies could be explained by site-specific soil (pH and clay content) and climate factors (mean annual temperature and mean annual precipitation). Of the four factors, clay content was the only factor that showed significant relationships with soil C and GHG exchange responses to eCO2, explaining 26 (soil C), 45 (soil respiration), 36 (N2O) and 73% (CH4) of the variability among studies. I conclude that 1) eCO2 often increases the net GHG balance in N fertilized agroecosystems thereby accelerating, not mitigating global warming, and 2) that soil C storage and GHG exchange in clayey soils is more sensitive to eCO2 than in sandy soils.

ORGANIC CARBON SEQUESTRATION PROCESSES DRIVEN BY AGRICULTURAL SOIL FOOD WEB

CAO, ZHIPING (ZHIPINGC@CAU.EDU.CN)

China Agricultural University, China

Soil is known to be the largest organic carbon reservoir in terrestrial biosphere, about two fold higher than the amount of carbon content in the vegetation or the atmosphere, playing a crucial role in the terrestrial carbon cycle. Agricultural soil compartment hold the potential for increase the carbon sequestration by available management options. Different farming practices resulted in various carbon sequestration rates, which were driven by soil food web. However, there is not adequate knowledge about the processes and the mechanisms, as result of scarce field observations based on long-term site experiments. In this study, a field site in the winter wheat - summer maize rotation agroecosystem had been selected in Northern China, the Great Northern China Plate, where fertilization experiment had been conducted for 9 and 11 years, respectively. Three fertilizer regimes were imposed in 1993 (experiment A) and 1995 (experiment B): organic fertilizer (OF) and chemical fertilizer (CF), and unfertilized (U) plots served as the control. The yields and organic carbon input were recorded annually, and the soil organic matter content were surveyed every two or three yields from 0-40cm soil depth. Abundance, diversity and community structure of soil biota, including soil microbes, protozoa, nematodes and mites under treatments were investigated monthly from 2004 to 2005, and 15 functional groups were found. In experiment A, the soil organic carbon sequestration rate in OF treatment reached top on 11th year as 14.67 Mgha-1yr-1, much higher than those in CF and U treatments, which were 6.07 Mgha-1yr-1 and 8.57 Mgha-1yr-1, respectively. Then it started to decline, and on 14th year, it decreased to be lower than in CF and U plots. In experiment B, similar phenomenon was observed. Meanwhile, the absolute biomass - volumes in treatments had been found to be significantly ($p<0.05$) different from the first to the 4th trophic level. At every trophic level, the average biomass in OF plots was obviously higher than in CF and U plots. For the trophic structure from bottom up starting with bacterial and fungal pathways, a significant variation was observed. In OF plots, the dominant fraction of biomass was from bacterial pathway, and in contrast, biomass of fungal pathway occupied the most fraction in U plots. While in CF plots, biomass in both bacterial and fungal pathways trended to a balance statues, waved nearly the ratio 1:1. Fertilizer application enhanced the biological carbon mineralization rate. On 9th year of experiment B, carbon mineralization rate of food web in OF treatment was 2.5 Mgha-1yr-1, which was 1.8 fold of that in CF treatment (1.4 Mgha-1yr-1), and 2.1 fold of that in U plots(1.2 Mgha-1yr-1). Higher carbon mineralization rate led to increased organic carbon loss in soil, which were 6.1 Mgha-1yr-1, 3.3 Mgha-1yr-1 and 1.6 Mgha-1yr-1 in OF, CF and U treatments, respectively. On 11th year of experiment A, the carbon mineralization rate in OF treatment kept stable and lightly increased in CF and U plots, while the organic carbon loss increased into 7.8 Mgha-1yr-1, 4.6 Mgha-1yr-1 and 2.7 Mgha-1yr-1 in OF, CF and U treatments, respectively. Soil carbon sequestration rate was strongly influenced by the carbon mineralization rate of soil food web. The long-term application of organic fertilizer in farmland, enhanced the bacterial mineralization route of food web, and increased the carbon loss. So in this area, the carbon sequestration rate of organic fertilization soil will decrease with application time. Our recommendation is to replace organic fertilizer with no tillage or return of crop residues after 5 to 10 years continuous application in north China, with the aim to increase the soil carbon sequestration efficacy in farmland.

GREENHOUSE GAS EMISSIONS AND YIELD-SCALED GLOBAL WARMING POTENTIAL OF MAJOR CEREAL CROPS

VAN KESSEL, CHRIS (CVANKESSEL@UCDAVIS.EDU)

University of California-Davis, The United States

With the projected increase in world population to reach 9 billion in 2050, there will be an increasing demand for cereals. World cereal production will need to increase at about 1.3% annually to 2025 in order to feed the population. Agriculture accounts for 10 to 12% of the total global anthropogenic emissions of greenhouse gases (GHG), which amounts to 58% of N2O and 47% of CH4, and the agricultural intensification has resulted in increased GHG emissions. To meet the growing demand for food requires sustainable intensification where high yields are achieved with reduced damage to the environment. Cereals (rice, wheat and maize) are also, directly or indirectly, the largest source of calories and energy for humans. Here we tested the hypothesis that if the Global Warming Potential based on non-CO2 gases (CH4&N2O) is expressed per ton of grain grown (yield scaled GWP), GWP values are similar for the main cereals with the lowest GWP values obtained at optimal yield conditions. A meta analysis using 60 study sites (328 observations) was carried out linking GWP with grain yield. The average GWP of rice systems was the highest (3757 kg CO2-eq ha-1 season-1) which was 5.7 times higher than wheat (662 kg CO2-eq ha-1 season-1) and 2.7 times higher than maize (1399 kg CO2-eq ha-1 season-1). Despite higher GWP emissions in maize, its yield-scaled GWP (185 kg CO2-eq Mg-1) was not significantly different from wheat (166 kg CO2-eq Mg-1), due to lower wheat yields. However, yield-scaled GWP was significantly higher for rice (657 kg CO2-eq Mg-1), being about four times more than wheat and maize. Large GWP was estimated for rice due to high CH4 emissions under flooded systems. An analysis of the lowest yield-scaled GWP showed that it remained highest for rice (279 kg CO2-eq Mg-1) but was roughly double that of wheat (102 kg CO2-eq Mg-1), and maize (140 kg CO2-eq Mg-1), suggesting greater opportunities to mitigate in rice systems. On average for the three cereals, the lowest yield-scaled GWP values were achieved at 92 % of maximal yield observed supporting the possibility of sustainable intensification. On average, 0.68%, 1.21% and 1.06% of N applied was emitted as N2O in rice, wheat and maize, respectively. Higher rates of fertilizer-N input led to disproportionally higher increases in yield-scaled GWP values for wheat and maize than increases in yield. In rice systems there was no direct correlation between CH4 emissions and N fertilizer input. Finally, GHG emissions are only one of the many factors that need to be considered when the role of the different cereals in feeding the world is evaluated. For example, much more rice is consumed directly by humans than either wheat or maize and therefore other GHG costs associated with processing or uses such as livestock feed do not play a large role for rice. Furthermore, other factors such as culture and other ecosystems services these crops provide need to be taken into consideration when mitigation strategies are developed.

MODELLING PAST AND FUTURE IMPACTS OF CHANGES IN CLIMATE, NITROGEN DEPOSITION, OZONE AND CO2 EXPOSURE ON CARBON SEQUESTRATION IN EUROPEAN FORESTS

DE VRIES, WIM[1] (WIM.DEVRIES@WUR.NL); POSCH, MAXIMILIAN[2]; SIMPSON, DAVID[3]; NYIRI, AGNES[4]; REINDS, GERT JAN[1]

[1]Wageningen University, The Netherlands
[2]RIVM-Lab for Ecological Risk Assessment, The Netherlands
[3]Chalmers University of Technology, Sweden
[4]The Norwegian Meteorological Institute, Norway

We modelled the combined effects of past and expected future changes in climate, nitrogen deposition, ozone and CO2 exposure on carbon sequestration in European forests and forest soils for the period 1900–2050. Forest inventory data around 1980 were used to assess reference forest growth rates, which were then modified for other years by factors accounting for deviations in climate and air quality compared to 1980. The impacts were evaluated using various assumptions with respect to interactions between drivers. Impacts of soil macro-nutrient availability (P, Ca, Mg, K) were also accounted for. Historical meteorological data were taken from a high resolution European data base that contains monthly values of temperature, precipitation and cloudiness for the years 1901–2000. Oxidised and reduced N deposition was calculated with the EMEP model. In addition, the phytotoxic ozone dose (POD) was calculated by the EMEP model, incorporating the DO3SE deposition module, which parameterises ozone uptake as functions of phenology, light, temperature, humidity, and soil moisture. Historic NOx, NH3 and VOC emissions were taken from available sources. For the future (2010-2050) we used two scenarios for deposition (current legislation and maximum technically feasible reductions) and two climate scenarios (no change and SRES A1 scenario). Results of the simulations will be presented during the conference.

KNOWLEDGE GAPS IN SOIL CARBON AND NITROGEN INTERACTIONS - FROM MOLECULAR TO GLOBAL SCALE

GÄRDENÄS, ANNEMIEKE I.[1] (ANNEMIEKE.GARDENAS@SLU.SE); ÅGREN, GÖRAN I.[1]; BIRD, JEFFREY A.[2]; CLARHOLM, MARIANNE[1]; HALLIN, SARA[1]; INESON, PHIL[3]; KÄTTERER, THOMAS[1]; KNICKER, HEIKE[4]; NILSSON, INGVAR[1]; NÄSHOLM, TORGNY[1]; OGLE, STEPHEN[5]; PAUSTIAN, KEITH[5]; PERSSON, TRYGGVE[2]; STENDAHL, JOHAN[1]

[1]Swedish University of Agricultural Sciences, Sweden
[2]School of Earth and Environmental Sciences, Queens College, CUNY, The United States
[3]Dept. of Biology, University of York, United Kingdom
[4]Institute for Natural Resources and Agrobiology, Spain
[5]Natural Resource Ecology Laboratory, Colorado State University, The United States

The objective of this review was to identify, address and rank knowledge gaps in our understanding of five major soil C and N interactions across a range of scales – from molecular to global. The studied five soil C and N interactions are: i) N controls on the soil emissions of greenhouse gases, ii) plant utilisation of organic N, iii) impact of rhizosphere priming on C and N cycling, iv) impact of black N on the stabilization of soil organic matter (SOM) and v) representation of fractions of SOM in simulation models. We ranked the identified knowledge gaps according to the importance we attached to them for functional descriptions of soil-climate interactions at the global scale, for instance in general circulation models (GCMs). We found that the level of understanding declined as the scale increased from molecular to global for four of the five topics. By contrast, the knowledge level for SOM simulation models appeared to be highest at the ecosystem scale. The largest discrepancy between knowledge level and importance was found at the global modelling scale. We concluded that a reliable quantification of greenhouse gas emissions at the ecosystem scale is of paramount importance for improving soil-climate representation in GCMs. Key questions in climate change research are to identify the role of different N species for temperature sensitivity of SOM decomposition. The importance of priming and plant uptake of various N species at the ecosystem scale, including how these processes are affected by climate change, land use, management and N deposition needs to be quantified. An ability to quantify these processes would enable selection of which soil N processes need to be included into GCMs. Multi-method approaches, such as the use of dual-isotopes are developing tools necessary to narrow the existing knowledge gaps in soil C and N interactions.

EVOLUTION OF SOIL ORGANIC CARBON CONTENT IN SWITZERLAND OVER THE LAST 25 YEARS, 1985-2009

MEULI, RETO GIULIO (RETO.MEULI@ART.ADMIN.CH); KELLER, ARMIN; SCHWAB, PETER

Swiss Soil Monitoring Network (NABO) Research Station Agroscope Reckenholz-Tänikon ART, Zurich, Switzerland

The potential of carbon sequestration in adaption strategies underpins the importance of establishing a reliable soil monitoring system. However, assessments of long-term trends in soil organic carbon (SOC) content based on repeated measurements over large areas are very few because most existing national monitoring systems have undertaken a single sampling only (Saby et al., 2008). Until today, often rates of changes are approximated via modeling with high uncertainties and consequently, direct measurements by repeated soil monitoring programs are needed to further constrain these estimates (Schulze et al., 2009) . Here we present the results of measured SOC data (0 – 20 cm) and soil carbon pools over 25 years from the Swiss Soil Monitoring Network (NABO) taken in 5 year sampling intervals between 1985 and 2009. In each sampling campaign four bulked soil samples, each consisting of 25 individual cores, were taken. The SOC (n=1645) was measured in one laboratory to avoid methodological errors. Bulk density and soil skeleton (> 2mm) are measured since 2003. Detailed studies at monitoring sites showed that short-term temporal variation of soil properties can result from different site conditions at the sampling date, e.g. regarding soil moisture, soil temperature and bulk density (Keller et al., 2006). For instance, at two forest sites 6 re-samplings within 3 years revealed short-term variation of the SOC content between ± 1.8 % and ± 0.6 % (absolute values). Therefore, the majority of the measured temporal variation for all forest sites is interpreted as natural variation (noise) and not as real SOC changes (signal). In addition, the variation of the soil bulk density is in the same order of magnitude as the measured changes in the SOC content and hence the results of the Swiss soil monitoring network strongly support the conclusion that within the NABO monitoring network neither the forest nor the cropland or grassland sites did act as a net carbon source over the last 25 years which in turn is not in line with results in other European countries (e.g. Bellamy et al., 2005; Goidts & van Wesemael, 2007).

References

- Bellamy, P.H et al. (2005). Carbon losses from all soils across England and Wales 1978-2003. Nature 437 (8), 245-248.
- Goitds, E. & B. van Wesemael (2007). Regional assessment of so8il organic carbon changes under agriculture in Southern Belgium (1955-2005). Geoderma 141, 341-354.
- Keller A., et al. (2006). Monitoring soil quality in the long term: examples from the Swiss Soil Monitoring Network. Mitteilungen der Österreichischen Bodenkundlichen Gesellschaft, Heft 73: 7-12.
- Saby P.A. et al. (2008). Will European soil-monitoring networks be able to detect changes in topsoil organic carbon content? Global Change Biology 14, 2432-2442.
- Schulze et al. 2009. Importance of methane and nitrous oxide for Europe's terrestrial greenhouse-gas balance. Nature Geoscience, 2: 842-850.

Session 5.2
Tropical peatlands, Andosols, and Biochar

SOIL CARBON STOCK AND THEIR CHANGES FOLLOWING FOREST DEGRADATION IN TROPICAL MONSOON FOREST IN SOUTHEAST ASIA

HIRAI, KEIZO[1] (HIRAI@FFPRI.AFFRC.GO.JP); TAKAHASHI, MASAMICHI[2]; LIMTONG, PITAYAKORN[3]; SUKUSAWANG, SONTAM[4]; TORIYAMA, JUMPEI[1]; KIYONO, YOSHIYUKI[1]; SATO, TAMOTSU[1]

Forestry and Forest Products Research Institute, Japan
Research Planning and Coordination Department, Forestry and Forest Products Research Institute, Japan
Land Development Department, Thailand
Department of National Parks, Wildlife and Plant Conservation, Thailand

To promote REDD+ activity in tropical countries, evaluation of the soil carbon stock (SCS) in each forest type and their changes following forest degradation were required. We investigated the SCS of mixed deciduous forest (MDF), dry dipterocarp forest (DDF), teak (Tectona grandis) plantation (TK) and, grassland (GL) in the tropical monsoon forest at Mae Klong Watershed Research Station (MWRS), western Thailand. MDF was dominant in this region. SCS in 0-30 cm depth following Tier 1 of IPCC-GPG and in 0-100 cm depth were estimated. Ratio of soil carbon stock in 0-30 cm to 0-100 cm was also calculated. SCS was highest in DEF and lowest in DDF. Amounts of SCS (kg C m-2) were 11.5 in DEF and 4.6 in DDF, those of MDF were 6.8 in the depth of 30cm, and were 20.5 in DEF, 7.1 in DDF, 13.4 in MDF in the depth of 100 cm. Ratio of SOC in 0-30 cm to 0-100 cm was 0.5-0.6 and not different among forest type. To discuss the effect of forest degradation, amounts of SOC in the depth of 30cm in primary forest (PF) and secondary forest (SF) were calculated for MDF. There were 7.3 in PF and 5.9 in SF. SCS was close in MDF but lower than Thai in DEF, in the Cambodian forest (Toriyama et al. 2007; 2010). It was considered that controlling factor for SCS was different between in the Thai and Cambodian forests. When amounts of clay contents were close, SCS was higher in the Thai than the Cambodian forest soils. These results shows that forest degradation introduce SCS and key factor for SCS conservation is to maintain the clay contest is of soils at the Thai and Cambodia in the tropical monsoon forest.

VEGETATION AND WARMING EFFECTS ON PEATLAND CARBON FLUXES

WARD, SUSAN[1] (S.E.WARD@LANCASTER.AC.UK); OSTLE, NICK[2]; OAKLEY, SIMON[2]; BARDGETT, RICHARD[1]

[1]Lancaster University, United Kingdom
[2]Centre for Ecology and Hydrology, United Kingdom

The vast stores of terrestrial carbon in northern hemisphere peatlands are at risk from global changes in climate and pressures from land use which threaten to alter the carbon sequestration ability of these ecosystems. Research into the drivers of peatland carbon cycling has largely concentrated on abiotic drivers of temperature and water table fluctuations, with less attention being given to biotic drivers such vegetation community composition. Changes in vegetation composition have the potential to affect ecosystem carbon cycling processes by altering the balance between carbon inputs and outputs through differences in functional traits of vegetation groups, with consequences for feedbacks to climate change through greenhouse gas emissions. The aim of our research was to test the relative importance of changes in vegetation composition and climate for peatland carbon fluxes, and how these two factors interact to influence carbon cycling processes. We present results from a unique peatland plant removal and warming experiment in northern England. This fully factorial field experiment has plots with all combinations of the three dominant plant functional groups (dwarf-shrubs, graminoids and bryophytes), plus open-topped passive warming chambers on half of the experimental plots to mimic global warming. Using a variety of sampling techniques, including trace gas fluxes, our results illustrate the importance of both vegetation composition and climate to peatland carbon cycling processes and greenhouse gas emissions. In particular we show that although warming consistently increases rates of respiration in all vegetation types, the effect of warming on CO2 uptake by photosynthesis and therefore net CO2 flux, depends on the identity of the plant functional group, with dwarf-shrubs showing greatest net CO2 sink strength. Our findings highlight the importance of considering interactions between climate and vegetation when predicting the effects of climate change on peatland carbon fluxes.

CARBON STABILIZATION MECHANISMS IN ECUADORIAN ANDOSOLS

JANSEN, BORIS[1] (B.JANSEN@UVA.NL); TONNEIJCK, FEMKE[2]; KALBITZ, KARSTEN[1]

[1]University of Amsterdam, Institute for Biodiversity and Ecosystem Dynamics (IBED), Earth Surface Sciences Research Group, The Netherlands
[2]IUCN National Committee of The Netherlands, The Netherlands

Whether soils become a net carbon source or sink upon climate and/or land-use change depends on the stability of SOM against decomposition, which is influenced by stabilisation mechanisms in the soil. Volcanic ash soils contain very large stocks of soil organic matter (SOM) per unit area. Consequently, they constitute important potential sources or sinks of the greenhouse gas CO2. To clarify the role of chemical and physical carbon stabilisation mechanisms in volcanic ash soils, we applied selective extraction techniques, performed X-ray diffraction analyses of the clay fraction and estimated pore size distributions at various depths in the top- and subsoil along an altitudinal transect in the Ecuadorian Andes. The transect encompassed a sequence of paleosols under natural upper montane forest as well as grassland (páramo). From several soils SOM was further characterized at a molecular level using GC/MS analyses of extractable lipids and Pyrolysis-GC/MS analyses of bulk organic matter. Our results show that organic carbon stocks under forest as well as páramo vegetation roughly doubled global averages for volcanic ash soils. The carbon stabilization mechanisms involved are: i) direct stabilization of SOM in organo-metallic (Al-OM) complexes; ii) indirect protection of SOM through low soil pH and toxic levels of Al; and iii) physical protection of SOM due to a very high microporosity. When examining the organic carbon at a molecular level, interestingly we found extensive degradation of lignin while extractable lipids were preferentially preserved, hinting at fungal degradation in the face of inhibited bacterial decomposition. Both vegetation types contributed to soil acidification, thus increasing SOM accumulation and inducing positive feedbacks. Our results stress the urgent need to protect the Tropical Andes 'hotspot' from destructive land-use change, not only for the sake of preserving its outstanding biodiversity but also for its function as a carbon sink.

BIOCHAR AMENDMENT TO IMPROVE SOIL PROPERTIES AND SEQUESTER CARBON

PEAKE, LEWIS (L.PEAKE@UEA.AC.UK)

University of East Anglia, United Kingdom

Current knowledge suggests that biochar can be applied to agricultural soils in order to boost crop yields and simultaneously sequester atmospheric carbon. Biochar could therefore have a role in ameliorating two of the major environmental problems facing humanity – climate change and food scarcity. Further benefits ascribed to biochar include reduced water demand (for irrigation), less downstream pollution and reduced emissions of greenhouse gases (eg NO2) from the soil. Evidence suggests that some of these effects are influenced by soil type. This ongoing PhD project is investigating the effect biochar has on a wide range of soil properties that influence productivity, in relation to soil type. Four distinct textural classes of soil widely found in eastern England (and surveyed in detail) are being compared, using four biochar treatment doses: 0, 0.1%, 0.5% and 2.5% w/w (equivalent to 0, 4, 20 and 100 t ha-1). Three types of experiment are being conducted: (1) Laboratory tests of soil hydrology, eg using Tempe cells; (2) Long-term outdoor pot trials with winter wheat; (3) Long-term farm field trials. Early results for pot trials to test available water capacity (AWC) show clear positive trends. It is expected that a great deal more data will have been obtained before presentation of the paper in September. The project will provide biochar data, which is lacking for this region, and extend our knowledge about the significance of soil type, which is also very scarce and fragmentary. By modelling and mapping the relative suitability of specific soils for amendment, according to various criteria, it is hoped that such information can pave the way for fine-tuning the strategic deployment of biochar. This methodology could be expanded and applied to other soils and other regions.

GREENHOUSE GAS EMISSIONS FROM BIOCHAR AMENDED LOAMY SOILS: A LAB CO2, CH4 AND N2O EMISSION EXPERIMENT

AMELOOT, NELE (N.AMELOOT@UGENT.BE); FUNKUIN, NKWAIN YVONNE; SLEUTEL, STEVEN; DE NEVE, STEFAAN

Research group of soil fertility, Department of Soil Management, Ghent University, Belgium

The search for solutions to mitigate climate change has lead to the development of new technologies, of which the pyrolysis of biomass residues seems to hold potential. During the pyrolysis process, biomass is heated in the absence of oxygen and yields bio-oil and syngas, which are used as renewable energy sources. While the charred by-product of this pyrolysis, biochar, was initially regarded as a residue which had to be minimized, several recent studies have demonstrated the potential of biochar addition to soils to improve chemical, physical and biological soil properties and consequently productivity. Carbon mineralization experiments have frequently been performed to assess the stability of biochars in soils, however the effect of biochar on the emission of other greenhouse gasses, such as nitrous oxide and methane is not well understood yet. Moreover, the influence of different pyrolysis conditions on biochar properties and reactions in soil is poorly documented. Here we measured the CO2, N2O and CH4 emissions from a nutrient rich loamy soil amended with 5 biochar types. Willow wood waste and digestate waste from a manure biogas installation (biogastec) was slowly pyrolysed at 350 °C and at 700 °C. Additionally, pine wood biochar from fast pyrolysis at 500°C, resulting in higher bio-oil yields than slow pyrolysis was used. We observed a biphasic biochar degradation pattern. In the first stage, labile compounds are mineralized rapidly, and thereafter mineralization rates drop dramatically. All biochar amended soils showed lower C mineralization rates than the control soil, suggesting the high C sequestration potential of biochar in soils. Woody feedstock and higher pyrolysis temperatures resulted in lower CO2 emission rates. N2O and CH4 emissions are being measured at this moment. A greenhouse gas emission balance will be calculated and will be reported during the congress and in the full paper.

PEATLAND RESTORATION IN INDONESIA TO MITIGATE CO2 EMISSIONS

WOSTEN, HENK[1] (HENK.WOSTEN@WUR.NL); BUDIMAN, ARIF[2]

[1]Wageningen University and Research Centre, Alterra, The Netherlands
[2]WWF Indonesia, Indonesia

Extensive degradation of Indonesian peatlands by deforestation, drainage and recurrent fires causes release of huge amounts of peat soil carbon to the atmosphere. Lowering groundwater levels, which naturally are close to the peat surface throughout the year, increases CO2 emissions by peat oxidation (decomposition). Moreover, once groundwater levels fall below a critical threshold of -40 cm, the dry peat surface becomes susceptible to fire. Complete rewetting by blocking drainage canals by dams to raise groundwater levels is the only way to prevent fires and peat oxidation. An efficient and cost-effective methodology was developed to plan hydrological restoration of disturbed tropical peatlands in the Sebangau catchment in Central Kalimantan under supervision of the World Wildlife Fund (WWF). Field inventory and remote sensing data are used to generate a detailed 3D model of the peat dome and a hydrological model predicts the rise in groundwater levels once dams have been constructed. Successful rewetting of a 590 km² large area of drained peat swamp forest could result in mitigated emissions of 1.4-1.6 Mt CO2 yearly. This equates to 6% of the CO2 emissions by civil aviation in the European Union in 2006, thus significant emissions reduction can be achieved. The Indonesian system of long-term ecosystem restoration concessions provides prospects for both private sector and local communities to engage in peatland restoration and may provide an attractive alternative to large scale unsustainable peatland developments.

Posters

Theme 1
Global Food Security

EFFECTS OF DIFFERENT N-FERTILIZERS ON NITROGEN MINERALIZATION AND MICROBIAL ACTIVITY IN COLLUVIAL AND UPPER SLOPE SOILS OF SOUTHERN ECUADOR

BAHR, ETIENNE (ETIENNE.BAHR@TU-DRESDEN.DE); HAMER, UTE; MAKESCHIN, FRANZ

TU Dresden, Germany

Nutrient balance analyses in an irrigated land use system with cash crops in Southern Ecuador revealed large fertilizer applications of up to 400 kg ha-1 a-1 for nitrogen which in the past was exclusively applied as Urea. Only recently, farmers started to use a combined fertilization by partially replacing Urea with guinea pig manure. Thus, the effects of Urea and guinea pig manure on nitrogen mineralization and microbial activity were investigated in the mineral soil (0-10 cm depth) of colluvial soils and upper slope eroded soils (n=5) in laboratory incubation experiment (28 days). Samples of the same plot were treated with equivalent N-amounts (200 kg ha-1) of Urea, guinea pig manure and a combination of both and compared to a control plot. To trace back the fate of KCl-extractable NH4-N and NO3-N, 15N-labelled Urea fertilizer was applied, moreover, microbial biomass with the chloroform fumigation extraction method and basal respiration as the amount of evolved CO2-C were determined in different time intervals (0, 7, 14, and 28 days). Eroded soils contained up to 30% more SOC and TN than colluvial soils whereas Cmic (g kg-1 SOC) and Nmic (g kg-1 TN) are in the same order of magnitude. However, all fertilizer variations revealed that microorganisms in colluvial soils mineralized 20 to 40% more of the initial SOC than in eroded soils. Urea-fertilized samples are characterized by high mineral nitrogen contents (230 mg kg-1 after 28 days) and a low microbial biomass whereas samples solely fertilized with guinea pig manure exhibited the contrary. Fertilization with 15N-marked Urea enhanced N-mineralization from soil derived mineral nitrogen (up to 220% in Urea and 140% in the combined fertilization after 28 days) and therefore showed a positive priming effect. A combined fertilization of Urea and guinea pig manure is preferred to solely applying Urea due to an increased activity of microorganisms and at the same time adequate mineral nitrogen availability for plant nutrition.

IMPROVED SPECTRAL ESTIMATION OF MULTIPLE SOIL PROPERTIES BY STRATIFICATION ON ANCILLARY AND SPECTRAL DATA

BARTHOLOMEUS, HARM (HARM.BARTHOLOMEUS@WUR.NL); SABAJO, CLIFTON; VAN GROENESTIJN, ANNEMARIE; KOOISTRA, LAMMERT

Wageningen University, The Netherlands

Reflectance spectroscopy, in combination with multivariate analysis methods has proven to be a powerful method for fast determination of multiple soil properties. Accuracies comparable to chemical soil analysis have been achieved for datasets with limited variation in soil type. However, these accuracies are only obtained for studies where local calibrations are made and where the soil property of interest is the main variable in the area. On the other side, large soil spectral databases are being constructed, to allow the investigation of global patterns in soil properties and stimulate the development of new algorithms that are more robust. We analyzed a dataset (N = 422) of the Netherlands with a large range of soil properties and originating from a variety of different landscapes and geomorphologic origin. Soil samples were chemically analyzed for e.g. K, Nt, Nts, Mg, SOM, P, pH and Cl and spectral measurements (from 350-2500 nm) were done with an ASD Fieldspec Pro FR. The conducted experiments show that stepwise multiple linear regression models, suffer from non-linear relations between soil properties and with measured reflectance. This problem can be overcome by sub-dividing the total dataset in subsets, where the assumption of linearity is valid. For this, we used several stratification methods, which yield better correlations per cluster and result in a strong improvement of the estimates of the soil properties for independent reference samples. With the development of global spectral datasets the need for models that can deal with the variation that exists within these datasets became clear. This research shows that proper stratification methods can improve the spectral estimation of soil properties in a highly variable dataset. With such methods, the full potential of large soil spectral databases can be used.

LESS ORGANIC MATTER INPUT REDUCES NITRATE LEACHING, CROP YIELD AND SOIL QUALITY ON A SANDY SOIL IN THE NETHERLANDS

DE HAAN, JANJO (JANJO.DEHAAN@WUR.NL); VAN GEEL, WILLEM

Wageningen University and Research Centre, Applied Plant Research, The Netherlands

Organic matter is applied to arable soils by crop residues and organic manure. Organic matter fulfills hereby vital functions for food production by e.g. improving soil structure and water holding capacity and the delivery of nutrients because of the gradually brake down. However there are negative aspects as well. On sandy soils in the South-East of the Netherlands, the most important negative aspect is the uncontrolled release of nitrogen from the organic matter in periods without crop uptake. This is one reason for high nitrogen leaching, higher than standards of the EU Nitrate directive, from arable fields to groundwater. When no organic matter is applied, less nitrogen is available for leaching to groundwater. However the question is if crop yields and soil quality remain stable without external organic matter input. This was tested on an experimental farm during four years in a full six-year intensive arable and vegetable rotation. A comparison was made between fields with regular organic matter input from crop residues, animal manure and compost (effective organic matter, EOM, input about 1600 kg/ha) and with fields with minimal organic matter input from crop residues only (EOM input about 900 kg/ha). The nitrate content in groundwater was on average 21 mg/l lower in the system with minimal organic matter input. Crop yields were equal in the first two years. In the last two years yields were on average 4% lower. The reason of lower yields is unclear. Nitrogen and Phosphorus uptake of the crops were equal in all years. It is concluded that no external organic matter input lowers nitrate leaching but in the medium term crop yields as well. This indicates a reduction in soil quality. Uncertain are effects in the long term on leaching, yield levels and soil quality. The research is continued in the next years.

PREDICTING GULLY INITIATION SUSCEPTIBILITY WITH COMMON SPATIAL DATA

DEWITTE, OLIVIER[1] (OLIVIER.DEWITTE@JRC.EC.EUROPA.EU); BOSCO, CLAUDIO[1]; VAN DEN EECKHAUT, MIET[1]; DAOUDI, MOHAMED[2]

[1]European Commission, Joint Research Centre, Institute for Environment and Sustainability, Land Management and Natural Hazards Unit
[2]King Abdulaziz University, Faculty of Arts and Humanities, Department of Geography, Saudi Arabia

Permanent gullies are common features in many Mediterranean and arid landscapes. The initiation and the development of a gully and gully systems are complex and somehow stochastic. From field evidences it is known that gully channel formation and upslope migration is usually very rapid just after the initiation of the gully. In order to prevent the undesired effects of gullies, there is thus a need to anticipate the places were new gullies might initiate. To model where gully erosion will occur by the extension of an existing gully or the formation of a new gully is difficult. It requires detailed field investigations and high resolution accurate DTMs, which is usually not easy to obtain. Several studies have demonstrated strong inverse relationships between contributing area and slope at channel heads over several catchments in different climatic and morphological environments. The knowledge of such area-slope thresholds (A-S) at gully heads allows prediction of the location of gully initiation. We propose an approach that combines the A-S thresholds with a logistic regression analysis (LR). The LR is low data demanding and requires predictor variables that can be extracted from common spatial data (topographic and lithologic maps, aerial photographs). The model is calibrated on a 51 km² sub-basin of the Isser River watershed (N Algeria), where gully erosion affects most slopes. The gullies extend up to several kilometres in length and up to 10 meters in depth. They cover 16% of the study area. First we locate the initiation areas of the existing gullies by applying A-S thresholds found in literature for Mediterranean areas. Then, using the initiation area map as the dependent variable with combinations of predictor variables we produce several LR models. It provides relevant results in terms of statistical reliability, prediction performance (areas under the ROC curve = 0.85) and geomorphology. This approach combining A-S thresholds with multivariate statistical models like LR proves to be efficient when applied to common spatial data and establishes a methodology that will allow similar studies to be undertaken elsewhere.

MODELING POTENTUAL LONG-TERM ACCUMULATION OF RADIONUCLIDES IN THE SOIL-PLANT-SYSTEM ORIGINATING FROM AN EVENTUAL GROUNDWATER CONTAMINATION

GÄRDENÄS, ANNEMIEKE I.[1] (ANNEMIEKE.GARDENAS@SLU.SE); ECKERSTEN, HENRIK[1]; REINLERT, ANDRÉ[2]; GUSTAFSSON, DAVID[3]; JANSSON, PER-ERIK[3]; EKSTRÖM, PER-ANDERS[4]; GREGER, MARIA[5]

[1] Swedish University of Agricultural Sciences, Sweden
[2]Lund University, Sweden
[3]the Royal Institute of Technology, Sweden
[4]Facilia Co., Sweden
[5]Stockholm University, Sweden

This study was conducted as part of the risk assessment of Swedish final deposits of nuclear fuel waste. The overall objective was to assess the possible long-term (i.e. 10.000 years) accumulation of radionuclides after an eventual continuous groundwater contamination. The specific objectives were to assess: i) What proportion of the contamination will accumulate in the soil-plant-system? ii) Where in the soil-plant-system will the radionuclides accumulate? and iii) Which ecosystem characteristics and radionuclides properties are important for the accumulation? We developed the trace element model Tracey for this study. Tracey includes two plant uptake approaches of radionuclides; (i) passive uptake driven by water uptake and (ii) active uptake driven by growth. Tracey was applied on two forest fecosystems; a mixed Pinus-Picea and an Alnus Glutinosa. The Pinus-Picea and the Alnus Glutinosa represented respectively re- and dis-charges areas of Forsmark at the east coast in central Sweden, where the climate is cold-temperate. Twenty-four different variations of each ecosystem were created by varying the root depth, radiation use efficiency and plant uptake approach of radionuclides. The contamination corresponded to 1 Bq per m2 yr-1 and lasted during the whole simulation period of 10.000 years. The sensitivity of the radionuclide accumulation to various radionuclide properties and ecosystem characteristics (e.g. allocation pattern for the radionuclide and adsorption coefficient) was assessed by Monte-Carlo simulations. We found that the Alnus forest type accumulated 20-90 % and the Pinus-Picea forest type 20-25 % of the contamination. Accumulation was highest in the Alnus ecosystems with deep roots and active uptake. In those ecosystems, radionuclides were predominately stored in soil organic matter in the upper soil layers, while they were adsorbed to mineral particles below the mean groundwater table in low-accumulating ecosystems. The most important ecosystem characteristics were adsorption coefficient, soil bulk density and the efficiency degree of convective transport.

USE OF CORINE LAND COVER DATA FOR THE EVALUATION OF LAND TAKE IMPACT ON SOIL RESOURCES AT EUROPEAN SCALE

GARDI, CIRO (CIRO.GARDI@JRC.EC.EUROPA.EU); YIGINI, YUSUF; MONTANARELLA, LUCA

Joint Research Centre, European Commission

European Union has one of the highest population densities in the world, and a very dynamic and diverse economy. Approximately 75 % of the European population live in urban areas, with more than a quarter of the European Union's territory been directly affected by urban land use and by 2020 this percentage will reach 80 % . In this context it is clear that the competition for the use of land, among different economic sectors, is extremely high. In this competition the agricultural sectors is often the looser: according to Corine Land Cover data, in 10 years (1990 – 2000), Germany, Spain and France lost between 200,000 and 150,000 ha each, while in relative terms, the Netherlands are most affected as they lost 2.5 % of their agricultural land resources. Apparently land take has continued at the same intensity also in the following years: between 2000 and 2006 more than 470,000 ha of agricultural land have been transformed in urban land uses. In many cases the land taken is characterized by the most fertile and valuable soils for agricultural production. This process, generally known as "land take", can have a strong influence on food security at European level. The objective of this research is to determine which type of soil, in the different member states, have been taken by the processes mentioned above, and analyse what is the influence on the agricultural production.

THE DESIRE PROJECT: DESERTIFICATION MITIGATION AND REMEDIATION OF LAND - A GLOBAL APPROACH FOR LOCAL SOLUTIONS

HESSEL, RUDI; VERZANDVOORT, SIMONE (SIMONE.VERZANDVOORT@WUR.NL); RITSEMA, COEN; VAN DEN ELSEN, ERIK (ERIK.VANDENELSEN@WUR.NL)

Wageningen University and Research Centre, Alterra, The Netherlands

Fragile arid and semi-arid ecosystems are in urgent need of conservation approaches that can prevent and reduce the widespread on-going land degradation and desertification processes, such as erosion, flooding, overgrazing, drought, and salinization. The DESIRE project identifies promising alternative land use and management conservation strategies based on a close collaboration of scientists with stakeholder groups in desertified areas around the world. This integrative participatory approach ensures both the acceptability and feasibility of conservation techniques, and a sound scientific basis for the effectiveness at various scales. DESIRE employs a bottom up approach such as is favoured by the UNCCD: i) degradation and desertification hotspots and stakeholder groups have been identified in countries surrounding the Mediterranean, and in 6 external nations facing similar environmental problems, ii) A desertification indicator system has been developed, used and results were analysed; iii) Conservation strategies have been defined with the stakeholder communities; iv) These strategies have been implemented in the field, and are being monitored and modeled to quantify their effectiveness at various scales; v) The results will be extrapolated using indicator sets, geoinformation data, and integrated modeling systems combining socio-economic and environmental aspects; vi) Finally the results will be translated to a series of practical guidelines for good agricultural practices and environmental management, which will be disseminated to all stakeholders in appropriate ways. The DESIRE project started in February 2007, has 26 project partners and will last 5 years. The results to date will be presented.

LAND /SOIL EROSION AND MEASURE PLANNING CONTROL IN ALBANIA

LUSHAJ, SHERIF (SHLUSHAJ@TRING.AL)

Director of Center of study Use and management of Natural Resources, Professor in University (part time) and President of Albanian Soil Science Society

Introduction

The overall countries territory of Albania, 2874800 ha, include 699500 ha agricultural land (24%), 1062770 ha forests (36.9 %), 414517 ha pastures and meadows (14.4 %), other land uses 699.013 ha (24.3 %). Albania is a mountainous country, and only 16 % of its territory is located at evaluations of less than 100 m above sea level. Consequently slope is determining factor for land agriculture erosion, because is distributed as fellows: 43.3 % located in the western plains or internal flat areas, 56.7% % in the hilly and mountain region. Land erosion in Albania is the most serious environmental problem that contributes to loss or decrease of soil fertility, limitations in normal soil functions. It is estimated that, about 85 percent of the country's territory is under natural and human –included degradation stresses. The productive capacity of agriculture Land used 60-65 %.The rate of export and import of agricultural and food products on the last ten years are average 1:10.

Materials and Methods

The assessment of Land/Soil Erosion in Albania is realized by National monitoring Program in the all country, during 9 years, established more experimental spots throughout Albania, on direct field surveys and Used Universal Soil Loss Equation. Also collection the data for Soil, slope, geologically formation, climate condition, land cover act. Monitoring of Soil fertility for land agriculture, every 4-5 year.

Results and Discussion

The studies show that erosion is present in the all of its forms (water erosion, coastal erosion, gully, bank erosion, massive Landslide, the deposition of solid materials act). About of 24 % of the all territory of the country are prone to soil erosion and around 60 % almost ready. Consequence of erosion: decrease of soil productivity, reduction of organic matter and nutrients in soil, water, pollution, landscape evolution, 15-20 % of land agriculture not cultivated, actually about 25% of agricultural land (>150000 ha), are under nutrient mining condition, reduction of soil fertility and potential production (Map erosion of Albania, 2010). The Majority factors of Soil/Land erosion in the country are: (I) rainfall intensity: Total rainfall, varies between 900 and 2200 mm/year. And about 80 % of them, take place during the period from November till April. (II) Reduction of Land cover, average altitude and rivers network, lack investments for land protection. (III) Hydrographic network of Albania is very intensive. Soil loss studies, using watershed sediment assessment methods indicate, that the rivers network transports in a year approximately more than 60 million tons of fine and coarse sediment, 1.2 million tons of organic materials; 170 thousand tons of salts. (IV) High slope. More than half of territory has slopes 25 % and grater areas (V) Average altitude of the country is 708 m. (VI) Illegal economic activity: Deforestation about 300000ha forest (illegal cutting) for commercial purposes and overgrazing, has further aggravated the situation, increased in 15-20 % soil Loss. In this area the level of erosion and Landslide is very high. Based on the use of USLE, monitoring system and GIS application, is verified that in the all country, average soil loss rate is 32 Ton/ha/year or totally about 91 million ton/year. In the place, when the slope increases to over 25 % and without Land Cover, value of soil loss is

verified till180 ton/ha/year (Map erosion of Albania). In the several experimental sites, throughout Albania for monitoring and used the USLE, according to included the data: the rainfall index "R", Soil "K "factors, type of soil, Land Cover "C", slope "S", management factor "P", studies have shown that the values of the soil erosion, for three zones are: -In the zone A, is included almost all the territory of Albania and mainly of the coastal area, central area and in some part and eastern area, where quantity of soil loss from erosion result=57.2 Ton/ha/year - In the zone B, is included the south-eastern part of Albania, where quantity of soil loss from erosion result=18, 8 Ton/ha/year - In the zone C, are included the North and the southern part of Albania, where quantity of soil loss from erosion result=36.9 Ton/ha/year (Map erosion of Albania, 2010). Soil/Land erosion is a continuous threat to Albania's land resources and should be considered as a priority action for the Government. The conservation practices should be focused on: controlling soil/Land erosion and implementation of strategy National and local action program for land protection from erosion, to integrate Legislation of natural resources conservation and management .Capacity building, scientific research issues should also focus on environmental aspects and Land protection.

HYDROPHILIC AND HYDROPHOBIC COMPONENTS OF SOIL HUMIC SUBSTANCES: DISTRIBUTION, STABILITY AND FUNCTION

MILANOVSKIY, E. YU[1] (MILANOVSKIY@GMAIL.COM), SHEIN, E.V.[1], KOGUT, B.M.[2]

[1]Moscow State University, Soil Science Faculty, Russia
[2] V.V. Dokuchaev Soil Science Institute, Russia

Our work represents generalization of the results of experimental researches and following from them general regularities of formation, differentiations on a soil structure and roles of humification products of organic material as the system of natural hydrophobic-hydrophilic compounds during soil formation.

The new approach to humic substances (HS) as a system of hydrophobic-hydrophilic compounds explains a number of controversial problems in soil science and chemistry of soil organic matter and allows to reveal the mechanisms and the reasons of the genetic diversity of soil humus substances and their role in soil formation processes at a qualitatively new level as well as to determine the strategy of future researches.

Hydrophobic-hydrophilic properties of humification products cause spatial differentiation of HS components in soils, which reflects causal relationship between the nature of organic matter intake, the type of a water mode and, as a consequence, the trend of modern metamorphism of soil mineral mass. The mechanism providing differentiation of hydrophobic-hydrophilic HS components in soils consists in carrying out of hydrophilic HS with a moisture current from the humification products in situ and accumulation of hydrophobic HS in the place of their formation.

The spatial differentiation of humus substance components in the aggregate consists in the localization of hydrophilic humification products with allochthonous genesis on the surface of mineral particles, and hydrophobic humus substances with autochthonous genesis - in structure of organic particles stochastically distributed in the pore space of the aggregate. The structurally functional organization of components of humus substances in the aggregate provides the formation of hydrophobic properties of the surface of the pore space of the aggregate. The total effect of intra-aggregate hydrophobic zones consists in the counteraction to fast water inflow in the aggregate and the rise of disjoining pressure. Under the deficiency of fresh organic substance the mineralization of humus substances located on the surface of mineral particles takes place, their hydrophilic surface opens up, the efficiency of hydrophobic interactions inside the aggregate drops and the latter is being dispersed by water.

This study was supported by the Russian Foundation for Basic Research, project Nos. 10-04-00993, 11-04-01241 and 11-04-00284

THE USE OF REMOTE SENSING FOR SOIL MAPPING AT REGIONAL SCALE

MULDER, V.L. (TITIA.MULDER@WUR.NL)

Wageningen University, Laboratory of Geo-Information Science and Remote Sensing, The Netherlands

The Group on Earth Observations - GEO plans a Global Earth Observing System and, within this framework, the e-SOTER project is the European contribution to a Global Soil Observing System. e-SOTER will deliver a web-based regional pilot platform with data, methodologies, and applications, using remote sensing to validate, augment and extend existing data. This work presents a methodological framework for the integrated use of remote sensing and spatial prediction methods to achieve complete area coverage of soil properties on a regional scale. Remote sensing provides data supporting; the segmentation of the landscape into soil-landscape units; the prediction of soil properties by means of physically-based and empirical methods and the spatial interpolation of sparsely sampled soil property data as primary or secondary data source. Hence, especially in development countries information about solids is sparse while at the same time resources for data acquisition are limited. Therefore, we propose a sparse purposive sampling approach which utilizes remote sensing data to sample the spatial variability in soil properties on a regional scale. With use of Latin Hypercube Sampling the thematic variability is sampled while ASTER image data provides the necessary spatial correlation needed for model-based soil mapping. With use of the field measurements as primary data source and satellite data as secondary data sources, a soil property map can be developed at regional scale. From this work it can be concluded that the use of satellite data as a measure of spatial and spectral variability for soil property mapping on a regional scale constitutes a useful addition to digital soil mapping techniques.

COPPER LEVELS AND DISTRIBUTION IN SOILS OF ACTIVE AND ABANDONED VINEYARDS AT THE VRŠAC SITE IN SERBIA

NINKOV, JORDANA[1] (JORDANA.NINKOV@IFVCNS.NS.AC.RS); MILIĆ, STANKO[1]; SEKULIĆ, PETAR[1]; VASIN, JOVICA[1]; ZEREMSKI-ŠKORIĆ, TIJANA[1]; ŠEREMEŠIĆ, SRĐAN[2]; MAKSIMOVIĆ, LIVIJA[1]

[1]Institute of Field and Vegetable Crops, Serbia
[2]Faculty of Agriculture, University of Novi Sad, Serbia

The study analyzed the copper content of vineyard soils as affected by the long-time use of copper-based fungicides. A vineyard located in the area of the town of Vršac, Serbia (45°06'N, 21°19'E) on a skeletal soil with an acid reaction was analyzed. A comparison was made between the soils of active and abandoned vineyards (21 and 4 plots, respectively). Soil samples were taken from three depths: 0-15, 15-30, and 30-60 cm. The pseudototal (CuT, aqua regia) and available (CuEDTA, 0,05 mol/L EDTA) copper contents were determined. Sequential extraction of copper according to Teisseire was performed on a selection of the soil samples. The CuT content at 0-15 cm depth ranged from 53.8 to 164.6 mg/kg in the active vineyards and from 27.6 to 105.2 mg/kg in the abandoned ones. The background concentration of the element was 27.6 mg/kg. Each of the studied plots in both the active and abandoned vineyards had at least one soil layer with the critical concentration of copper (>60 mg/kg). An analysis of the CuT and CuEDTA concentrations and the CuEDTA/T ratio has confirmed that soil copper content has been decreasing at the site over time. When it comes to the relative contribution of individual copper fractions, the relative proportion of the residual fraction in the soil of abandoned vineyards has been decreasing as a result of the increase in the proportion of the fraction bound to organic matter. In the active vineyards, the level of CuT and CuEDTA was the same in the first soil layer (0-15 cm) as in the second je (15-30 cm), but deeper down the profile a sharp drop was recorded. In the abandoned vineyards, the levels of the two copper fractions increased from the first layer to the second. Such distribution is probably a result of copper having started to be redistributed from the surface soil layer down to the deeper ones, but it may also be due to vegetation cover. A check of the background Cu levels has shown that the distribution of CuT and CuEDTA is completely uniform throughout the soil profile. Data from some of the plots analyzed indicate that the process of erosion is under way at the site. The soil on lower-lying terrain has been found to be more exposed to copper pollution than the soil of higher terrain. Since copper at the studied site is very persistent and accumulates in a short period of time, focus should be placed on the preventive measure of reducing the use of copper-based fungicides to an optimum level.

EFFECTS OF CONSERVATION AGRICULTURE ON CROP YIELDS, SOIL AGGREGATION, AND C & N DYNAMICS IN A SOYBEAN-MAIZE ROTATION IN WESTERN KENYA

PAUL, B.K.[1] (BIRTHE.PAUL@WUR.NL); AYUKE, F.; GASSNER, A.; HOOGMOED, M.; HURISSO, T.T.; LELEI, D.; NDABAMENYE, T.; SIX, J.; VANLAUWE, B.; PULLEMAN, M.M.

[1]Wageningen University, The Netherlands

Agriculture in Sub-Saharan Africa (SSA) is faced with the urgent challenge to increase productivity while conserving natural resources. Yet, spurring soil degradation is one of the main reasons for stagnating crop yields. Conservation agriculture (CA) is promoted for its potential contribution to, amongst other benefits, stabilized yields, soil conservation and C sequestration. CA has three fundamental principles: 1) Minimum tillage, 2) soil cover, 3) crop rotation or association. Despite of the considerable interest in CA, rigorous quantification of the effects of CA principles in SSA is still rare.

Here, we determined the effect of tillage and residue management on crop yields, aggregate stability and associated C & N dynamics in a long-term trial in sub-humid Western Kenya. Bimodal rainfall (1800 mm $year^{-1}$) allows for two crops per year, where maize (*Zea mays* L., long rains) was grown in rotation with soybean (*Glycine max* L., short rains). Treatments included a factorial combination of conventional tillage (+T) and minimum tillage (-T), and residue retention (+R; 2 t ha^{-1} maize stover) and residue removal (-R). Soil samples were taken at two soil depths (0-15 cm and 15-30 cm) from year 3 to 6 after trial establishment (in 2003.) All data were analyzed using GenStat 13.2 Mixed Model Repeated Measurements.

Maize and soybean grain yields were significantly affected by tillage (P=0.007, P=0.008). Whereas crop yields under CA (-T+R) and conventional tillage (+T+R, +T-R) ranged between 4.1-4.4 t ha^{-1} for maize and 1.0-1.1 t ha^{-1} for soybean, -T-R led to reduced grain production (3.6 t ha^{-1} maize, 0.7 t ha^{-1} soybean). Tillage strongly decreased aggregate mean weight diameter at 0-15 cm (P<0.001) and 15-30 cm (P=0.004) soil depth. At 0-15 cm, residue retention significantly increased total C (P=0.016) and N (P=0.037), with highest values under full CA. At 15-30 cm, both tillage and residue significantly increased total C (P=0.001 and P=0.005) and N (0.002 and 0.005).

In conclusion, CA principles can improve upper soil quality. Tillage was beneficial for aggregate stability, whereas residue retention improved C&N content. However, this trend could be reversed at deeper soil layers, where tillage increased C&N through residue incorporation. With respect to crop productivity, partial CA (no-tillage without residue retention) appeared as worst option.

NUTRIENT USE AND DYNAMICS IN CONSERVATION AGRICULTURE INCLUDING LEGUMES IN THE MIDWEST OF THE MALAGASY HIGHLANDS

RANDRIAMANANTSOA, LALAJAONA[1]; ZEMEK, OLIVER[2]; ALBRECHT, ALAIN[1,3]; BÜNEMANN, ELSE[2]; DOUZET, JEAN MARIE[4,5]; JANSA, JAN[2]; OBERSON, ASTRID[2]; RABEHARISOA, LILIA[1]; RAKOTOARISOA, JACQUELINE[5,6]; RAKOTONDRAVELO, JEAN CHRYSOSTÔME[7]; RAMIANDRISOA, RINDRA SUZETTE[1,5]; SCOPEL, ERIC[4,5]; FROSSARD, EMMANUEL[2]
(EMMANUEL.FROSSARD@IPW.AGRL.ETHZ.CH)

[1]Laboratoire des Radioisotopes, France
[2]Group of Plant Nutrition, Switzerland
[3]IRD, France
[4]CIRAD, France / Madagascar
[5]SCRiD, France / Madagascar
[6]FOFIFA, Madagascar
[7]ESSA, Madagascar

Soil degradation in tropical agrosystems results in increased food insecurity and environmental degradation. Conservation agriculture has been proposed to improve production in the tropics. This approach combines direct-seeding, permanent mulch cover and a diverse crop rotation. The ETH Zurich, and the Radioisotopes Laboratory and the International Research Unit on Sustainable Farming and Rice Cropping Systems in Antananarivo started in 2010 in the Midwest of Madagascar a project to understand how conservation agriculture would affect the fluxes and dynamics of nitrogen (N) and phosphorus (P) in the presence of legumes, and to identify with farmers strategies that will allow them to sustainably use these resources. The project is organized in 4 work packages (WP1-4). In WP1, we conduct a survey to evaluate how farmers manage plant residues, manure and mineral fertilizers and if relevant, how and why they implement conservation agriculture. We will also in this WP1 assess crop performances and nutrient budgets in farmers' fields under conservation and conventional agricultures. In WP2, we study the effect of soil preparation (direct sowing/plough) and Stylosanthes guianensis (stylo) residues management (removal/mulch) on upland rice yields, root growth, and N and P dynamics in a field experiment. In this experiment, we will measure N2 fixation by stylo and N use by rice from different sources (manure, stylo, fertilizer, soil). In WP3, we will study the effect of legume residue and manure application on the dynamics of microbial and organic P in soils and on plant P uptake. In WP4, we will evaluate the relevance of our results beyond the reference areas studied in WP1. This will be done through an undergraduate students' work in the Midwest and by workshops with stakeholders in the Midwest and in two other ecological zones of Madagascar. The first results of the project will be presented at the conference.

SOIL PRODUCTIVITY LOSSES DUE TO COMPACTION IN ESTONIA

REINTAM, ENDLA[1] (ENDLA.REINTAM@EMU.EE); KÖSTER, TIINA[2]; KREBSTEIN, KADRI[1]; SANCHEZ DE CIMA, DIEGO[1]; KUHT, JAAN[1]; SUUSTER, ELSA[1]; SELGE, ARE[1]; ASTOVER, ALAR[1]

[1]Estonian University of Life Sciences, Estonia
[2]Agricultural Research Centre, Estonia

It have been reported the yield losses of cereal crops from 5% due to one pass of machinery up to 90% due to several passes on field edges. Although grassland species are more resistance to soil compaction, the yield losses occur also there due to repeated overriding. In conventional agriculture the whole field is passed usually more than once and field edges even 8 to 10 times. However, the losses of plant biomass may not be remarkable high, but soil compaction affects also the quality of the production. The field experiments with cereals and grassland species at different compaction and fertilization levels were conducted on sandy loam Stagnic Luvisol at Estonian University of Life Sciences in Tartu in time period 2001–2010. Soil physical and chemical properties, such bulk density, porosity, penetration resistance, water content and permeability, pH, available P, K, Ca, Mg, total N and organic C content were measured. From plant analyses the plant shoots and roots biomass, yield and their nutrient content was measured. From cultural plants the spring barley (Hordeum vulgare L.), spring wheat (Triticum aestivum L.), red clover (Trifolium pratense L.), lucerne (Medicago sativa L.) and rye-grass (Lolium perenne L.) were under investigation. The results revealed the reduction of grassland and cereal plants productivity due to heavy compaction (6 times tyre by tyre) with 4.84 ton tractor. Moderate compaction (3 times) in some years increased and some years decreased the plants productivity compared to un-compacted treatment, but had no effect on grassland species in most years. However, even the compaction did not affect the biomass of the plants; it decreased the nutrient content of shoots and grains. Mainly the losses of plant productivity were connected with lower soil aeration in wet years and higher penetration resistance and amount of plant unavailable water in dry years.

DO SOIL AMENDMENTS APPLIED FOR THE SUPPRESSION OF PLANT PATHOGENS INFLUENCE DISSOLVED ORGANIC CARBON POOLS?

STRAATHOF, A.L.[1] (ANGELA.STRAATHOF@WUR.NL); VAN AGTMAAL, M.[2]; COMANS, R.N.J.[1,3]; DE BOER, W.[2]; TERMORSHUIZEN, A.J.[4]; HOFFLAND, E.[1]

[1]Wageningen University, Department of Soil Quality, The Netherlands
[2]Department of Microbial Ecology, Netherlands Institute of Ecology, The Netherlands
[3]Energy Research Centre of the Netherlands, The Netherlands
[4]BLGG AgroXpertus, The Netherlands

Crop destruction due to soil-borne plant pathogenic outbreaks results in considerable financial losses annually. Recent research has indicated that organic amendments play a dynamic role in the general disease suppression of soil-borne plant pathogens in agricultural soils. Ongoing experiments in Dutch soils are testing the efficacy of various organic matter sources and application rates on disease suppression in various crop rotations. The addition of organic matter to the soil surface may alter the quality and quantity of substrate available to fuel microbial processes. A large and metabolically active soil microbial community may contribute to the suppression of plant pathogens via resource competition and the production of suppressive volatiles. We hypothesized that plant pathogen dynamics are regulated by the availability of substrate for the soil microbial biomass, primarily in the form of dissolved organic matter. Dissolved organic carbon (DOC) is the most bioavailable substrate in soil, especially the labile hydrophilic pool. In this preliminary experiment, we quantified DOC fractions from two different sandy soils using a rapid-batch fractionation procedure which divides extracted DOC into humic acids, fulvic acids, and hydrophilic compounds. This was coupled with measurements of microbial biomass, microbial respiration, and fungal and bacterial DNA copy numbers. Having been previously amended with various sources and levels of organic amendments, differences in the relative sizes of the quantified DOC fractions were observed which corresponded with the various measurements of microbial activity. This study is part of a larger, integrative study on the general disease suppression of agricultural soils, and is the first to characterize these DOC fractions in the context of an agricultural organic amendment experiment.

APPROACHES TO INTEGRATED SPATIAL DATA MANAGEMENT FOR THE PROVISION OF SOIL ECOSYSTEM SERVICES AND FOOD SECURITY

THALLON, GUY[1] (GUY.THALLON@PRODUCEWORLD.CO.UK); SIMMONS, ROBERT[1]; RITZ, KARL[1;] GARROD, EMMA[2]

[1] National Soil Resources Institute, School of Applied Sciences, Cranfield University, United Kingdom
[2] Produce World Ltd., United Kingdom

Soil is a finite resource requiring proactive management in order to sustain it and provide both a growth medium for crops and numerous additional benefits which have previously been unappreciated. The fundamental principles of sustainable agriculture promote the importance of soil health to continue the provision of such ecosystem functions. Integrated approaches are required to support these principles, acknowledging and monitoring the complex spatio-temporal interactions that exist between land use and soil functions. This may be achieved by collating and assessing a suite of soil health proxies.

The primary objective of this project is to develop a geographic information system (GIS) based soil information system (named 'Soil-for-life') for the entire land-bank (*c.*17,000 ha) of a horticultural grower group, which will enable the visualisation and integrated analysis of soil attribute data from a varied range of sources at a multitude of scales. These data sources include: agronomic data from land managers, crop yield and quality information from pack-houses, soils data from the National Soil Resources Institute LandIS data holdings and datasets from UK Government agencies such as the Environment Agency, the Rural Payments Agency and Natural England.

This Soil-for-life system will provide a framework to harmonise and document these data sources to allow like-by-like comparison and an integrated approach to data analysis. It is intended that this system will provide information to facilitate the spatial and temporal monitoring of soil attributes, drive scenario-based assessments, protect against risks such as pests and diseases and ultimately achieve improved soil health and agricultural sustainability. In addition the system will provide extensive data sources to form a powerful research tool to conduct data-driven, and ultimately evidence-based research into themes such as soil health indicators and soil-crop interactions.

LAND AVAILABILITY, SOIL PRODUCTIVITY AND FOOD SECURITY IN THE EUROPEAN UNION: STATUS AND PROSPECTS

TÓTH, GERGELY (GERGELY.TOTH@JRC.EC.EUROPA.EU); BODIS, KATALIN; IVITS, EVA

Joint Research Centre, European Commission

Food security of Europe is based on the crop output of its land which is conditioned by ecological and socio-economic factors. Socio-economic factors influence land availability for food production, land use allocation and land use efficiency. Ecological factors set conditions for productive potential of agricultural land and limits to environmentally acceptable inputs. Optimization of land utilization to secure adequate food production in Europe while keeping land provision for other uses and maintaining good environmental status needs a complex approach. The first step is an evaluation of productivity of lands potentially available for food production. Land allocation scenarios together with integrated socioeconomic and environmental assessment can be built upon the land productivity model. A land productivity evaluation system was worked out to allow comparative assessment of land resources of the European Union. Spatial analyses of the land productivity, land use and crop output data show that the EU has adequate margins to manage its basic food demand on a long term. Climate change, environmental conservation needs and global economic pressure might alter this margin.

DEALING WITH SOIL HETEROGENEITY TO REACH A MORE SUSTAINABLE AGRICULTURE

VAN VLIET, PETRA (PETRA.VANVLIET@BLGG.NL); VAN ERP, PETER; TERHOEVEN-URSELMANS, THOMAS

BLGG AgroXpertus, The Netherlands

Nowadays, regulations regarding fertilizer usage, crop protection and environmental issues make it more challenging for farmers to produce sufficient, healthy food using sustainable plant production systems which are also economically feasible. One of the major problems farmers have to deal with is the heterogeneity of soil chemical, physical and microbial characteristics within their fields and the effect on crop growth. Precision farming with GPS seems a promising management tool because it uses location specific information on the actual soil and crop status. The localized information can be used by farmers to perform special tasks at that location, thereby optimizing crop growth conditions and reducing negative side effects on the environment. In 2010 BLGG AgroXpertus, WUR, TTW, Van den Borne and Novifarm started a 4 year lasting field experiment on two arable farms which focusses on the implementation of precision farming techniques. On each farm one field was divided into several small blocks (10 by 30 or 15 by 30 meters) which were all sampled and analysed according to conventional methods. One field was a sandy soil and had a very heterogeneous distribution of soil organic matter. The other field was located on a loamy soil and showed a gradient in clay and soil organic matter. Goal of the first year was to get more insight into soil and plant heterogeneity within the fields. The fields were scanned in 2010 with different types of soil sensors and several times during the growing season with several plant sensors. In this paper/presentation, we will present the results. Thereby we will focus on the following aspects: 1) are the soil sensors suitable to estimate soil heterogeneity? 2) does soil heterogeneity determine crop heterogeneity? 3) how can precision agriculture contribute to more sustainable food production systems?

ADEQUACY OF LEGACY SOIL DATA FOR AGRICULTURAL LAND SUITABILITY AND LAND DEGRADATION ASSESSMENTS – THE CASE OF RWANDA

VERDOODT, ANN[1] (ANN.VERDOODT@UGENT.BE); BAERT, GEERT[2]; FINKE, PETER[1]; VAN RANST, ERIC[1]

[1]Laboratory of Soil Science, Department of Geology and Soil Science, Ghent University, Belgium
[2]Department of Plant Production, University College Ghent, Belgium

Forty-three semi-detailed soil maps of Rwanda, produced at a scale of 1:50,000 and consultable online at http://zadeh.ugent.be/rwanda/, have been drawn based on a conventional national soil survey from 1981 to 1994. The digitised soil maps as well as the soil profile database were subjected to an auditing, and corrected where necessary. Positional, semantic and thematic quality criteria were evaluated, the pedodiversity was examined and the between and within soil unit variability was revealed. This presentation aims at giving a brief overview of the Rwandan soil diversity, the quality of the available soil survey data and its implications for the future exploitation of the soil resources knowledge base of the region. It also provides an assessment of the vulnerability of the Rwandan soils to erosion, the organic carbon stocks, as well as the agricultural suitability of different agricultural regions. The Rwandan soil resources are characterised by a large variability and thus also offer possibilities for better Central African soil characterisation. For the development of sustainable land use strategies and natural hazard mitigation, Rwandan decision makers furthermore need good baseline information. Our analyses highlight challenges faced when characterising the spatial distribution of specific physical and chemical soil parameters in environmentally very diverse tropical regions with high population densities.

EFFECTS OF NITRIFICATION INHIBITORS ON N_2O EMISSION FROM ANDOSOL UNDER TEMPERATURE AND MOISTURE REGIMES

ELGHARABLY, AHMED[1,2] (AGE@AUN.EDU.EG); ITO, OSAMU[1]

[1]Japan International Research Center For Agricultural Sciences (JIRCAS), Japan
[2]Department of Soil and Water Sciences, Faculty of Agriculture, Assiut University, Egypt

The application of nitrogen fertilisers leads to different ecological problems such as nitrate leaching and the release of nitrogenous gases. This study evaluated the inhibitory effects of dicyanideamide (DCD) and Methyl-p-hydroxyphenyl propionate (MHPP) on nitrification and N_2O emission in N-fertilized Andosol soil under different moisture and temperature regimes. In addition to the control, ammonium sulfate was added at 10 µg N with and without 250 or 500 µg MHPP or 2.5 and 5 µg DCD g^{-1} soil. Soil moisture was adjusted to 40, 60 or 80% water-filled pore space (WFPS). Soil was incubated at 10, 20 or 30±2 °C and subsamples were taken at intervals over 28 days. Nitrification rates in the control soil were strongly influenced by the temperature and moisture, increasing by a factor of 4.1 for each 10 °C increase. With increasing addition of MHPP, nitrification and N_2O emission decreased effectively for 15-21 days at 10-30 °C and 40-80% WFPS. Higher application of DCD also slowed nitrification appreciably at 30 °C when the soil was at 80% WFPS, but was less effective at 40% WFPS. Nitrification and N_2O emission increased with increasing temperature and moisture and decreased variably with addition of inhibitors in a wide range of moisture and temperature levels.

Theme 2
Water Resources

ESTIMATION OF MEAN FLOW VELOCITY OF OVERLAND FLOW IN A FLUME

ALI, MAZHAR[1]; SEEGER, MANUEL[1] (MANUEL.SEEGER@WUR.NL); STROOSNIJDER, LEO[1]; STERK, GEERT[2]

[1]Land Degradation and Development Group, Wageningen University, The Netherlands
[2]Department of Physical Geography, Utrecht University, The Netherlands

Precise estimation of mean flow velocity is imperative for the accurate prediction of hydrograph and sediment yield. For overland flow, the mean flow velocities are normally estimated by multiplying the dye or salt based velocity measurements with a correction factor (α). A wide range of correction factors are available in the literature, which were proposed under different experimental conditions. The selection of a suitable correction factor has become a main challenge for accurate flow calculations. Therefore, this study aimed to assess the variability of correction factor (α) with grain size and bed gradient for mobile beds and also to evaluate the dependency of mean flow velocity on flow rate, grain size and slope by regression analysis. In order to accomplish the objectives, laboratory flume experiments were performed at flow rates from 33 to 1033 x 10-6 m3 s-1, bed gradients ranged from 3o to 10o, and median sediment diameters ranging from 0.233 to 1.022 mm. Flow velocities were measured directly with the dye tracing technique (Udye) and indirectly derived from flow depth measurements (Udepth). Dye based flow velocity measurements are always considerably higher than depth derived flow velocities, particularly for finest sand due to its steep velocity profile. The derived values of α (Udepth/Udye) do not remain constant for all selected grain sizes and increase significantly with the increase of grain size: the derived mean values of α for 0.230, 0.536, 0.719 and 1.022 mm sands were 0.44, 0.77, 0.82 and 0.82 respectively. Hence, due to the substantial variation of α with grain size, no absolute value of α is applicable to all hydraulic and sedimentary conditions. However, the derived mean α values for 0.230 and 0.719 mm sands were found comparable with the α values available in the literature for similar grain sizes. In this study, Udepth measurements were considered as the mean flow velocities (Umean). The influence of discharge (Q), slope (S) and median grain diameter (D50) on Umean was studied by regression analysis. The regression analysis depicted the significant influence of Q and D50 on Umean, but the effect of slope was found to be almost non-significant. The proposed model was successfully validated with five literature datasets. Therefore, the proposed model could be confidently used to estimate mean flow velocity within the range of conditions for which it was derived i.e. 33<Q< mm. 0.233<D50

INFLUENCE OF HYDRAULIC PARAMETERS ON SEDIMENT TRANSPORT UNDER SHALLOW FLOWS

ALI, MAZHAR[1]; SEEGER, MANUEL[1] (MANUEL.SEEGER@WUR.NL); BOERSEMA, MATTHIJS[2]; STERK, GEERT[3]

[1]Land Degradation and Development Group, Wageningen University, The Netherlands
[2]Hydrology and Quantitative Water Management Group, Wageningen University, The Netherlands
[3]Department of Physical Geography, Utrecht University, The Netherlands

Sediment transport capacity (Tc) plays a pivotal role in the physical description of soil erosion processes. It depends on several hydraulic parameters like unit flow rate (q), mean flow velocity (U), flow depth (h), and slope gradient (S). However, the impact of these hydraulic parameters on Tc is still ambiguous, which needs to be further examined in order to get better understanding of the processes involved in sediment transport. Therefore, the main objectives of this research were (1) to study the influence slope (S) and median grain size (D50) on relationships between Tc and q, U, and h under mobile beds and (2) to ascertain the optimal composite force predictor among shear stress, stream power, unit stream power, and effective stream power to estimate Tc. Experiments were carried out in a 3.0 m long and 0.5 m wide flume with four well sorted commercially available non-cohesive sands with D50 equal to 0.230, 0.536, 0.719, 1.022 mm. The unit flow rates used to conduct experiments ranged between 66 and 2066 x 10-6 m2 s-1. For the experiments, the flume bed was adjusted at four gradients (5.2, 8.7, 13.1, and 17.4%), to study their impact on sediment transport. Flow depths were measured by using the point gauge system and mean flow velocities were estimated by using an empirical equation, which was derived from a previous experiments. The measured sediment transport rate was considered equal to the sediment transport capacity, because a flume length of 3.0 m is considered sufficient to reach sediment transport capacity. In order to accomplish the objectives, regression analysis was carried out between Tc and hydraulic parameters or composite force predictors. Regression analysis exhibited that the relationships between Tc and q, U, and h were found dependent on S, while independent of D50 effect. Hence, multiple regression analysis was carried out to study the influence of q, U and h with S on Tc. The regression analysis between Tc, q and S depicted a strong power relationship with a coefficient of determination (R2) equal to 0.92. Replacing q with U gave a slightly better regression (R2 = 0.96), while substitution of h resulted in a poor regression (R2 = 0.62). Hence, U showed more pronounced impact on Tc than any other selected hydraulic parameter. Sediment transport capacity was correlated with composite force predictors (shear stress, stream power, unit stream power and effective stream power) by regression analysis and the impact of D50 on these relations was also studied. The strongest relationships were obtained between Tc and unit stream power (R2 = 0.87) and effective stream power (R2 = 0.85), because both were derived by using mean flow velocity. Unit stream power is preferred for estimating Tc, because (i) it fitted best with the Tc, and (ii) its relationship with Tc independent of D50 effect.

TOWARDS THE REPRODUCIBILITY IN SOIL EROSION MODELING: A NEW PAN-EUROPEAN SOIL EROSION MAP

BOSCO, CLAUDIO; DE RIGO, DANIELE; DEWITTE, OLIVIER (OLIVIER.DEWITTE@JEC.EC.EUROPA.EU); MONTANARELLA, LUCA

European Commission, Joint Research Centre, Institute for Environment and Sustainability, Land Management and Natural hazards Unit

Soil erosion by water is a widespread phenomenon throughout Europe and has the potentiality, with his on-site and off-site effects, to affect water quality, food security and floods. Despite the implementation of numerous and different models to estimate soil erosion by water in Europe, there is still a lack of harmonization of assessment methodologies. Very often, different approaches give soil erosion rates significantly different and even when the same model is applied to the same region the results may be different. This can be due to the way the model is implemented (i.e. with the selection of different algorithms when available) and/or to the use of datasets having different resolution or accuracy. Scientific computation is emerging as one of the central topic of the scientific method, to overcome these problems there is thus the necessity to develop reproducible computational method where codes and data are available. The present study is an illustration of such an approach. Using only public available datasets, we applied the Revised Universal Soil loss Equation (RUSLE) to locate the most sensitive areas to soil erosion in Europe. A significant effort was made to select the better simplified equations to be used when a strict application of the RUSLE model is not possible. In particular for the computation of the Rainfall Erosivity factor (R) the reproducible research paradigm was applied. The calculation of the R factor was implemented using public datasets and the GNU R language and an easily reproducible validation procedure based on measured precipitation time series was applied using Matlab language. Designing the computational modeling architecture with the aim to ease as much as possible the future reuse of the model in analyzing climate change scenarios is also a challenging goal of the research.

HEAVY METALS CONCENTRATIONS IN SOIL AND WATER ON THE ROSIA MONTANA AREA

CITU, GEORGE (GEORGE_CITU@HOTMAIL.COM)

AMEC, United Kingdom

Keywords: pollution, mining, arsenic, cadmium, risk

The paper deals with the mining pollution in Rosia Montana area which have been chosen as case studies, in order to show the effects of pollution with heavy metals provided by the old historical mining activity and to emphasize its environmental risk. Water and soil sample analyses show a risk of arsenic and cadmium pollution in Rosia Montana area. Some methods of remediation are listed at the end of the paper.

EFFECT OF REDUCED SOIL DISTURBANCE ON EARTHWORM DENSITY AND DIVERSITY AND SOIL PHYSICAL QUALITY

CRITTENDEN, STEVE[1] (STEPHEN.CRITTENDEN@WUR.NL); PULLEMAN, MIRJAM[1]; VERMEULEN, BERT[2]; HEINEN, MARIUS[3]; BRUSSAARD, LIJBERT[1]

[1]Wageningen University, The Netherlands
[2]Wageningen University and Research Centre, Plant research International, The Netherlands
[3]Wageningen University and Research Centre, Alterra, The Netherlands

Reduced tillage systems and controlled traffic farming (CTF) are being implemented in the Netherlands to lessen compaction and improve soil physical quality. Changes observed in soil physical quality after reducing tillage and starting controlled traffic are often attributed to ecosystem engineers such as earthworms. Through the burrowing and casting behaviours of diverse earthworm species these soil physical functions may be affected differentially between reduced tillage systems. It was hypothesized that reduced tillage systems, where soil is not inverted during tillage, and controlled traffic will promote earthworm density and diversity and therefore encourage an improvement in soil physical quality (soil water retention and infiltration). Two replicated field experiments in randomized complete block designs were performed on organic farms in Flevoland, the Netherlands. The soils are marine loams and climatic data was collected from nearby weather stations. Different tillage treatments with or without controlled traffic were compared. Earthworm abundance, biomass and species were assessed during biannual sampling in the spring and fall of 2009, 2010 and 2011. Soil water retention, infiltration, penetration resistance, aggregate stability and saturated hydraulic conductivity were measured in the fall of 2010 and spring of 2011. Controlled traffic showed a significant positive effect on earthworm density, infiltration capacity and reduced penetration resistance. Data on the effect of tillage system is thus far not conclusive, possibly due to insufficient time for changes to occur, however data from an additional season will be added for this conference.

SALTWATER CONTAMINATION IN THE VENICE LAGOON MARGIN, ITALY. 1: THE INFLUENCE OF THE GEOMORPHOLOGICAL SETTING

DONNICI, SANDRA[1]; RIZZETTO, FEDERICA[1]; TOSI, LUIGI[1]; SCUDIERO, ELIA[2]; MORARI, FRANCESCO[2]; DEIANA, RITA[2]; CASSIANI, GIORGIO[2]; TEATINI, PIETRO[2]
(TEATINI@DMSA.UNIPD.IT)

[1]Institute of Marine Sciences - National Research Council, Italy
[2]University of Padova, Italy

The coastal area bounding the southern margin of the lagoon of Venice, Italy, was reclaimed for agricultural purposes between the end of the XIX century and the beginning of the XX century. Presently, it is a precarious environment subject to both natural changes and anthropogenic pressures. One major environmental problem is the saltwater contamination of the shallow aquifers and soils that yields a strong negative effect on the productivity of the farmlands. Saltwater intrusion is enhanced by a land elevation well below the mean sea level, the seawater encroachment along rivers and channels during the dry periods, the drainage activities implemented to keep dry the farmland, and the presence of several ancient sandy fluvial ridges and buried paleo-channels. As part of a research project aimed at understanding the dynamics of the saltwater intrusion and its effects on the soil productivity by an experimental and a numerical approach, a 25-ha basin was selected just south of the Venice Lagoon and approximately 6 km far from the Adriatic Sea. The contribution reports on an accurate investigation carried out to characterize the geomorphological features of the area, identifying possible pathways of saltwater intrusion. The task was carried out by photo-interpretation of historical aereophotographs, geophysical surveys (i.e., electro-tomography, electromagnetic induction), and about 60 shallows cores distributed in the area according to the variability of the apparent electrical conductivity in the upper 1.50 m soil profile. The results point out a significant depth and areal variability of the soil deposits and the presence of a few sandy paleo-river beds. These latter cross the farmland with a main direction from inland to the lagoon boundary and can act as preferential pathways for groundwater flow and solute transport from the nearby salty waterbodies.

PROJECT WATERSENSE, AN INTEGRAL DECISION SUPPORT SYSTEM (DSS) FOR WATERMANAGEMENT

ENTING, GEERTJE (G.ENTING@WMD.NL)

Project WaterSense, The Netherlands

The WaterSense project applies advanced sensor systems technology to the agricultural and water sectors. In WaterSense partners have developed a first draft for an integral Decision Support System (DSS) for water quantity issues in the area of the Dutch Peatarea in Groningen. WaterSense constantly monitors a region of approximately 30.000 hectares using 100 sensors measuring soil moisture. The draft DSS turn these data into practical advice for farmers and water managers. The WaterSense approach combines sensor data, together with other environmental and meteorological data, with hydrological models. The models are constantly validated with real-time data, providing the best insight into short and long-term developments of the water balance in a region. The DSS provides water managers and farmers with advice regarding overhead irrigation and water-level management. In WaterSense steps are taken to monitor the water quality in the unsaturated zone. Ways to combine these data with the DSS water quantity are to be explored. This may lead to an integral DSS system that will support both farmer and water authorities with sustainable water management. Together wilth the development of the DSS, field experiments with potatoes, manuring and irrigation strategies provide more knowledge for the farmer to improve water management on the farm. 2011 is the last year of this three year research project and results will be presented at the conference. Partners in the project are the regional water company, the regional water authority, three private enterprises, the province of Drenthe, and two knowledge institutes. For more information: www.projectwatersense.nl

IMPACT OF IRRIGATION MANAGEMENT ON WATER TABLE FLUCTUATION AND SOIL SALINITY IN SIWA OASIS

KISHK, FAWZY M.; ALY, ANWAR A. (ANWARSIWA@YAHOO.COM); GABER, HESHAM M.

Soil and Water Sciences Department, Faculty of Agriculture, Alexandria University, Egypt

Keywords: Soil salinity, water table, modelling

Soil salinity is a common problem in arid and semi arid areas but the dynamics of soil salinity in these areas are not well understood. The main causes of soil salinity in these areas are generally known as low precipitation, high evapotranspiration, and capillary flux from saline shallow groundwater.

In Siwa oasis, situated in Egypt, secondary salination of irrigated lands is a crucial problem. The visible salt deposits and soil salination processes are the consequence of several factors including the excessive use of saline irrigation water, inefficient irrigation practices, and shallow saline water table. Understanding the mechanism of the secondary salination is of interest in order to maintain existing oasis, and thus ensure the sustainability of olive and date production in this part of the country. Therefore, a conceptual, daily, semi-distributed hydrologic model will be developed to analyze the impact of irrigation management on the water table fluctuation and soil salinity to evaluate measures to control salinity within Siwa oasis ecosystem.

ANALYSIS OF YIELD OF WINE GRAPES ON BROWN SOIL ON GRAVEL AND CONGLOMERATE IN BJELOPAVLICKA PLAIN – MONTENEGRO

KNEZEVIC, MIRKO[1] (MIRKOK@AC.ME); RUDIĆ, DRAGAN[2]; TODOROVIC, MLADEN[3]; PEROVIC, NATALIJA[1]; RADULOVIC, MIRJANA[1]; TOPALOVIC, ANA[1]

[1]Biotechnical Faculty, University of Montenegro, Montenegro
[2]Agricultural Faculty, University of Belgarade, Serbia
[3]Mediterranean Agronomic Institute of Bari, Italy

Keywords: irrigation, water balance, net irrigation, budget

The analysis of yield of wine grapes on brown soil on gravel and conglomerate in Bjelopavlicka Plain was done by means of Budget. Budget is a model for the calculation of relative yield in the function of water balance. The daily values of climatic parameters (precipitation, maximal and minimum temperature, relative air humidity and sunny hours) were used for 30 years period.

For the period of vegetation, parameters of the water balance such as precipitation, infiltration, surface runoff, drainage, reference evapotranspiration, crop evapotranspiration, actual evapotranspiration, net requirements of irrigation, and relative yield were processed with Budget.

Grape growing season on brown soil on gravel and conglomerate was characterized with the rainfall of 809.8±260.2 mm (mean and standard deviation), while the minimum and maximum being 289.7 mm and 1457.7 mm, respectively.

Potential evapotranspiration was in the range from 402.1 to 527.2 mm (472.6±31.2 mm).

Actual evapotranspiration ranged from 268.2 to 436.6 mm with the average value 360.7±48.4 mm.

The maximum value of infiltration was 1442.2 mm and the amount of the drained into the deeper layers 1116.4, whereas the minimum value of infiltration was 289.7 mm and 105.6 mm drainage. The corresponding mean values were 805.0±255.5 mm and 485.8±230.1 mm. Considering examined soil being very permeable with very low runoff values as well as there was no the occurrence of runoff during some years, the mean runoff was 4.8±8.2 mm. The maximum runoff was 35.9 mm.

Net irrigation norm varied from 32.5 to 295.9 mm, averaging 158.0±62.0 mm. In the conditions without irrigation the significant reduction in yield was obtained. Namely, in comparison to irrigated contitions the decrease of yield was in range 6 – 75%. In average, the calculated relative yield was 53.8±18.8%.

WATER USE EFFICIENCY OF BIOENERGY CROPS ON DEGRADED SOILS IN SOUTHERN BRANDENBURG – A COMPARISON BETWEEN BLACK LOCUST AND GIANT KNOTWEED

MANTOVANI, DARIO[1] (MANTDAR2@GMAIL.COM); VESTE, MIKE[2]; FREESE, DIRK[1]

[1]Brandenburg University of Technology, Chair of Soil Protection and Recultivation, Germany
[2]CEBra – Centre for Energy Technology Brandenburg e.V., Germany

The cultivation of fast-growing trees and new bioenergy crop for biomass production is an alternative land-use for marginal and degraded lands. Southern Brandenburg, NE Germany is characterized by large areas of recultivated former open-cast mining with low nutrient content and limited ground water resources. As the availability of water influences also the biomass production significantly, a central role is played by the optimisation of these processes through the species selection. For the understanding of the governing processes of an efficient water use in agricultural systems it is important to develop a crop growth models for predictions of biomass production under various water regimes. Therefore, we compare the water use efficiency (WUE) of two bioenergy crops: a) Robinia pseudoacacia L. and b) Fallopia sachalinensis. As an early successional and nitrogen-fixing tree species, black locust grows rapidly even under unfavourable site conditions in the former mining sites, while the Giant Knotweed is characterized by a high annual biomass production and can be harvested 2-3 times during the growing season. For the determination of transpiration-yield relations at whole plant level we used a new modified wick lysimeter system, which allows us to study plant growth under controlled water regimes (well-watered, moderate, drought). The lysimeters are filled with a loamy sand. Water is supplied by an automatic drip irrigation system and water amounts is controlled by the actual evapotranspiration and water demand of the plants. Transpiration is calculated on the basis of water input, storage and drainage in daily intervals. The ecophysiological response of the plants to drought stress is investigated by using a portable gas exchange system with a minicuvette chamber, which allows the measurements of net photosynthesis and transpiration under various light, temperature and air humidity regimes. WUE of the plant level have been linked to their ecophysiological performance.

SOIL WATER REPELLENCY – A CONFOUNDING FACTOR IN SOIL AND WATER MANAGEMENT

MOORE, DEMIE[1] (DEMIE.MOORE@WUR.NL); KOSTKA, STANLEY[2]; BOERTH, THOMAS[2]; MCMILLAN, MICA[2]; RITSEMA, COEN[3]; DEKKER, LOUIS[3]; OOSTINDIE, KLAAS[3]; STOOF, CATHELIJNE[1]; WESSELING, JAN[3]

[1]Wageningen University, The Netherlands
[2]Aquatrols, The United States
[3]Wageningen University and Research Centre, Alterra, The Netherlands

Soil water repellency (SWR) changes a soil's hydrological properties at least temporarily. The reduction or loss of soil wettability caused by SWR leads to drastically different hydrological behavior, and reduces the ability of the soil to function as expected. Water repellency in soil is more wide spread than previously thought and has been identified in many soil types under a wide array of climatic conditions and cropping systems worldwide. Consequences of SWR include increased runoff and preferential flow, reduced plant available water, reduced irrigation efficiency, suboptimal crop performance, increased requirement for water and other inputs, and increased potential for non-point source pollution. Research has shown that SWR can be alleviated or avoided with certain (soil) surfactants which ensure soil wettability and uniform distribution of water and other inputs in the soil. This presentation consolidates information on basic soil system functions related to the plant growth environment, irrigation efficiency and water conservation, and shows what happens in soils affected by varying levels of SWR compared to what happens in wettable soils or where a soil surfactant has been used to restore or optimize soil wettability. The impact on irrigation efficiency and the plant growth environment is also discussed. It is apparent that SWR compromises hydrological properties and the plant growth environment in a wide range of conditions. It is a confounding factor in soil and water management that needs to be recognized, monitored and addressed in crop systems in order to optimize rainfall and irrigation use as well as crop performance.

RATIONAL USE OF WATER USING IRRIGATION SUPRESSION IN ONE OF THE BEAN PHENOLOGICAL STAGES

SAAD, JOAO CARLOS CURY (JOAOSAAD@FCA.UNESP.BR); MIORINI, THOMAS JOSÉ JUSTO; MENEGALLE, MARCELA LEITE CAMPOS

Faculty of Agricultural Sciences, UNESP, Brazil

Bean (Phaseolus vulgaris L.) is widespread in the social and economic scene in Brazil, as well it is Brazilian population main dish, and it also helps small and medium farmers' income. The hypothesis is that if the water supply is suppressed in just one of the five development stages of irrigated beans, the yield reduction would be lower than 10%, allowing water economy. The objective of this study was to compare the performance of bean Carioca group IAC Alvorada yield components, with irrigation suppression in each of the five phenological phases (emergence, vegetative, flowering, grain filling and maturation) and no irrigation and irrigated in all stages. The study was conducted at Agronomical Sciences College, UNESP, Botucatu, SP, Brazil. The statistical design was the randomized block with seven treatments and four replications, each plot of 2.0 x 4.5 m. Irrigation was conducted to increase the soil water content to the condition equivalent to soil field capacity. Data were subjected to analysis of variance and "t" test at 5% probability. The irrigation suppression during emergence, filling, and maturation phases did not show any statistical difference in productivity when compared with the irrigated at all stages. The irrigation suppression at vegetative and flowering phase, reduced the production at 75.1 and 76.2% respectively when compared with irrigation at all stages, despite the reduction of the water depth being around 20% for flowering and 33.8% for the vegetative phase when compared to the irrigated at all stages. Irrigation suppression in all phases generated a reduction of approximately 87.3% when compared with irrigation at all stages. During the experiment there was a total recorded rainfall of 156mm (35.6% of the total water applied). It is possible to produce using less water applied in the filling and maturation phase without reduction in the bean yield.

GRANULOMETRIC COMPOSITION OF SOILS: THE PROBLEMS OF PREPARATION AND ANALYSIS BY DIFFERENT METHODS

SHEIN, EVGENY (EVGENY.SHEIN@GMAIL.COM); MILANOVSKIY, EVGENY; MAKAROVA, TATIANA

Moscow State University, Russia

Taking into account the diversity of soils and the significant differences in the mechanisms of soil aggregation, none of the existing pretreatment methods can be recommended as a single standard. Dispersion of soil samples by pyrophosphate method (but not for carbonated soils), compared to the dispersion of ultrasound, does not ensure the complete destruction of microaggregates. Power requirement for the dispersion of the sample increases in the presence of stable microaggregates, i.e. depends on soil type. For the loamy soils from the forest soils to steppe chernozems the sonication in water at power 100-150 W and a frequency of 20 kilohertz is sufficient. Difference between the results of granulometric analysis by the method of sedimentation and laser diffraction cause (1) non-sphericity of particles, (2) the presence of organic matter and (3) the heterogeneity of particle density. After removal of the organic substances or at low content of silt the differences between the methods became minimal. Dispersion of soil suspension by ultrasound is mandatory pre-processing, ultrasonic power is increased by the presence in samples of solid microaggregates that is dependent on the type and origin of interparticle bonds.

SNOWMELT DRIVEN DISCHARGE MODELING FOR A SMALL CATCHMENT IN NORWAY

STOLTE, JANNES[1] (JANNES.STOLTE@BIOFORSK.NO); KRAMER, GEOFFRIE[2]; FRENCH, HELEN[3]

[1] Bioforsk Soil and Environment, Norway
[2]University of Minnesota, The United States
[3]University of life Sciences, Norway

Climate changes will increase the frequency of extreme precipitation events, floods and snow melt periods. The anticipated climate change effects suggest that the potential for an increase in extreme runoff events will exist disproportionately during periods of soil frost and snow cover. Several factors combine during cold periods to increase the potential for large runoff events, including reduced infiltration capacity due to frozen soils and increased water stored on the landscape in the form of snow. Increasing runoff in spring period also might increase the losses of sediment and nutrients. The capability for accurately modeling catchment-scale hydrological processes during periods of snowpack creation and ablation is currently limited. Research into appropriate snowpack and snowmelt modeling tools is integral to gaining an understanding of the hydrologic processes which occur within a catchment during cold seasons. Combining this snowmelt modeling with catchment scale discharge and soil erosion modeling is done for the 2009 and 2010 melt period for a small catchment in Norway. For this, the Utah Energy Balance model is used for the snowmelt calculations. Initially, the UEB model is calibrated on measured snow dynamics. The LISEM model is used to calculate catchment discharge, and is calibrated on a summer event in 2010. Afterwards, output of the UEB model is used in the LISEM model for surface discharge estimates and results are compared with measured discharge for the 2009 and 2010 melt period. Good results were found for both timing and magnitude of peak discharge, were infiltration capacity is used for calibration purposes. The coupling of the UEB and LISEM models provides valuable insight into the hydrological processes and responses occurring during winter periods. However, more work is needed to improve our understanding and quantification of soil-water interactions during cold periods, which can cause great deviations from hydrologic processes observed during warmer periods.

ASSESSMENT AND MITIGATION OF DROUGHTS IN AFRICAN DRYLANDS

STROOSNIJDER, LEO (LEO.STROOSNIJDER@WUR.NL)

Wageningen University, The Netherlands

Agricultural production in drylands suffers from drought. In sub-Saharan drylands, only about 15% of the terrestrial rainwater is used by plants for food, fodder and fiber. An agricultural drought framework distinguishes three major types of drought, each with different coping strategies. (1) meteorological drought, (2) soil water drought and (3) nutrient drought. Farmers often have a different perception of drought than scientists. This gap can be solved with an analysis of rainfall data that focuses on drought. Onset and length of the growing period are most important. Farmers also have a different opinion about climate change; farmers' climate change has more to do with desertification and its related soil water or soil nutrient drought, than with changes in rainfall. Meteorological drought can be due to a too short growing season due to late start and/or early cessation of rains, to a too long dry spell at a critical growth stage or due to total failure of rain. Coping strategies for meteorological drought are adaption of sowing date, in-situ water conservation and water harvesting for deficient irrigation. Physical water conservation structures need to account for extreme variations in rainfall typical for semi-arid regions. Ridging is most promising while mulching is no longer promoted. Coping strategies for soil water and nutrient drought aim at improving soil quality for which Conservation Agriculture is the current mode. Agronomic measures such as the use of quick maturing and drought resistant crops are often more attainable than adoption of water conservation practices. Crop failure is often more due to water scarcity than to lack of fertility. However, when agricultural production increases, water and nutrients often alternate as production limiting factors. The strong water-nutrient synergy in drylands requires precision fertilization and plant density adjustment whereby farmers may benefit from seasonal rainfall forecasts.

QUANTIFICATION OF ECOSYSTEM SERVICES IN THE BAVIAANSKLOOF, SOUTH AFRICA

VAN ECK, BART[1]; RIKSEN, MICHEL[2]; SOMMEIJER, MARJAN[2]; DRAAIJER, ANNE-GERRIT[2]; VAN GASTEL, JEROEN[2]; JANSEN, HERCO[3]; VAN LUIJK, GERSON[2] (GERSON.VANLUIJK@WUR.NL)

[1]Living Lands, South Africa
[2]Wageningen University, Land Degradation and Development group, The Netherlands
[3]Wageningen University and Research Centre, Alterra, The Netherlands

The Baviaanskloof in South Africa is highly degraded due to mismanagement of the land under various socio-economic influences. The PRESENCE network is guiding the process that should cut through the negative circle of further degradation and at the same time ensure that all the inhabitants can support their Livelihoods. The introduction of Payment for Ecosystem Services (PES) is one of the strategies followed to stimulate local actors towards better land management and ecology restoration activities that should result in new sources of income. One of the services to the down –stream community is to improve the water availability and quality by reducing the peak flows and increasing the base flow by better land management. The quantity and values of these services to downslope water users have to be investigated before payment system can be set in place. The here presented research is focussed on the quantification of water infiltration and runoff. In 2009 a monitoring plot on a hillslope with various types of equipment has been set up in an area where the results of degradation, restoration and intact vegetation can be measured. Various measurements have shown run-off values on degraded land five times higher than on intact natural vegetation. Improvement of water infiltration under newly planted vegetation has also been measured and show promising results. Much information is already been gathered and good insights have been given through these measurements. Now it is time to look for opportunities to upscale the monitoring event in such way that we can truly visualize the effects of restoration at watershed level and how this can contribute to a future income for local farmers.

SIMULATION OF SOIL WATER DYNAMICS IN AN IRRIGATED DISTRICT OF SOUTHERN ITALY

VENTRELLA, DOMENICO (DOMENICO.VENTRELLA@ENTECRA.IT); CASTELLINI, MIRKO; GIGLIO, LUISA

CRA-Unità di Ricerca per i Sistemi Colturali degli ambienti caldo-aridi (CRA-SCA), Italy

The available approaches for predicting the soil hydraulic functions include direct methods, using laboratory and field experiments, and indirect methods, such as the application of pedo-transfer functions or inverse methods. This last approach consists of a non-linear estimation of the soil hydraulic parameters by minimising the residuals between observed and simulated values of variables, such as the volumetric water content and the soil water pressure head. Numerical models are increasingly being used to simulate water and solute movement in the vadose zone for a variety of applications in research and soil/water management. While a large number of models of various complexity have been developed over the years, relatively few have been tested under field conditions. Soil water flow in physically-based models is described by Richards' equation. Application of this equation requires knowledge of the two functions: the soil water retention and the hydraulic conductivity. Inverse procedures have been successfully applied to analyse laboratory results using multistep or evaporation methods. During the last years, the application of inverse method is increasing by being applied to field experiments. Recently, several Authors have estimated the effective soil hydraulic function parameters with the inverse method by using evapotranspiration (ET) and soil water content data collected from a lysimeter experiment for a soil cropped with wheat. The objective of this paper is to test different strategies to optimize the simulation of soil water content dynamics for a typical cultivation of water melon (Cuccumis citrullus L.) for the area of "Arco Jonico Metapontino" located in Basilicata and Puglia regions (Southern Italy). The strategies utilized in the comparison are based on: (i) direct measurements of the soil water content and hydraulic conducibily functions; (ii) utilization of pedotransfer functions starting from textural information and (iii) inverse procedures including data of soil water content. Such data were collected in a private farm by means of an instrument system including TDR 100, datalogger, multiplexers and 16 15-cm trifilar probes installed in horizontal and vertical positions between two rows of water melon. With the approaches utilized here, it was possible to describe the evolution of soil water content during the water melon cultivation with the HYDRUS-1D model reproducing the general trends of measured soil water content at the field site reasonably well. We could individuate the contribution of the inverse optimisation to improve the simulation of soil water content compared to the other strategies included in this paper.

THE FUTURE GROUNDWATER RECHARGE: EVAPOTRANSPIRATION RESPONSE OF NATURAL VEGETATION TO CLIMATE CHANGE

VOORTMAN, BERNARD R.[1] (BERNARD.VOORTMAN@KWRWATER.NL); BARTHOLOMEUS, R.P.[1]; WITTE, J.P.M.[1,2]

[1]KWR Watercycle Research Institute, The Netherlands
[2]Vrije Universiteit Amsterdam, Institute of Ecological Science, Department of Systems Ecology, The Netherlands

In The Netherlands, climate change is likely to cause longer periods of drought, wetter winters and high intensity rain showers. These changes will affect the water balance, freshwater availability and the spatial distribution and type of vegetation. Vegetation characteristics that determine evapotranspiration, like vegetation coverage, biomass and water use efficiency, may alter due to climate change and may subsequently affect groundwater recharge. Future groundwater recharge can only be assessed if we understand how vegetation responds to changing climatic conditions.

Our study focuses on coastal and inland sand dunes of The Netherlands. We hypothesize that in these regions prolonged periods of drought will lead to a larger cover fraction of non-rooting plants (mosses and lichens) and bare soil. This vegetation feedback will reduce the effects of meteorological drought on groundwater recharge by reducing transpiration. Our simulations show that groundwater recharge may even increase in the future climate due to this vegetation response.

We pursue a modeling approach to simulate dynamically the response of vegetation to climate change and the impact on groundwater recharge. Hereto, we will first determine evapotranspiration characteristics for different plant species. Special attention will be paid to the interception evaporation of mosses which may occupy large areas in coastal an inland sand dunes. Secondly, field experiments will be used to relate water stress to cover fractions of different plant functional types. Thirdly, we will assess the significance of vegetation patchiness on soil moisture contents, as the vegetation structure or patchiness may cause radial unsaturated flow from barren surfaces to rooting plants. Fourthly, we will analyze climate change effects on soil organic matter contents. Finally, this will lead to a robust, dynamic model that takes account of climate change effects on vegetation and soil physical characteristics, required to estimate future groundwater recharge.

LAND USE AS A STRESS FACTOR TO SOIL DIVERSITY AND ITS PROTECTION IN CHINA

WEI, SHANGGUAN[1] (SHANGGV@GMAIL.COM); PENG, GONG[2]; LU, LIANG[3]; YONGJIU, DAI[1]

[1]State Key Laboratory of Land Surface Processes and Resource Ecology, College of Global Change and Earth System Science, Beijing Normal University, China
[2]The State Laboratory of Remote Sensing Science, Institute of Remote Sensing, CAS, China
[3]College of Global Change, Tsinghua University, China

With the largest population in the world, China is facing with great pressures on land resources. Many parts of China have been dramatically converted to agriculture and construction land uses, which raised growing recognitions of soil resource shortage. The government and the scientific community have a common sense of protecting China's limited soil resources. However, the decision on what and where to do soil protection is difficult to make due to a lack of assessment of the level of soil disturbance in the entire country. Here we employ a GIS-based approach to assess the human impact on soil diversity in China. We find that 7.5% of natural soils in China are in danger of substantial loss, due to agriculture and construction(Fig. 1.). 231 anthropogenic soils, which occupy about 12% of the nation's total soil area, have already replaced the original natural soil(Fig. 2.). Most of the endangered soils are unprotected due to the negligence of soil function, especially when nature reserves and ecological function zones are established and planned. The distributions of endangered soils and plants in China are quite different. However, they are all located in the vicinity of areas with high human impacts.

TEMPORAL VARIATION OF SOIL HYDRAULIC PARAMETERS AFFECTED BY LAND USE

Kashkuli, H.A. [1] (kashkulihda@gmail.com); Zeinalzadeh, K.[2]

[1]Deptartment of Irrigation , Science and Research Branch, Islamic Azad University ,Khouzestan- Iran.
[2]Ph. D student. Department of Irrigation and Drainage, Shahid Chamran University, Ahwaz, Iran.

Keywords: Soil hydraulic conductivity, pore size distribution, Disc infiltrometer, temporal variability, Land use

Soil hydraulic conductivity (K) and the pore size distribution parameter (Gardner α) are important hydraulic parameters for understanding some aspects of unsaturated soil water flow. These parameters vary with time as well as spatial position. For investigating these changes, field measurements using disc infiltrometer at pressure heads of −15,-10,−6,-4,−3, and 0 cm were performed three times from June to August in 2009 on four fields under different land uses as winter barley, silage single cross corn, apple orchard, and unused bare land in agricultural fields of Urmia university, Iran. Five replicate sequences of infiltration rate tests were conducted for each measurement set and land use. Soil at these sites was classified as Clay. The study was conducted employing split plot in time experiment. Results of ANOVA showed that land use, time and the relative contributions of both had significant impact at one percent level on K values (except at pressure head of -15 cm). At pressure head of -15 cm, the average k displayed significant variation at five percent level. Therefore, land use and time showed the least impact on K15. Gardner α had a significant difference at one percent level with respect to land use and time, but showed no significant difference at five percent level with respect to the relative contributions of both. Results of this study showed that the initial soil moisture has an important role on the rate of temporal variation of k.

Theme 3
Biodiversity

SPATIAL DIVERSITY PATTERNS IN FOREST SPRINGTAIL (COLLEMBOLA) COMMUNITIES

AHLBÄCK, LINA (LINA.AHLBACK@SLU.SE)

Department of Ecology, Swedish University of Agricultural Sciences, Sweden

Keywords: Collembola, species diversity, spatial

In most landscapes a substantial amount of the regional diversity (gamma-diversity) is not explained by high local diversity (alpha-diversity) but instead by turnover of species between sites and habitats (beta-diversity). Natural patterns of alpha- and beta-diversity are for many organisms largely unknown. There is also a lack of knowledge on the relative importance of space compared to environmental factors, for regional diversity patterns. One of the taxonomically and ecologically best known groups of soil animals are springtails (Collembola). In Scandinavia, the species are well known, but ecological investigations have only been conducted at a small number of sites. Hence there is enough background knowledge but presently too little data to examine patterns of diversity, as well as the relative importance of space, which is the main aim of this study.

I looked at the effect of spatial distance on the difference in diversity and community composition of Collembola (springtails) at a small local scale (5*20 meter). Within the plot 100 soil samples were taken in an irregular grid design. Abiotic (pH, water content etc.) and biotic (ground cover vegetation, distance to trees) variables were measured in each sampling point. Semi-variograms are created to enable detection of spatial patterns and to create kriging maps to visualize these.

Scaling up to a regional scale, the large-scale diversity patterns in relation to space will be examined for mature pine forest stands. The sites are located at several distances from each other, distributed across central Sweden and southern Norway. Sites are kept as homogenous in habitat characteristics as possible to isolate the spatial distance component from other environmental factors. To determine the importance of environmental and spatial processes in structuring the Collembola community the variation of the community data is partitioned into unique components (spatial, abiotic and biotic) using partial canonical ordination.

FUNCTIONAL TRAITS OF SNAILS ON ISLANDS

ASTOR, T.[1] (TINA.ASTOR@SLU.SE); BERG, M.[2]; LENOIR, L.[1]; STRENGBOM, J.[1]; BENGTSSON, J.[1]

[1]Department of Ecology, Swedish University of Agricultural Sciences, Sweden
[2]Department of Animal Ecology, Vrije Universiteit Amsterdam, The Netherlands

It is generally known that island area, isolation and habitat heterogeneity are important factors contributing to species diversity on islands. Often, island area is found to be the single most important determinant of species diversity but the mechanisms behind this relationship are still discussed. Functional traits are potential candidates to improve the mechanistic understanding of species distribution and community assembly among varying environmental conditions. I have analyzed land snail community data from 17 islands on the lake Mälaren in central Sweden together with information on species functional traits. The islands are mainly covered with mature forest vegetation and showed no signs of recent disturbance. Information on morphology, physiology, reproduction, feeding strategy, macro-and micro site preference of the snails was extracted from a data base. These traits can be divided into dispersal traits and persistence traits. The main aims were a) to identify functional traits suitable to explain the distribution of snail species along an island area/isolation gradient b) to test if there is a different distribution pattern of dispersal vs. persistence traits and c) to test if the addition of traits improves the explanation of the species-area relationship. RLQ analysis and linear regression methods were used to approach these questions. The first preliminary results suggest that there is a significant association between certain traits and island parameters.

SPRINGTAIL DIVERSITY AND PLANT DECOMPOSITION IN THE FYNBOS BIOME, SOUTH AFRICA

BENGTSSON, JAN[1] (JAN.BENGTSSON@EKOL.SLU.SE); JANION, CHARLENE[2]; CHOWN, STEVEN L.[2]; LEINAAS, HANS PETTER[3]

[1]Department of Ecology, Swedish University of Agricultural Sciences (SLU), Sweden
[2]Centre for Invasion Biology, Department of Botany and Zoology, Stellenbosch University, South Africa
[3]Integrative Biology Group, Department of Biology, University of Oslo, Norway

The Cape Floristic Region (CFR) in South Africa is one of six floristic kingdoms, and known as a hotspot for vascular plant biodiversity. Fire is thought to be the main contributing factor for litter breakdown and nutrient release in the CFR. We studied soil animal (springtail) diversity and plant decomposition in two vegetation types in the CFR, fynbos and renosterveld. We used litterbags containing litter of different plant species representing the major plant life forms to sample springtails and measure decomposition over 180 days during the South African winter.

Decomposition rates varied more than 10-fold between plant species, and several common species had litter half-lives of less than 1 year. This variation suggests that importance of biological decomposition in the Fynbos biome may have been underestimated previously.

In fragmented renosterveld in an agricultural landscape, many of the approx. 15 morphospecies of Springtails were undescribed, and more than half of the individuals comprised the invasive species Hypogastrura manubrialis. This is attributed to the species being favoured by the shrub species yellowbush (Galenia africana), which has litter with high nutrient content, is easily decomposed, and is favoured by disturbance such as overgrazing.

Preliminary results from other sites suggest that similar to plant diversity, soil biodiversity (as indicated by springtail richness) is also high in the CFR.

PUTTING SOIL MANAGEMENT IN A LANDSCAPE CONTEXT FOR ECOLOGICAL INTENSIFICATION OF AGRICULTURE

BIANCHI, FELIX[1] (FELIX.BIANCHI@WUR.NL); PULLEMAN, MIRJAM[1]; BRUSSAARD, LIJBERT[1]; JACKSON, LOUISE[2]

[1]Wageningen University, Soil Quality Department, The Netherlands
[2]University of California, Dept. of Land, Air and Water Resources, The United States

A greater role for biodiversity in agricultural fields and landscapes can support a range of ecosystem services and reconcile food security with the sustainable use of biodiversity. To acquire a better understanding of the opportunities for the transition towards more ecologically-based management of agricultural fields and landscapes, agricultural practices and their scope for 'ecological-intensification' (EI) are being evaluated at 8 benchmark sites around the world. These sites are located in Indonesia, India, Burkina Faso, Brazil, Mexico, USA and The Netherlands and capture gradients of intensification and different socio-economic conditions. Priority interventions at field and landscape scale have been identified across all sites, including the stimulation of beneficial soil biota in agricultural fields. Ecologically based soil management may impact on crop production and water quality in different ways. It can affect soil ecosystems services related to nutrient and water dynamics and may also increase above-ground pest regulation by soil-bound predators (e.g. ants and carabid beetles), support the food chain as many predators (e.g. birds) rely on soil-borne prey, and may increase landscape connectivity for organisms that are sensitive to agrochemicals, vegetation structure and microclimate. Ongoing participatory research focuses on the design and evaluation of a variety of management practices aimed at enhancing belowground biodiversity and synergies between multiple ecosystem services, and puts soil management in a landscape perspective. This knowledge will help to guide research and investments in the transformation towards sustainable agricultural production systems that are high-yielding and environmentally sound.

RHIZOSPHERE EFFECTS ON SOIL MICROBIAL ACTIVITY

BROLSMA, KARST (KARST.BROLSMA@WUR.NL); DE GOEDE, RON; HOFFLAND, ELLIS; VONK, ARIE

Wageningen University, Dept. Soil Quality, The Netherlands

Aims and Background

Plant root exudates, the production of mucilages and the release of sloughed-off root cells affect the rhizosphere microbial community and activity. We profiled the microbial activity in the rhizosphere using the MicroResp™ system to see if these effects are plant specific

Methods

Brassica juncea cultivars with different glucosinolate content were used in a field experiment on a sandy soil in Münster, Germany (2010). Glucosinolates are secondary plant metabolites and precursosrs of potentially toxic compounds. After flowering cultivars were chopped and incorporated into the soil. Rhizosphere and bulk soil samples were taken during growth and after incorporation of the cultivars. Five carbon substrates were added separately to the soil samples and microbial CO_2 production was measured.

Results

We showed that decomposition rates of certain substrates are different between bulk soil and rhizosphere and amoung rhizosphere samples of various cultivars. Future research should focus on the selection of carbon substrates for better distinction in respiration response of the microbial community and improving the sampling techniques to reduce variation in the respiration measurements.

Conclusion

The MicroResp method is capable of identifying cultivar differences in rhizosphere respiration and differences between rhizosphere and bulk soil.

INDICATORS OF SOIL BIODIVERSITY FROM NATIONAL PERSPECTIVES TO EUROPEAN POLICY

CREAMER, RACHEL[1] (RACHEL.CREAMER@TEAGASC.IE); BLACK, HELAINA[2]; RITZ, KARL[3]; GRIFFITHS, BRYAN[1]

[1]Teagasc, Ireland
[2]James Hutton Institute, United Kingdom
[3]National Soil Resources Institute, Cranfield University, United Kingdom

The development of biological indicators for the assessment of change to soil quality has become an increasingly important research agenda item. This emphasis is logical since the soil biota is the driving force behind many soil functions including nutrient transformations, water purification, C-sequestration and soil structural dynamics. There is a substantial amount of information available concerning the measurement and implementation of soil biological indicators for the assessment of soil quality; from small-scale field trials up to national-scale studies (Black et al., 2003; Rutgers et al., 2009). At a European level (Bispo et al., 2009) initiatives have been taken to promote the use and standardisation of such indicators. Currently there are over 15 European Member States which have collected soil biological data as part of a monitoring programme. However, this information has been derived from specific environmental situations using a wide range of methods, which challenges effective comparison and integration of such data. The European Union are increasingly prescribing the need for standardised information to provide the foundation for integrated assessments of soil biodiversity and soil quality. To achieve this, measurement of biological indicators need to be consistently applied, with standardised methodologies which can be validated across a range of environmental and climatic conditions. Approaches and results from four large-scale research projects are here reviewed in this context, viz. (i) the SQID project (UK) which investigated the sensitivity and discrimination power of 9 biological indicators across a range of land-uses; (ii) the ENVASSO project which proposed a set of suitable indicators for monitoring the decline in soil biodiversity across Europe; (iii) the Ecofinders project which is assessing the standardisation of biological indicator methodologies, to be implemented and tested in several counties across Europe; (iv) a soil respiration study which assessed the ISO basal respiration methodology across a range of climatic zones within Europe.

PEATLAND DEGRADATION PROCESSES IN THE MEDITERRANEAN KARST REGION OF BOSNIA AND HERZEGOVINA

CUSTOVIC, HAMID (CUSTOVIC.HAMID@GMAIL.COM); TVICA, MIRZA

University of Sarajevo, Bosnia and Herzegovina

Peatland degradation processes in the Mediterranean Karst region of Bosnia and Herzegovina Dr Hamid Custovic , Mr.sc Mirza Tvica Livanjsko Polje, (term „polje" usually represent closed depressions in karst area draining underground, with flat floors),is one of the most specific natural phenomena of Bosnia and Herzegovina, representing the typical landscape features of the Karst. It is the largest Karst polje worldwide and also the largest wetland of Bosnia and Herzegovina, as more then two thirds are regularly flooded. The cultural landscape and main habitats this area are still in very natural and semi-natural state. The uniqueness of Livanjsko Polje and its global ecological value, according the criteria of the Ramsar Convention (size, vegetation, indicator as the Corn Crake), but also of the ecological values of the other surrounding Karst poljes in the upper parts of the Cetina River Basin, have as the facts have to be integrated into the UNEP study (2000) and in the spatial development model based on the existing sectoral plans. The clear visible impacts endangering the ecological and hydrological functions of Livanjsko Polje are: a) use of water for energy production including a canal system near Livno; b) peat excavation and drainage on the peatland Ždralovac in the NE part of Livanjsko Polje, and c) the planned meliorations cited in the UNEP study (2000). On the peatland Ždralovac (3615 ha) local firm responsible for peat excavations regulates and drains the peatland and heavily impact not only the unique flora and fauna of this site but also the entire hydrological system including the water supply in downstream area. Any drainage system or regulation of natural water regime could lead to subsidence of peat column, change of vegetation, and the mineralization processes that will release nutrient from the mire as well as carbon dioxide. Also, drainage produce shortage of water in summer and increase desiccation of Dinara cave system as well as remaining downstream wetland site in Croatia.

THE ROLE OF BIODIVERSITY FOR THROUGHFALL KINETIC ENERGY IN SUBTROPICAL FOREST ECOSYSTEMS

GEIßLER, CHRISTIAN[1] (CHRISTIAN.GEISSLER@UNI-TUEBINGEN.DE); NADROWSKI, KARIN[2]; BARRUFOL, MARTIN[3]; KÜHN, PETER[1]; SCHOLTEN, THOMAS[1]

[1]University of Tuebingen, Germany
[2]University of Leipzig, Germany
[3]University of Zurich, Germany

Throughfall kinetic energy (tKE) was measured in a species rich subtropical forest ecosystem in SE-China as part of BEF-China (www.bef-china.de, Bruelheide et al. 2010). For estimation of tKE we used calibrated splash cups (Scholten et al., 2011). The splash cups were positioned under secondary natural forests in Gutianshan National Nature Reserve. These forests are extraordinarily rich in species with 148 woody species in total and 25 to 69 species per plot. Fifteen splash cups were positioned randomly under the canopy in the study plots (each 30x30m in size). The study plots were selected along a biodiversity and successional gradient. Data were obtained during eight rainfall events in 2009 and 2010. The data were analyzed using linear mixed effects models. Results show a significant effect of biodiversity on tKE. An increase of tKE with tree age and weighted mean tree height of the plots could be detected. Contrarily, tKE decreases with increasing LAI measured in the plots. Data analysis showed rainfall amount and intensity to be the strongest effects on tKE. The effect of biodiversity and other forest stand variables on tKE may differ, depending on the amount and intensity of rainfall. These results suggest a strong interrelation between biodiversity and kinetic energy of throughfall in subtropical forests. This could help to improve soil erosion models as well as afforestation measures in order to prevent soil erosion.

TOWARDS A PREDICTIVE MODEL OF SOIL AND RHIZOSPHERE PHOSPHORUS AVAILABILITY

GERARD, FREDERIC (GERARD@SUPAGRO.INRA.FR); DEVAU, NICOLAS; DUPUTEL, MAREK; JAILLARD, BENOIT; HINSINGER, PHILIPPE

INRA, France

Phosphorus (P) is limiting plant growth in many soils. Inorganic fertilisation has been massively used after world-war II in order to ensure high crop productivity by increasing soil P availability. However, the perspective of scarcity of the P-ore (phosphate rock) reserves and the negative side effects of P fertilization (e.g. eutrophication) urge to find an alternative. An option is to rely on naturally occurring interactions between roots and soil constituents in the rhizosphere. Such root-induced processes can promote P availability and thereby enhance or at least maintain crop productivity under reduced P fertilizer input. Different root-induced processes have been reported for their ability to increase P availability. The release of protons/hydroxyls in response to unbalanced uptake of cations and anions (e.g. Hinsinger, 1998) and the release of organic ligands (e.g. Ryan et al., 2001) are often considered as most important. Dissolution/precipitation and/or adsorption/desorption are the soil processes recognized for their control of P availability. The precipitation of P minerals has been largely reported in soils subjected to inorganic P fertilization, especially in calcareous soils, while adsorption/desorption would control P availability at low concentrations (e.g. Tunesi et al., 1999). However, little is known about the interactions occurring within the rhizosphere. Their promoting influence has been sparsely demonstrated and understood at a mechanistic level. A good understanding of both soil and root processes is required for that. Furthermore, the influence of global changes should be accounted for in order to anticipate their effects on P availability. Mechanistic modelling can be profitably used for those purposes, by enabling us to determine the nature of the controlling processes and mechanisms in rhizosphere, and by supplying a tool with reliable predictive capabilities. The present communication is aimed at reviewing recent works that proposed a mechanistic equilibrium model for simulating P availability in soil and rhizosphere (e.g. Devau et al., 2010). The predictive capacity of the model was demonstrated by modelling P availability as measured over a range of pH values and salt concentrations in soils exhibiting contrasted mineralogical composition. The major interest of the model for assessing the nature of the controlling processes and to determine the key mechanisms was also demonstrated through its applications to the rhizosphere of a crop species: durum wheat. A new root-mediated process was found to play a key role, the uptake of Ca ions, which markedly increased P availability in the rhizosphere as pH increased. This is an important finding as Ca is an essential element and a major nutrient for all plant species (White and Broadley, 2003). This communication will end up with application perspectives, such as to other important crop species as grain legumes, where the influence of low molecular weight organic ligands on P availability may be more important (e.g. Pearse et al., 2006).

References

- Devau N., Le Cadre E., Hinsinger P., and Gerard F. (2010) A mechanistic model for understanding root-induced chemical changes controlling phosphorus availability. Annals of Botany 105, 1183-1197.
- Hinsinger P. (1998) How do plant roots acquire mineral nutrients? Chemical processes involved in the rhizosphere. Advances in Agronomy 64, 225-265.
- Pearse S. J., Veneklaas E. J., Cawthray G. R., Bolland M. D. A., and Lambers H. (2006) Carboxylate release of wheat, canola and 11 grain legume species as affected by phosphorus status. Plant and Soil 288, 127-139.
- Ryan P. R., Delhaize E., and Jones D. L. (2001) Function and mechanism of organic anion exudation from plant roots. Annual Review of Plant Physiology and Plant Molecular Biology 52, 527-560.
- Tunesi S., Poggi V., and Gessa C. (1999) Phosphate adsorption and precipitation in calcareous soils: the role of calcium ions in solution and carbonate minerals. Nutrient Cycling in Agroecosystems 53, 219-227.
- White P. J. and Broadley M. R. (2003) Calcium in plants. Annals of Botany 92, 487-511.

HOW DO DIFFERENT EARTHWORMS SPECIES CHANGE NEMATODE COMMUNITY STRUCTURE?

GRABCZYŃSKA, OLGA[1] (OLGA_GRABCZYNSKA@CBE-PAN.PL); MAKULEC, GRZEGORZ[1]; UVAROV, ALEXEI[1,2]; ILIEVA-MAKULEC, KRASSIMIRA[1]

[1]Polish Academy of Sciences Centre for Ecological Research in Dziekanów Leśny, Poland
[2]Institute of Ecology and Evolution, Russian Academy of Sciences, Russia

Biostimulation is receiving now a lot of attention. One of the organisms used in biostimulation are earthworms but their introduction beside improving soil proprieties also change abundance and diversity of soil fauna. In a field experiment three earthworm species from different ecological group – *Lumbricus rubellus*, *Lumbricus terrestris* and *Apporectodea caliginosa* – were introduced to mesocosms. After five months abundance, trophic structure and genre composition of nematodes in litter were determined. All earthworm species decreased nematode abundance significantly comparing to control. Decrease observed in *L. terrstris* treatment was the most severe and differed also from results observed in *A. caliginosa* treatment. In all treatments proportion of bacteriovorous and fungivorous decreased significantly in all treatments. Proportion on plant feeders and omnivorous was significantly reduced in presence of *L. terrestris*. Also *A. caliginosa* reduced proportion of omnivorous nematodes.

In presence of earthworms nematodes from genera *Cervidellus* and *Prismatolaimus* were absent. Characteristic only for *L. rubellus* treatment were genera: *Chiloplacus, Panagrolaimus, Paraxonchium* and *Tylenchus*. Specimens from genus *Acrolobus* were only found in *L. terretris* treatment. Only in presence of *A. caliginosa* were nematodes from genus *Mesorhabditis* and genus *Microdorylaimus* were found. Also proportions of nematode genera was affected by earthworm species. Proportion of *Alaimus* was significantly higher in *L. terrestris* than *A. caliginosa* treatment. Proportion of *Aphelenchoides* was significantly decresed in presence of *L. terretris*, while proportion of *Drilocephalobus*, *Eucephalobus* and *Filenchus* significantly increased. Proportion of *Metateratocephalus* was significantly decreased in *L. rubellus* treatment. In case of *Heterocephalobus* all treatments differed from each other.

To check whether reduction of nematode abundance was caused only by the reduction of quantity of litter or is an effect of specific earthworms praying food choice experiment was conducted. As a food sources dried litter with agar, colonies of soil bacteria on agar, colonies of soil fungi on agar, pure agar as a control and pure agar with addition of known number of nematode specimens. Differences in consumption (grams of consumed by earthworm food/ fresh biomass of earthworm) of different food sources were compared. *L. rubellus* and *A. caliginosa* reduced significantly amount of litter. *L. terrestris* consumed significantly more nematodes and litter comparing to agar with bacteria but also consumption of litter was significantly higher then consumption of nematodes. *L. terrestris* in compare to consumed significantly higher amount of nematodes and litter than *L. rubellus* and *A. caliginos*a.

Results for *L. rubellus* and *A. caliginosa* suggest that most of earthworm species consume nematodes accidentally while searching in soil or litter for spots rich in organic matter. Case of *L. terrestris*, species that decreased nematodes the most severely in the field experiment, is more complicated – it is possible that specimens of *L. terrstris*, beside consuming nematodes with litter, selectively choose them as a pray.

The study was supported by the grants of Polish Ministry of Science and Higher Education (2P04F03030 and N N304 402038).

CONSEQUENCES OF MICROBIAL SPECIES LOSS FOR AGRICULTURAL SOILS UNDER DIFFERENT MANAGEMENT INTENSITIES

HOL, GERA[1] (G.HOL@NIOO.KNAW.NL); DE BOER, WIETSE[2]; VAN DER PUTTEN, WIM[3]

[1]Terrestrial Ecology, The Netherlands Institute of Ecology, The Netherlands
[2]Microbial Ecology, The Netherlands Institute of Ecology, The Netherlands
[3]Nematology Laboratory, Wageningen University, The Netherlands

Microbial communities are crucial for soil ecosystem services such as nutrient cycling and disease suppressiveness. In a greenhouse experiment agricultural soil with manipulated microbial communities was used to test the impact of microbial species loss for intensively and extensively managed agro-ecosystems (grassland, a crop rotation and an intensive wheat rotation). The hypothesis is that diverse microbial communities are less sensitive to species loss due to redundancy among microbial species. Triticum aestivum plants were grown on these manipulated soils. The evaluated functions were primary production and pest development. Effects of microbial diversity loss on primary production varied with management intensities. Plants on grassland soils tended to have a lower biomass production after microbial species loss, whereas the reverse was observed for some of the crop rotation and intensive wheat rotation soils. Nutrients levels in soil varied according to management intensity, but were not affected by species loss. Effect of microbial species loss on aphids was observed for grassland soil, but spatial variation had considerable larger effects than microbial species loss. Interactions between management intensities and species loss, in combination with spatial variation and the varying responses of the different functions hampers the evaluation of microbial diversity for functioning of agricultural soils. Prediction of the consequences of microbial species loss is only possible when we know which microbial species are present, what their interactions with each other are, what their function is and which species are vulnerable to disturbance.

ARE EARTHWORMS GOOD OR BAD FOR THE SOIL GREENHOUSE GAS BALANCE?

LUBBERS, INGRID[1] (INGRID.LUBBERS@WUR.NL); FONTE, STEVEN[2]; BRUSSAARD, LIJBERT[1]; VAN GROENIGEN, JAN WILLEM[1]

[1]Soil Biology and Biological Soil Quality Group, Wageningen University, The Netherlands
[2]College of Agricultural and Environmental Sciences, University of California, The United States

The soils of the world are a major source of greenhouse gases (GHG's). Terrestrial ecosystems have contributed as much as half of the anthropogenic carbon dioxide (CO2) emission over the past two centuries and soils are by far the dominant source of nitrous oxide (N2O) emissions. Yet, soils can also be a GHG sink through C-sequestration and biological reduction of N2O. The GHG balance of the soil therefore depends on soil management. Land use conversion from conventional tillage to reduced or no-tillage systems stimulates activity of soil engineers such as earthworms. It has been suggested that earthworm activity can result in stabilization of fresh organic C in soil organic matter. However, several studies reported detrimental effects of earthworms on the soil GHG balance: increasing emissions of N2O and CO2. Here, we report on a meta-analysis and an experiment to study these effects. The meta-analysis quantified earthworm effects on the soil GHG balance, including C-stabilization and emissions of N2O and CO2. Overall, earthworm activity significantly increases N2O and CO2 emissions. No proof was found that they increase soil organic matter. The available data was fragmentary and measurements were often indirect, of short duration, and under controlled laboratory conditions. Knowledge gaps that need to be addressed are (i) direct measurement of C-stabilization over longer time periods, and (ii) field-based studies on N2O effects. To address the first knowledge gap, we installed a 2.5-year mesocosm experiment in which 15N-labeled maize (Zea mays L.) residue was regularly applied to the soil in the presence or absence of earthworms. We quantified N2O and CO2 emissions as well as C stabilization. After 1.5 years, cumulative emissions of both N2O and CO2 increased in the presence of earthworms, and C stabilization decreased. Our preliminary results therefore suggest a detrimental role of earthworms on the soil GHG balance.

UNDERSTANDING HOW THE ABOVEGROUND COMMUNITY MODULATES THE BELOWGROUND COMMUNITY WITH REGARD TO PHOSPHORUS INCORPORATION AND UTILISATION

MASSEY, PAUL[1,2] (P.MASSEY@CRANFIELD.AC.UK); CREAMER, RACHEL[1,2]; RITZ, KARL[2]; WHELAN, MICHAEL[2]

[1]Johnstown Castle Environmental Research Centre, Ireland
[2]Cranfield University, United Kingdom

The soil biota provides a crucial ecosystem function in agricultural soils by promoting nutrient cycling. Their ability to act as a nutrient sink for the plant community is intricately linked to increased yield in grassland systems.

The objective of this study was to investigate how different botanical communities effect the processing of phosphorus (P) by belowground communities. To investigate this we set-up a mesocosm trial, that incorporated; 1) three treatments of vegetation (bare soil, grass monoculture and 4 species polyculture), 2) presence or absence of earthworms and 3) fertilisation via organic or inorganic amendment.

The experiment was run over a 12 month period and consisted of 30 (27 x 38 cm, 30 cm) large mesocosms, which represented 3 replicates for each of the above treatments. To ensure a gradient in phosphorus content relative to that found in the field, two soils were selected with contrasting P concentrations. The mean Olsen P concentration for 0-1 cm was 29.2 mg/kg and for the remaining 29 cm 3.9 mg/kg. Soil from the two sites was sieved to 4 mm to ensure removal of earthworms and baseline analyses were completed for microbial biomass P, C and N, nematode trophic groups, pH, organic matter and phosphorus content. Vegetation treatments were sown and once established earthworms (epigeic and anecic species) and fertiliser (inorganic 16% superphosphate or dairy slurry) were added to the appropriate mesocosms.

Microbial biomass C, N and P and Olsen P were determined using chloroform fumigation extraction at three depth intervals (0-1, 1-5 and 5-10 cm) to investigate the vertical mixing of phosphorus in the most biologically active depth of the mesocosm. Nematodes samples (0-10 cm) were extracted by elutriation followed by further extraction using Baermann funnels. Nematodes were identified to family and into feeding groups using a compound microscope. Plant yield and P concentrations were determined every six weeks once plants were fully established.

This experiment produced a plethora of results. Inorganic phosphorus amendment resulted in greater plant P content compared to the organic application. A vegetation effect was also observed with significantly greater plant phosphorus content in the polyculture treatments, both these observations were affected by sampling date. The presence of earthworms resulted in greater Olsen-P incorporation throughout the top 10 cm; however, no treatement effects were observed on the vertical distribution of microbial biomass P. Data obtained from this study facilitates our understanding of the role of soil organisms in the redistribution and utilisation of P.

IMPACT OF FERTILIZATION HISTORY OF GRASSLANDS ON APPARENT NITROGEN RECOVERY FROM RECENTLY APPLIED SOLID CATTLE MANURE

RASHID, MUHAMMAD IMTIAZ (MUHAMMAD.RASHID@WUR.NL); LANTINGA, EGBERT A.

Biological farming systems group, Department of plant sciences, Wageningen University and Research Centre, The Netherlands

Keywords: mineral N fertilizer, soil pH, immobilization, bacterial activity

Long-term application of solid cattle manure (SCM) usually not only builds up soil organic matter content but also the soil mineral nitrogen (N) supply. However, within this context it is not clear yet whether fertilization history of grasslands affects the N dynamics of recently applied SCM and therefore its short-term apparent N recovery (ANR). To test this, we selected two dairy farms on peat soil which differed both in type of home-produced and applied cattle manure, and the use of artificial fertilizer. Already for a number of decades, farm A is characterized by the application of slurry and artificial N fertilizer, whereas on farm B only organic N-rich slurry and partly composted SCM are being used. We measured on both farms for one growing season herbage ANR of the SCM from farm B after surface spreading in spring (200 and 400 kg N ha^{-1}). Besides, soil pH, bacterial biomass and its activity were monitored. Remarkably, on farm A herbage ANR was not different from zero at both application rates, whereas on home-farm B, ANR values were around 27% of the applied N_{total}. This observation was accompanied by a decreased soil pH-KCl (down to 4.4), and a

much lower bacterial biomass and activity on farm A compared to farm B. This can be attributed to N immobilization of the recently applied SCM from farm B on farm A. It is wellknown that long-term applications of artificial N fertilizers and slurries rich in mineral N lead to a decrease in soil pH. At a soil pH value below 4.5 this will hamper especially the activity of bacteria and thus the soil N availability to plants. In conclusion, our study clearly demonstrates that fertilizer input history indeed affects the herbage ANR by influencing the soil pH and the activity of soil organisms in the belowground foodweb. Above all, this finding has large consequences for evaluating the short-term fertilizer value of SCM in comparative trials.

LAND USE AROUND ATLANTIC FOREST PARKS (SP, BRAZIL)

RITTL, TATIANA (TATARITTL@GMAIL.COM); COOPER, MIGUEL; BALLESTER, MARIA; HECK, RICHARD

University of São Paulo, Brazil
University of Guelph, Canada

Over time, human interventions can change the function and structure of landscapes. These changes, in the use and land cover, can be observed in landscape patterns. The Atlantic Forest of Brazil has historically been degraded by unsustainable development policies. Currently only 9% of this biome remains throughout the country. In the state of São Paulo, approximately 795, 0004,569.38 ha are protected within Conservation Units. However, the quality of these protected areas is threatened by lack of planning in their surroundings. The Rapid Assessment and Prioritization of Protected Area Conservation (RAPPAM) is a methodology that enables identification, and prioritization, of vectors of human pressure in the surroundings of Protected Areas. This study aimed to characterize human activities that are exerting pressure on the Alto Ribeira Tourist State Park (PETAR), and compare them with the vectors of pressure that are threatening the conservation of three other protected areas of the Atlantic Forest in the state of Sao Paulo. The results show that the main activities that put pressure on PETAR are the same activities that are endangering the conservation units; these are mining, rural occupation, illegal harvesting for palm-heart and forestry.

HYDROLOGICAL AND THERMAL REGIMES OF COMPLEX SOIL COVER

SHEIN, EVGENY[1] (EVGENY.SHEIN@GMAIL.COM); KUZNETSOV, MIKHAIL[2]; TROSHINA, OLGA[1]

[1]Moscow State University, Russia
[2]Ben-Gurion University of the Negev, Israel

Complex soil cover has peculiarities of paleocryogenic soilscape such as areas with high organic matter content (loose zones) and compacted soil. Typically soil density varies from 0.73 g/cm3 to 1.54 g/cm3 in the arable layer and from 1.0 g/cm3 to 1.68 g/cm3 at the depth of 35-40 cm. Organic carbon content varies from 1.36% to 2.98% and from 0.23% to 4.65% in the arable layer and 35-40 cm layer, respectively. Spatial patterns of the compact and loose zones create a specific structure in water and temperature distribution. Objective of the study was to identify the spatial distribution in soil water and thermal regimes and to relate regimes to zones with different soil density. Soil water and thermal regime monitoring was conducted during 5 years at different temporal and spatial scales (from 0.01 to 4 ha). Temperature measurements showed that the loose soil layers were slowly warmed up during spring and summer months and became cold in winter due to low thermal diffusivity. The loose horizon accumulates and conserves more water during wet periods and becomes dryer during drought periods, compared to the compacted horizons. The results of the monitoring illustrate spatial variability of the hydrothermal fields in the studied area and its relationship with locations of the compacted and loose soil zones. For the quantitative assessment of the regimes pedotransfer functions were developed to calculate soil water retention, hydraulic conductivity, thermal diffusivity from soil bulk density and soil organic carbon content. Good agreement was obtained between measured and estimated with the pedotransfer functions water content and temperature distributions in the soil.

IMPACT OF COCOA CULTIVATION ON SOIL HEALTH IN IVORY COAST: A CHRONOSEQUENCE STUDY

TONDOH, JEROME EBAGNERIN[1] (J.E.TONDOH@CGIAR.ORG); GUEI, ARNAUTH MARTINEZ[2]

[1]CIAT-TSBF IER CRRA Sotuba, Mali
[2]UFR des Sciences de la Nature/Centre de Recherche en Ecologie, Ivory Coast

Keywords: Cocoa plantations, soil health, physical and chemical characteristics, earthworm diversity, standing litter

Land degradation due to cocoa farming systems is a serious threat to agricultural productivity and environment conservation in Ivory Coast, the largest cocoa producer in the world. In the humid and sub-humid areas of the country where most of plantations are located, after 15 to 20 years of cultivation, landscapes result in degraded lands with low productivity and significant biodiversity loss. However, very few studies have been undertaken to quantify the effect of cocoa farming systems on the extent, magnitude and process of soil degradation of areas in the country. The main objective of this study was to assess the impact of forest conversion into cocoa-based cropping systems on soil health by measuring chemical, physical properties in the topsoil (0-10 cm) and earthworm diversity along a chronosequence of different ages (5, 10 and 20 years). Results showed that soil pHH20 experienced a short increase after forest conversion into cocoa plantation and reached values similar to the forest over time, after 10 years. Soil bulk density increased significantly with the highest value found under the plantation age of 20 years. Soil C and total N contents declined significantly until after 20 years of cultivation, though the lowest values were obtained after 10 years. Soil C and total N stocks decreased significantly after 10 years with no marked change in 20 year-old plantations. Similarly, exchangeable Ca, Mg and CEC under cocoa plantations declined significantly after 10 years. As for earthworm communities, only Shannon diversity index coupled with the evenness, and the cumulative species richness showed a significant decrease after 10 and 20 years of cultivation. With respect to the standing litter mass, there was a steady increase after forest conversion over time with in parallel, significant impact on C and total N stock in the litter. However, litter characteristics did not influence soil parameters and earthworm diversity.

SOIL BIOLOGICAL QUALITY AFTER 17 YEARS OF CONTINUOUS MAIZE CROPPING WITH AND WITHOUT COVER CROP AND TWO LEVELS OF ORGANIC FERTILISATION

VAN EEKEREN, NICK[1] (N.VANEEKEREN@LOUISBOLK.NL); VAN SCHOOTEN, HERMAN[2]; SCHOUTEN, TON[3]; BLOEM, JAAP[2]

[1]Louis Bolk Institute, The Netherlands
[2]Wageningen University, The Netherlands
[3]RIVM-Lab for Ecological Risk Assessment, The Netherlands

It is well documented that soil biological quality is low in continuous arable cropping compared to permanent grassland or a ley-arable crop rotation. The use of cover crops and organic fertilisation are potential measures to counteract the impoverishment of soil quality. Effects of these treatments were investigated in a 17 year old experiment with continuous maize cropping on a podzolic sandy soil, by measuring a broad range of soil biological parameters. In general, the levels of C and N-mineralisation were low but comparable to other arable fields with continuous cropping. Fungal biomass and bacterial biomass and growth rate were not significantly affected by the treatments. Both potential C-mineralisation and potentially mineralisable-N increased significantly with fertilisation level. Potential C-mineralisation was also higher with the cultivation of a cover crop. Potentially mineralisable N was positively correlated (r=+0.89) with the dry matter yield of the maize. Total number of nematodes was as low as in other experiments with continuous cropping. The nematode community composition was not significantly affected by the treatments, only the cp1-group percentage of nematodes was significantly higher with the fertilisation level. The total number of nematodes was positively correlated (r=+0.90) with dry matter yield of maize. Earthworm abundance was very low and not affected by the treatments. We conclude that soil biological quality of continuous maize cropping on a poor sandy soil cannot substantially be improved by a cover crop or organic fertilisation. To recover the soil biological quality, either a ley-arable crop rotation should be practised or direct sowing techniques with minimal tillage could be used.

LAND USE INTENSITY AND SOIL MICROORGANISMS IN AGRICULTURE

JØRGENSEN, HELENE BRACHT (HELENE.BRACHT_JORGENSEN@BIOL.LU.SE); D'HERTEFELDT, TINA; HEDLUND, KATARINA

Department of Biology, Lund University

Soil and soil biodiversity are the basis of each terrestrial production system. Soil biodiversity is pivotal for delivering ecosystem services as the activities of these organisms provide us with production of provisioning services as food, feed, timber and clean water. Though, in intensively managed agricultural soils the soil biodiversity is reduced. This may be the case for the decomposing microbial community as well, which implies a reduction in ecosystem services provided by these organisms. As a part of a larger EU-project "Soil Service" we have investigated the microbial biomass in agricultural soils managed with different intensities. We have extracted the phospholipid fatty acids in the sampled soil and can thereby measure the biomass of the fungi and the bacteria. Three land use intensities were chosen (winter wheat without lay in the rotation, lay in rotation and permanent grassland) and soil sampling was repeated in 4 different European countries (United Kingdom, Greece, Czech Republic and Sweden). In addition the microbial biomass was investigated in biofuel plantations (Salix or Poplar) as biofuels probably will be incorporated into the agricultural rotation scheme much more in the future.

Generally we find higher microbial biomass in the permanent grassland than in the wheat fields while the microbial biomass varies a lot in the lay. For the Salix plantations in Sweden, which is the data we have so far, no big differences in microbial biomass is found compared to wheat fields.

SOIL MICROBIAL BIOMASS AND ACTIVITY IN ORGANIC HORIZONS OF DECIDUOUS AND CONIFEROUS FOREST SOILS IN THE CZECH REPUBLIC

MALÝ, STANISLAV (STANISLAV.MALY@UKZUZ.CZ)

Central Institute for Supervising and Testing in Agriculture, Czech Republic

Application of soil microbial parameters for the assessment of the capacity of soil to store and transform organic matter requires knowledge how these parameters are related to the environmental properties of a given habitat. The purpose of this study was to reveal how soil microbial biomass and activity in organic horizons of forest soil are influnced by the vegetation cover.

Samples from the F and H horizons were taken on 23 localities (10 deciduous forests, 13 coniferous forests) in the Czech Republic. Soil microbial biomass C (MBC), substrate induced respiration (SIR), ammonification, growth respiration curves after the addition of glucose and eight enzymatic activities along with pH, C_{org}, N_{tot} were measured. Stepwise linear discriminant analysis separated F horizons from H horizons with the higher values of MBC, SIR and the proportion of active microbial biomass (SIR/MBC) in the former one. Soils from deciduous forests showed the higher ability to accumulate organic matter in microbial biomass (MBC/C_{org}) in comparison with soils from coniferous forests. The higher activity of β-glucosidase and phosphodiesterase in the F horizons discriminated them from H horizons and lower activity of β-xylosidase and higher of arylsulphatase in soils from deciduos forests separated localities according to vegetation cover. If MBC was used as a covariable, F and H horizons were undistinguishable by the enzymatic activities.

Theme 4
Governance and Policy

THE SNOWMAN NETWORK: TRANSNATIONAL PROGRAMMING OF STRATEGIC RESEARCH ON SOILS

AGTERBERG, FRANK[1]; BARDY, MARION[2]; DUESO, NADINE[3]; JANSBO, KERSTIN[4]; VAN DEN BULCK, SOFIE[5]; VAN REIJSEN, INGRID[1]; MOOLENAAR, SIMON (SIMON.MOOLENAAR@SKBODEM.NL)[1]

[1]SKB, The Netherlands
[2]MEDDTL/CGDD/DRI/SR, France
[3]ADEME, France
[4]Swedish Environmental Protection Agency, Sweden
[5]OVAM, Belgium

The SNOWMAN Network is a transnational group of research funding organizations and administrations in the field of soil and groundwater in Europe. It started as an EU ERA-NET project in 2004 and has then turned to a self sustained network in 2009.

Initially focused on soil and water management under the pressure of contamination, it recently widened its research agenda to integrate all the soil threats and functions presented by the European Thematic strategy for soil protection. All SNOWMAN partners believe that soil quality management should change from a specific sectoral policy and management issue into an integrated factor in social and economic decision processes based on trans-disciplinary researches.

The SNOWMAN partners want to develop a lasting structure for collaborative research funding to support their policies in the field of soil and groundwater in Europe. To achieve this, all the partners agreed on a common research agenda based on societal developments related to soil and groundwater. It is implemented through thematic research calls. Three calls for projects have already been published. In addition, there is an on-going dynamics to update the SNOWMAN research agenda to better integrate socio-economic issues and to structure the corresponding research community.

A particular attention is additionally paid to the sharing and dissemination of knowledge, both coming from the funded projects or from existing knowledge within the members of the network. In order to facilitate this, it is highly recommended to involve stakeholders and especially end-users (policy-makers, regulators, service providers…) in the project teams.

The SNOWMAN network thus adds coherence between European, national and regional research on soil. It also enhances the efficiency and effectiveness of research funding by avoiding overlaps and broadening the dissemination of the research results.

SOIL CONSERVATION IN ICELAND AND THE FUTURE IMPLICATIONS OF WHETHER ICELAND WILL JOIN THE EU

ÁGÚSTSDÓTTIR, ANNA MARÍA[1] (ANNAMARIA@LAND.IS); MONTANARELLA, LUCA[2]; RUNÓLFSSON, SVEINN[1]

[1]Soil Conservation Service of Iceland, Iceland
[2]Joint Research Centre, European Commission

Iceland is currently involved in accession negotiations with the European Union. Iceland already cooperates closely with the EU and has adopted significant amount of EU legislation into Icelandic law, through the Agreement on the European Economic Area (EEA). Issues not covered by the EEA such as nature protection, agriculture and rural development are however subject to negotiations. Iceland can deliver a substantial added value to the European Community through its experience in participatory land conservation programs and services. Iceland has North Europe's only designated, and possibly the world's oldest, Soil Conservation Service (SCSI), established 1907. The organized soil conservation in Iceland began as a response to severe land degradation and desertification that was seriously threatening the existence of several communities. Harsh nature and unsustainable land use over 1100 years had degraded Icelandic ecosystems to the extent that severe soil erosion covered 40% of Iceland (http://www.lbhi.is/desert/). A century of soil conservation has provided a learning process on various aspects in environmental legislation, policy design and implementation approaches. EU membership could be beneficial for soil conservation in Iceland, indirectly as an external driver for legislation improvements and directly through capacity building for environmental assessments needed for designing future policy for sustainable land use. However, Iceland´s uniqueness compared to other European countries, regarding it soil, geographical location, low population density, agriculture and vast land degradation may limit the benefits as EU solutions may not provide the answers Iceland needs. Given the current difficulties that the proposed EU Thematic Strategy for Soil Protection is experiencing, particularly for its legally binding component, there is a need for a fresh start in European soil protection strategies. Redesigning the EU approach to soil protection on principles of stakeholder participation and bottom-up approaches involving the local farming community could prove to be the best way forward also for other EU countries, as it has been the case for Iceland. Introducing participatory soil conservation practices in a reformed CAP could be the way forward for future EU soil protection.

ASSESSING THE RISK OF NUTRIENT LOSS FROM COVERED FIELD HEAPS OF POULTRY LITTER

DOODY, DONNACHA; BAILEY, JOHN (JOHN.BAILEY@AFBINI.GOV.UK); FOY, BOB

Agri-Food and Biosciences Institute, United Kingdom

Keywords: nitrate, nutrient loss, phosphorus, plastic covered, poultry litter field heaps

Introduction

Various studies have highlighted the need for careful storage of poultry litter in order to mitigate the risks posed to water quality by leakage of nutrients into drainage water (Bolan *et al*., 2010). Accordingly, the Nitrates Action Programme (NAP) Regulations Northern Ireland (NI) 2010, state that up to the 30th September 2011, poultry litter may be stored in field heaps covered with impermeable plastic sheeting. However, before this date expires, investigations must be undertaken to demonstrate that field storage of poultry litter using this, or alternative, methods, poses no risk to water quality. Accordingly, a study was undertaken to evaluate the risk of nutrient loss from poultry litter heaps on arable land, when heaps are either covered or enveloped with plastic.

Methods

There were three experimental treatments, *T1-T3*:

T1 Control: No poultry litter heap;

T2 Covered: 2.5 tonne heap covered with polythene;

T3 Enveloped: 2.5 tonne heap enveloped with polythene.

The treatments were replicated on arable land on 6 farms with different soil types. Soil samples were taken from below heaps to depths of 15cm and 90cm, before heap establishment and after heap removal. Samples taken to 15cm were air dried and analysed for Olsen P, pH and organic matter, and those taken to 90cm were analysed for KCl extractable N. Using runoff collector equipment (photograph), runoff was collected following rainfall events (1st Jan to 31st Mar) and analysed for a range of P and N fractions plus suspended sediment (SS) and biological oxygen demand (BOD).

Results and Conclusions

Compared to the controls, the presence of poultry litter heaps did not affect soil P concentrations nor did it increase the concentrations of P, N, BOD or SS in runoff. Using a mixed ANOVA model, the main factor controlling P export across sites was the pre-existing soil P concentration. Compared to controls, the presence of litter heaps produced small increases in soil NO_3 concentration (60-90 cm depth) probably because heat generated by litter heaps had enhanced soil nitrification. Overall, the results suggested that correctly situating and managing poultry litter heaps in accordance with current NAP regulations should render negligible any risk of increased nutrient export from fields.

Reference: Bolan, N.S., et al. (2010). *Worlds Poultry Litter Science Journal* 66: 673-698.

Acknowledgement: Moy Park Ltd, Craigavon, NI for co-funding the study.

MAPPING SOIL ECOSYSTEM SERVICES: A METHODOLOGICAL APPROACH

GARDI, CIRO (CIRO.GARDI@JRC.EC.EUROPA.EU)

Joint Research Centre, European Commission

The Ecosystem Services approach for the evaluation of natural capital is increasingly adopted. This approach can be used also for the evaluation of soil resources, enabling to achieve a better comprehension on the real contribute of different soil and land use types, to the delivery of ecosystem services. The potential to deliver ecosystem services by a soil is a function of its intrinsic characteristics and of its use. The existence of trade-offs among soil ecosystem services, regulated mainly through land use planning and land management, implies that we can evaluate these services on the base of the actual use of the land. In this paper a methodological approach for the evaluation of spatial distribution of Soil Ecosystem Services, at detailed scale, is presented.

EU SOIL THEMATIC STRATEGY: SOIL THREATS AND PRIORITY AREAS

HACK-TEN BROEKE, MIRJAM (MIRJAM.HACK@WUR.NL); DE VRIES, FOLKERT; VAN DEN AKKER, JAN

Wageningen University and Research Centre, The Netherlands

Considering the EU Soil Thematic Strategy and the proposal for a framework Directive the Dutch government wanted to know what this would mean for the Netherlands in terms of policy and measures or in terms of impact on for instance agriculture and environment. The proposal for the Framework Directive to protect soil mentions the following soil threaths: soil sealing, erosion, organic matter decline, salinisation, compaction, landslides and contamination. All these soil threats occur in the Netherlands to some extent except landslides and salinisation because the latter is defined as accumulation of soluble salts in the soil. Our country is simply too flat for landslides and our sea climate typically shows a net rainfall surplus which will not allow accumulation of soluble salts. Focusing on the soil threats for which risk areas (also called priority areas) should be identified we were asked to try and locate where such areas would possibly be located within the country. This meant that we focused on the occurrence of three soil threats: a) erosion bij water or wind, b) organic matter decline resulting from a steady downward trend in the organic fraction of the soil and c) compaction through an increase in bulk density and a decrease in soil porosity. For the identification of these risk areas the proposed Framework Directive states that the so called common elements should be used. Our research resulted in maps showing potential risk areas in the Netherlands for erosion, organic matter decline and compaction, providing comments on the use of these common elements. We propose to present these maps, the use of common elements and other data and also reflect on the remaining research questions.

IDENTIFICATION OF PRIME AGRICULTURAL LAND

HACK-TEN BROEKE, MIRJAM (MIRJAM.HACK@WUR.NL); RIETRA, RENE; RÖMKENS, PAUL; DE VRIES, FOLKERT

Wageningen University and Research Centre, The Netherlands

The EU Soil Thematic Strategy is intended for the protection of soils, adressing the main soil threats. The intention is to prevent soil degradration and to preserve the different soil functions. In this context one might also want to consider which soils are most suited for the defined functions. Over decades, land users and scientists have discussed ways to define the suitability of land for different purposes, most often for agricultural use. The suitability for agriculture depends on many other things than solely the physical, chemical and biological properties of soils. The type of agricultural production and land management determine the suitability for food production, but also the extent to which land owners, land users and societies are prepared to accept harmful effects to the environment. Soil scientists use definitions based on biophysical parameters, like properties of soils and climate. Social scientists and economists focus on the human factors determining agricultural production, such as human capital, institutions or farming systems. Another point of view is that of environmental scientists, who emphasize the impact on the environment. A definition encompassing these viewpoints could be: prime agricultural land includes land suitable for agriculture due to its physical, chemical and biological properties, providing maximum yields while providing least pressure on the environment, and requiring least inputs. Following this definition we tried to identify prime agricultural land in the Netherlands using various sources: historic and current land use, classic soil suitability assessments for arable land and grassland, indicators for quantifying environmental impact of land use, such as nitrate leaching, phosphate saturation and heavy metal concentrations. The synthesis of these data resulted in a first indication of which soils can be considered as Dutch prime agricultural land. This concept may be further developed and tested in order to be of use for policy making.

IDEAS FOR INNOVATIVE 21ST CENTURY FIELD SYSTEMS

KIBBLEWHITE, MARK G. (M.KIBBLEWHITE@CRANFIELD.AC.UK)

National Soil Resources Institute, Cranfield University, United Kingdom

Agriculture needs to double food production with a smaller environmental impact. This requires 'sustainable intensification' as agricultural land is limited and will become more so, due to climate change, desertification and urban expansion. Current arable agriculture uses batch processing. Standard operations are applied to a large number of individual plants, each of which contributes to a batch yield. Current precision agriculture optimises smaller areas than whole fields, but these still contain significant variation. Moreover operations are spatially but not temporally discriminated over the field. Natural variation in soil and water conditions, individual plant development, slope and radiant energy means that the optimal set of operations differs for individual plants. Ideally, a customised approach would be applied to each plant and although this is not feasible at least as smaller area as is economically possible should have customised management. Ecological theory indicates that mixed cropping can be more efficient in utilising soil, water and radiant energy resources – but most arable crops are monocultures because establishing, supporting and harvesting mixed crops has been difficult. And while conventional patterning of plants in rows is convenient for wheeled or tracked vehicles, the most productive patterns may be more complex, not least because of variations in soil and other field properties. Thus there is a need to explore options for new field layouts that are less linear with mixtures of crops arranged in optimal patterns. This paper sets out a research agenda to explore how information technology, cognitive science, robotics and artificial intelligence could support highly precise spatial and temporal interventions in complex field layouts based on mixtures of plant communities that exploit soil and water conditions better than do conventional systems.

EFFECTIVENESS OF UNFERTILIZED GRASS BUFFER STRIPS ALONG DITCHES IN THE NETHERLANDS TO REDUCE NUTRIENT LOADS FROM INTENSIVE AGRICULTURE

NOIJ, GERT-JAN[1]; HEINEN, MARIUS[2] (MARIUS.HEINEN@WUR.NLmailto:); GROENENDIJK, PIET[1]; HEESMANS, HANNEKE[2]; THISSEN, JAC[3]

[1]Wageningen University and Research Centre, Alterra, Water and Climate Center, The Netherlands
[2]Wageningen University and Research Centre, Alterra,Soil Science Center, The Netherlands
[3]Wageningen University and Research Centre, Biometris, Plant Research International, The Netherlands

Hydrogeology is recognized as an important factor governing the effectiveness of unfertilized buffer strips to reduce nutrient loads from agricultural fields (BSE). However, BSE is still unknown for intensively drained plain deltas with deep aquifers and intensive agriculture. We provided experimental evidence for BSE in these circumstances with a novel appropriate experimental method and investigated the influence of hydrogeology We selected five locations, one per major hydrogeologic class of the NL. Nutrient loads from a 5 m wide BS and a reference strip (REF) were measured with reservoirs in the ditch. Additionally, nutrient concentrations in groundwater were measured inside and outside both strips. BSE for nitrogen (N) in the reservoirs was only significant (10%) at Zegveld (peat). BSE for phosphorus (P) was only significant (60%) in Winterswijk. BSE was governed by specific local hydrogeologic factors: shallow and deep groundwater flow, downward seepage, too low residence time in the BS for denitrification, denitrification outside the BS and surface runoff away from the ditch. Effective application of BS on agricultural fields in a delta should therefore be tailor made. Locations with shallow flow, like Winterswijk offer best perspective, the shallower the better for P, but for N an optimum still remains to be established: not too deep, not too shallow. Measuring nutrient concentration reduction in groundwater between field and ditch proved insufficient to explain BSE for surface water quality. The novel method used has added value for assessment of BSE in a delta. This research was conducted for and financed by the Ministry of Economic Affairs, Agriculture and Innovation, and the Ministry of Infrastructure and the Environment. It was initiated as part of the negotiations between the Netherlands and European Commission on Agriculture regarding the implementation of unfertilized field edges (buffer strips) along water courses.

CAN LYSIMETERS BE USED TO REDUCE EMISSION IN SOIL BASED GLASSHOUSE HORTICULTURE?

VOOGT, WIM[1]; HEINEN, MARIUS[2] (MARIUS.HEINEN@WUR.NL); BALENDONCK, JOS[1]; KLAP, JOKE[3]; WELLES, HUUB[4]

[1]Wageningen University and Research Centre, Greenhouse Horticulture, The Netherlands
2Wageningen University and Research Centre, Alterra, The Netherlands
[3]Dutch Horticultural Product Board, The Netherlands
[4]LTO Growing Services, The Netherlands

The ecological surface water quality in areas with intensive glasshouse horticulture in the Netherlands is not fulfilling the goals of the EU Nitrates Directive and Water Framework Directive. Opposite to soilless grown crops with obligatory recycling of drainage water, emission in soil based growing systems is difficult to manage. For some crops the conversion from soil based to soilless systems is economically (e.g., chrysanthemums) or principally (organic horticulture) not an option. In the Netherlands a steady approximately 20% of the total glasshouse horticulture is therefore soil based. Since greenhouse production occurs year-round and at a high level, the amounts of water and nutrients used are much higher than in field crops. Thus emission of excess water and nutrients to the ground water and open surface water is likely to occur. The Dutch policy is aiming to tackle the problem of emission at its source. Therefore, we need methods to apply water and nutrients at rates equal to the crop demand. We recently started a project to develop a decision support system for the growers for achieving this goal and thus to minimize the leaching to the ground water and discharge to open surface water. The system exists of a lysimeter in the glasshouse to collect excess water and nutrients, water content sensors inside and outside the lysimeter, and models to determine, guide and predict evapotranspiration and leaching. At eight commercial farms the system has been implemented. Via local discussion groups neighboring growers can discuss the findings obtained at the test locations. These discussions are then used to further develop the decision support system and to develop best practices for the growers. We will present our approach and give some first illustrative results.

Theme 5
Climate Change

SYMBIOTIC SOIL FUNGI REDUCE N2O EMISSIONS FROM MODEL GRASSLAND MICROCOSMS

BENDER, FRANZ[1] (FRANZ.BENDER@ART.ADMIN.CH); NEFTEL, ALBRECHT[1]; JOCHER, MARKUS[1]; OLBRECHT, LUISE[1]; CONEN, FRANZ[2]; ROLLOG, MARK[2]; OBERHOLZER, HANS-RUDOLF[1]; VAN DER HEIJDEN, MARCEL[1]

[1]Agroscope Reckenholz-Tänikon Research Station (ART), Switzerland
[2]Institute of Environmental Geosciences, University of Basel, Switzerland

Global warming is one of the major concerns for the ecological equilibrium on our planet as it exists today. Factors need to be determined that help to reduce greenhouse gas emissions. The role of soil microorganisms in atmospheric gas exchange processes is still poorly understood. Here we show that one of the most widespread and abundant group of soil microorganisms, the arbuscular mycorrhizal fungi (AMF), affect greenhouse gas emissions in model grassland microcosms. We focus on N2O, an important greenhouse gas with a very high global warming potential. The presence of AMF in grassland microcosms reduced the production of N2O by 30 % compared to control microcosms without AMF after a fertilization pulse. The results indicate that AMF are important regulators of N2O emissions. A reduction of their abundance e.g. by intensification of agricultural practices could increase N2O production and hence further intensify the greenhouse effect.

COMPARING AMMONIA VOLATILIZATION AND DRY MATTER YIELD OF FERTILIZED CROPS WITH NITROGEN AND ALUMINOSILICATES

BERNARDI, ALBERTO[1] (ALBERTO@CPPSE.EMBRAPA.BR); CARDOSO, RODRIGO[2]; MINUSSI, FERNANDO[3]; PEREIRA, ELAINE[3]; CAUE, OLIVEIRA[4]

Embrapa Pecuaria Sudeste, Brazil
UNICASTELO, Brazil
UFSCar, Brazil
Embrapa Instrumentacao Agropecuaria, Brazil

The nitrogen loss by ammonia volatilization is one of the main factors for low efficiency of N-urea applied on the soil surface. The reduction of losses by volatilization can be obtained with the addition of aluminosilicates to the urea fertilizer. The objective of this study was to evaluate ammonia volatilization and dry matter yield of Zea mays and Brachiaria brizantha fertilized with nitrogen sources and with aluminosilicate addition. Two experiments were carried out: in green house with pots and in the field. Experimental design was a randomized blocks design with three and four replications, respectively. Treatments comprised: ammonium sulfate, ammonium nitrate, urea, urea mixed with an aluminium phyllosilicate and two species of heulandite, and control applied at the level of 100 kg ha-1 of N on soil surface. Ammonia volatilized was captured by a foam absorber with politetrafluoroetilene. The reduction in ammonia losses by volatilization and the increased efficiency of N utilization when urea is used together with aluminosilicates was demonstrated in both green house and field experiments. These results indicate that aluminosilicates minerals are able to improve the efficiency of nitrogen use, contribute to increasing N uptake through the control of retention of ammonium ion.

DECOMPOSITION OF PEAT IN LAB EXPERIMENTS SIMULATING SUMMER DROUGHT

BROUNS, K. (K.BROUNS@UU.NL); HEFTING, M.M.; VERHOEVEN, J.T.A.

Institute for Environmental Biology, Utrecht University, The Netherlands

Peatlands encompass 7-8% of the Dutch land area. In the western part, peatland drainage has resulted in a characteristic landscape with long but narrow parcels separated by ditches. Dairy farming is the current main land use. Drainage leads to oxidation of peat and problematic soil subsidence (ca 15 mm/yr at 75 cm drainage) (Schothorst, 1977). The W+ climate change scenario indicates a decrease in summer precipitation (19%) and an increase in potential evaporation (15%) (Van den Hurk *et al.*, 2006). This results in a 'concave' water table in the parcel with a very low level in the centre. In this situation, the anaerobic peat will become aerobic for the first time.

We are performing an experiment simulating the effects of summer drought and addressed the following research question: *"What is the effect of aerobic periods and the length of these aerobic periods on anaerobic and aerobic decomposition of* Sphagnum *and* Carex *peat samples extracted from the anaerobic layers of peatlands?*

The (previously) anaerobic peat contains more phenolic substances, like lignin and tannin, than peat that has been exposed to oxygen more often as phenolics are degraded in aerobic conditions (Freeman *et al.*, 2001). The degradation of phenolics is generally considered the rate-limiting step in decomposition (Meentemeyer, 1978) and the presence of phenolics hampers other enzymes (Freeman *et al.*, 2001). Therefore it is expected that decomposition rates of previously anaerobic peat samples exposed to air will decompose faster than peat samples that did not experience an aerobic period.

For this experiment *Carex* (C) and *Sphagnum* (S) peat samples were collected from anaerobic layers in nature reserves (N) and agricultural areas (A). 10 g of fresh peat were incubated in 5-fold replication in 300 mL infusion flasks sealed with airtight rubber stoppers. Incubation flasks were purged with nitrogen gas to ensure anaerobic headspaces and were incubated during 14 weeks with different lengths of aerobic versus anaerobic periods (aerobic period of 0, 1, 2, 4, or 8 weeks, respectively). Gas samples for CO_2 and CH_4 analysis were collected of each sample at the end of the aerobic period, 4 weeks afterwards and at the end of the experiment. pH, water extractable NO_3, NH_4, PO_4, SO_4, DOC (Dissolved Organic Carbon) and soluble and condensed phenolics were analysed at the end of the experiment.

On the poster results of this experiment will be shown, addressing the effects of peat type and land use.

References

- Freeman, C., Ostle, N. & Kang, H. (2001) An enzymic 'latch' on a global carbon store: A shortage of oxygen locks up carbon in peatlands by restraining a single enzymes. *Nature,* **409**, 149.
- Meentemeyer, V. (1978) An approach to the biometereology of decomposer organisms. *International Journal of Biometeorology,* **22**, 94-111.
- Schothorst, C.J. (1977) Subsidence of low moor peat soils in the western netherlands. *Geoderma,* **17**, 265-291.
- Van den Hurk, B., Klein Tank, A., Lenderink, G., Van Ulden, A., Van Oldenborgh, G.J., Katsman, C., Van den Brink, H., Keller, F., Bessembinder, J., Burgers, G., Komen, G., Hazeleger, W. & Drijfhout, S. (2006) KNMI climate change scenarios 2006 for the netherlands. *KNMI, De Bilt, the Netherlands*.

USING AN ARBUSCULAR MYCORRHIZA DEFECTIVE TOMATO MUTANT SHOWS INCREASES IN SOIL-PLANT NITROGEN CYCLING

CAVAGNARO, TIMOTHY[1] (TIMOTHY.CAVAGNARO@MONASH.EDU); JACKSON, LOUISE[2]; RUZICKA, DAN[3]; SCHACHTMAN, DANIEL[3]

[1]School of Biological Sciences and Australian Centre For Biodiversity, Australia
[2]Land, Air and Water Resources, UC Davis, The United States
[3]Donald Danforth Plant Science Center, The United States

Agricultural systems are being intensified to meet the world's increasing demand for food and fiber, which may reduce the dependence of crop species on arbuscular mycorrhizas (AM). The role of AM for crop nitrogen (N) uptake has recently been studied using a mycorrhiza defective tomato mutant, and its mycorrhizal wildtype progenitor, as a means of establishing non-mycorrhizal controls; this allows for the direct investigation of mycorrhizal effects on soil and plant processes with the wider soil biota intact. Field and glasshouse based studies undertaken in Australia and California have shown that AM increase N uptake, as well as that of P and Zn, and reduce the risk of N loss from soils via leaching. Using a microarray-based transcriptome analysis coupled with real-time PCR studies of the tomato genotypes, rapid changes in expression of genes related to N metabolism occurred in response to N addition, showing that AM contribute to the capacity of roots to scavenge N rapidly. Nutrient uptake per unit root length, and per unit CO2 respired, was not significantly different in mycorrhizal and non-mycorrhizal genotypes. Furthermore, soil emissions of greenhouse gases are generally similar between the genotypes when grown in the field. Combining whole plant physiological and gene expression studies highlights the important role of AM in the interception of N and other essential macro- and micro-nutrients.

SOIL CARBON SEQUESTRATION IN INTERCROPPING AGROECOSYSTEMS

CONG, WENFENG[1] (WENFENG.CONG@WUR.NL); VAN DER WERF, WOPKE[1]; HOFFLAND, ELLIS[2]; MEINKE, HOLGER[3]; LI, LONG[4]; ZHANG, FUSUO[4]

[1] Wageningen University, Centre for Crop Systems Analysis, The Netherlands
[2]Wageningen University, Department of Soil Quality, The Netherlands
[3]School of Agricultural Science, University of Tasmania, Australia
[4]Department of Plant Nutrition, China Agricultural University, China

Keywords: intercrop, soil organic carbon, carbon sequestration, wheat, maize, faba bean

Intercropping increases field-level biodiversity and often results in improved aboveground productivity. Little is known about the belowground productivity and soil carbon sequestration in intercropping agroecosystems. In 2003, a long term field experiment was established in Gansu Province, Northwest China, to determine soil carbon dynamics in different cropping systems consisting of three crop species (wheat, maize and faba bean), and grown in different rotations (or lack thereof) and species mixture (or single species). Soil organic carbon contents (SOC; g kg-1) and soil bulk density were obtained in 20 cm increments to a maximum depth of 1 m. After 8 years, intercropping resulted in an increase in SOC in the top 40 cm, but a decrease between 60 and 80 cm, and no significant change in the other layers. Integrated over the whole soil profile to 1 m depth, there was no significant effect of intercropping on C stocks (Mg ha-1). These first results about intercropping effects on C sequestration challenge existing ideas on the relationship between productivity and carbon sequestration in diversified systems. They are not congruous with the well established yield and total above ground dry matter increases in mixed crop systems, while they are also in disagreement with results in species diverse grassland systems. Plausible explanations and extrapolations of these findings will be presented.

FUNCTIONAL TRAITS UNDERPINNING DESICCATION RESISTANCE AMONG TERRESTRIAL ISOPODS

DIAS, ANDRÉ T. C.[1] (A.TAVARESCORREADIAS@VU.NL); KRAB, EVELINE J.[1]; MARIËN, JANINE[1]; ZIMMER, MARTIN[2]; CORNELISSEN, JOHANNES H. C.[1]; ELLERS, JACINTHA[1]; WARDLE, DAVID A.[3]; BERG, MATTY P.[1]

[1] Department of Ecological Science, Faculty of Earth and Life Sciences, Free University Amsterdam, The Netherlands
[2] FB Organismische Biologie: Ökologie & Diversität der Tiere, Paris-Lodron-Universität, Austria
[3] Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, Sweden

Expected changes in soil water availability with climate and land-use change will have important impacts on the community structure of functionally important soil organisms, such as detritivores. Resistance to desiccation varies greatly among macro-detritivore species, but the mechanisms that underpin this variation remain elusive. Here, we identified and quantified the functional traits underlying interspecific differences in desiccation resistance of macro-detritivores. This will enhance our ability to predict soil community responses to changing water regimes; and the consequences of species shifts for organic matter turnover. Using structural equation models, we tested (1) how interspecific differences in desiccation resistance among 22 dominant NW European isopod species could be explained by three underlying traits: body surface area, water loss rate and fatal water loss; and (2) whether these relationships were robust when controlling for phylogenetic signal and under contrasting experimental conditions. Isopods were exposed individually to standard dry condition – 85% air relative humidity (RH) at 15°C – to record their desiccation resistance (i.e. survival time), water loss rate and fatal water loss (i.e., maximum water loss tolerance). Desiccation resistance varied greatly among species (2.2 ± 0.4 to 83.5 ± 29.5 hours; mean ± SD) and 90% of such variation was explained by water loss rate and (secondarily) fatal water loss. Our path model indicated that body surface area affects desiccation resistance only indirectly, via changes in water loss rate. Moreover, these relationships between the traits were not only determined by shared evolutionary history, in spite of a significant phylogenetic signal. Water loss rate measured under contrasting humidities (85 and 36%RH) showed a strong relationship with desiccation resistance, meaning that it is possible to use functional traits measured under standard conditions to predict soil biota responses to decrease in water availability. The next challenge is to test the repercussions of such responses for organic matter decomposition.

EFFECT OF THE IRRIGATION WITH WASTEWATER ON GREENHOUSE GAS EMISSIONS AND FERTILITY OF AMENDED SOIL

GALVEZ, ANTONIA[1,2] (AGALVEZP@UGR.ES); SINICCO, TANIA[1]; CAYUELA, MARIA LUZ[3]; MINGORANCE, Mª DOLORES[2]; MONDINI, CLAUDIO[1]

[1]Gruppo di Ricerca di Gorizia, CRA-RPS, Spain
[2]Instituto Andaluz de Ciencias de la Tierra (CSIC-UGR), Spain
[3]CEBAS-CSIC, Spain

The application to soil of organic residues and wastewater can represent an effective solution to counteract the loss of soil organic matter and the decreasing availability of water for irrigation. Therefore, the aim of this work was to investigate the effects of the combined application of wastewater and organic residues on soil GHG emissions, C and N mineralisation and microbial biomass size and activity. A Fluventic Eutrudept soil was brought at 40% of its water holding capacity using distilled water or an artificial wastewater and thereafter amended (0.5% w/w) with 3 different organic residues: pig slurry digestate, rapeseed meal and a compost. The amended soil was then incubated for 30 days at three different temperatures: 10, 20 and 30 ºC. During incubation, CO2 and N2O evolution, K2SO4-extractable organic C, N, NH4+, NO3- and P, soil microbial biomass content and some enzymatic activities were determined. The addition of wastewater provoked an increase in cumulative respiration in all amended soils incubated at 10 and 20 °C and a priming effect in soils amended with rapeseed meal. The treatment of amended soil with wastewater did not cause a significant increase in N2O emissions. Net mineral N increased in the amended soil, except for the compost which led to N immobilization. Amended soil treated with wastewater showed a higher content of net mineral N. Soil amendment caused a general increase in soil microbial biomass content and activity that was higher with rapeseed meal. Addition of wastewater did not significantly affect the content and activity of soil microbial biomass. On the whole, results demonstrated that the use of wastewater in combination with organic residues does not negatively affect soil GHG emissions, organic matter mineralisation and microbial biomass pool. Furthermore, the wastewater provided additional nutritive elements to those added with the organic amendments.

SOIL C TURNOVER UNDER ELEVATED CO_2: AN INTEGRATIVE META-ANALYTIC APPROACH

HUNGATE, B.A.; VAN GROENIGEN, K.J. (CORNELIS-JAN.VAN-GROENIGEN@NAU.EDU); OSENBERG, C.W.

Northern Arizona University, The United States

Because stimulated assimilation of carbon (C) by plants can increase soil C input and soil C storage, terrestrial ecosystems could help to reduce the increase in atmospheric CO_2 and thereby slow climate change. However, the priming effect, i.e. the phenomenon where adding extra C stimulates the turnover of the soil C pool, causes large uncertainty in C sink predictions. To estimate the effect of elevated CO_2 on soil C turnover, we extracted data on above- and below-ground biomass and productivity (NPP), soil respiration and soil C contents from CO_2 enrichment experiments. We divided studies into grassland, cropland and forest. Changes in total soil C were explained by effects on soil C input (I) and loss (k), using the model: $C_t = C_o e^{-kt} + I/k\ (1-e^{-kt})$. Measurements of productivity were used to constrain I. Measurements of Ct and soil respiration were then used to estimate k, and overall CO_2-effects were summarized through meta-analysis. We found that elevated CO_2 significantly increased both soil C input and soil C turnover in all three study categories. Although N additions tended to decrease soil C turnover, the CO_2 effects on soil C turnover were not dependent on N availability. By ignoring the increase in soil C turnover under elevated CO_2, estimates on the terrestrial C sink are overly optimistic.

CARBON STOCK IN 15-YEAR-OLD FOREST STANDS PLANTED ON AGRICULTURAL LAND

KARKLINS, ALDIS[1] (ALDIS.KARKLINS@LLU.LV); LIPENITE, INARA[1]; DAUGAVIETE, MUDRITE[2]

[1]Latvia University of agriculture, Latvia
[2]Latvian State Forest Research Institute Silava, Latvia

The area of forest stands in Latvia makes 3162.43 thou. ha or 48.96% of the total territory of the country, the area of agricultural land – 2429.8 thou. ha from which about 2000 ha are converted into forest plantations annually. Therefore changes in land use pattern, soil properties as well as carbon sequestration gradually occur. The research objective was to evaluate the carbon stock in two locations in agricultural land where stands of pine (Pinus sylvestris L.), spruce (Picea albis (L.) Karst.), and birch (Betula pendula Roth) had been established 15 years ago. The organic carbon stock and C/N ratio in soil as well as in the biomass of tree stock and roots were calculated. The productivity of stands in terms of wood volume, m3 ha-1, (and number of trees) was estimated to be: for pine – 115.4 (2925), for spruce – 50.9 (2640), 42.9 (2190) and 82.6 (2500), for birch – 143.5 (3635) and 121.9 (1480). The accumulation of organic carbon stock, Mg ha-1, in overground biomass was: pine – 140.57, spruce – 71.96, 80.87 and 132.09, birch – 126.54 and 67.05; but in root system: pine – 46.76, spruce – 23.89, 24.17 and 39.47, birch – 37.24 and 19.73. Accumulation of organic carbon (total nitrogen), Mg ha-1, in soil was calculated to be: under pine – 67.8 (4.6), spruce – 61.9 (6.1), 82.8 (7.9) and 677.2 (54.8), birch – 76.1 (6.5) and 44.2 (5.0). If there were no significant changes in the organic carbon and total nitrogen accumulation under the planted forest (as compared with similar soil in the adjacent area where farming activities were taking place at the time of the research) then carbon sequestration in tree biomass was remarkable. Therefore planting forests on abandoned agricultural land contributes not only to future economic growth but also stimulates carbon sink.

ENRICHED 15N-N2O TRACING REVEALS THE IMPORTANCE OF SOIL MOISTURE AND BULK DENSITY FOR N2O REDUCTION

KLEFOTH, ROLAND R.[1] (ROLAND.KLEFOTH@WUR.NL); CLOUGH, TIM J.[2]; OENEMA, OENE[3]; VAN GROENIGEN, JAN WILLEM[4]

[1]Wageningen University and Research Centre, Environmental Sciences, Soil Science Centre, The Netherlands
[2]Faculty of Agriculture and Life Sciences, Lincoln University, New Zealand
[3]Wageningen University and Research Centre, Alterra, The Netherlands
[4]Wageningen University, Soil Biology and Biological Soil Quality Group, The Netherlands

During denitrification or nitrifier-denitrification the greenhouse gas nitrous oxide (N2O) is an obligatory intermediate during the reduction of nitrate or nitrite to dinitrogen gas (N2). Topsoil fluxes of N2O can occur as a result of incomplete denitrification, and are strongly influenced by soil physical properties. However, quantitative insights into the relationship between N2O reduction and soil physical properties influencing this are still limited. Here we used artificially enriched 15N-N2O to measure N2O reduction in the soil profile as function of both soil bulk density and moisture content. Columns were repacked with a sieved sandy soil, using three moisture contents (60, 75 and 90% water-filled pore space; WFPS), to one of three bulk densities (1.02, 0.96 and 0.89 g cm-3). At the bottom of the columns, a silicon sheet, (permeable to N2O) was installed. The reservoir below the sheet simulated a subsoil from which N2O diffused upwards. After a pre-incubation phase of 9 days, 15N-N2O was injected into the reservoir every 12 hours and topsoil N2O emissions were subsequently measured for 20 days. Preliminary results indicate that 90% WFPS resulted in low and 60% WFPS in high N2O emission. However, the higher N2O flux at 60% WFPS was the result of an increased diffusion rate rather than enhanced production of N2O. At both high and low soil moisture contents, bulk density did not affect N2O emissions. However, at 75% WFPS, higher bulk density decreased N2O emissions by decreasing the diffusion rate and thereby increasing complete denitrification to N2. Our results show that N2O profile dynamics (diffusion characteristics and reduction of nitrous oxide) should be taken into account when linking soil characteristics to N2O emissions. A wet soil can either lead to higher or lower emissions when compared to a drier soil, depending on the situation in the subsoil.

THE ACCUMULATION OF THE ORGANIC MATTER AND THE CHANGE OF HUMIFICATION PROCESS FOLLOWING AFFORESTATION OF ABANDONED FARMLAND

KUKULS, IMANTS (IMANTS.KUKULS@INBOX.LV); KASPARINSKIS, RAIMONDS; NIKODEMUS, OLGERTS; ANSONE, LINDA

University of Latvia, Faculty of Geography and Earth Sciences, Latvia

In the last fifty years in Europe, including Latvia, the natural afforestation of the abandoned farmland is observed. In the last decade approximately 660 thousand ha of ligneous plants are overgrowing the abandoned farmlands. Soil properties and processes are changing due to the natural afforestation process (Kasparinskis et al. in press). As a result of this process there are change of organic matter and its distribution in the soil profile and humification rate. In the study were analyzed soil samples collected from soil profiles of different age farmlands, formed on glacial till deposits (Luvisols, Albeluvisols, Stagnosols, Cambisols) and Baltic Ice lake sandy deposits (Cambisols, Podzols, Arenosols). Alkali extractable organic carbon (OCNaOH, mg g-1) and humification rate of the organic matter in the soil were investigated. The results showed that the amount of OCNaOH increases in the mineral topsoil (<30 cm) with the rise of forest land age. Rapid increase of OCNaOH is observed in the 0–10 cm layer of the first 50 years. In the 11-30 cm layer is observed decrease of OCNaOH in forest lands of age 10 years and older. The study concludes that in the naturally afforested farmlands the organic carbon in mineral topsoil increases with the age of forest land. There were no initial decrease of organic carbon observed in the mineral topsoil of naturally afforested farmlands of age 5 to 10 years. Furthermore, the development of the natural afforestation process promotes the rise of humification rate of organic matter in the mineral topsoil.

POSSIBLE IMPACT OF CLIMATE CHANGE ON GROUNDWATER RECHARGE AND SOIL MOISTURE BUDGET

LETERME, BERTRAND; MALLANTS, DIRK (DMALLANT@SCKCEN.BE)

Belgian Nuclear Research Centre (SCK-CEN), Belgium

The Belgian Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS) aims to develop a surface disposal facility for low and intermediate level radioactive waste in Dessel (north-eastern Belgium). The objective of this study is to provide estimates for the next few millennia of groundwater recharge in the vicinity of the Dessel site, characterized by a current maritime temperate climate. Besides groundwater recharge, other components of the soil water budget – soil evaporation, plant transpiration, soil moisture availability - are examined under different climate conditions. Regional groundwater recharge is calculated by coupling the Hydrus-1D model (Simunek et al., 2005) with a Geographical Information System (GIS). Simulations are performed using time series of measured precipitation and calculated potential evapotranspiration typical of an anticipated future climate. Water budget calculations we based on soil hydraulic properties generated by means of pedotransfer functions in combination with vegetation data (LAI, rooting depth, canopy interception) representative for the dominant land use of the study area (coniferous and deciduous forests, cropland and meadow). The sensitivity of groundwater recharge to long-term climate change is assessed through the use of measured climate data obtained from so-called climatic analogue stations. Using criteria such as similarity in altitude and distance to moisture source when compared to the study area, analogue stations were selected for the nearest future climate state Cs/Cr (subtropical with dry summers/no rainfall seasonality). Existing climate data from northern Spain (Gijon) is then used in 1-D modelling of the soil-plant-atmosphere system to quantify drainage on sandy soils (podzol) characteristic of the study area. Results showned that all water budget components are sensitive to the type of lower boudary condition used: the influence of using either a constant and relatively shallow groundwater depth or a deep drainage boundary conditions is discussed through several examples. Potential impact of climate change on soil water content variations for individual years are estimated by comparing the evolving water content profiles for current and future climate conditions. For example, simulations suggest a significant decrease in soil water content in summer for 10% and 50% dry years.

THE POTENTIAL USE OF LUCAS DATABASE FOR THE ASSESSMENT OF SOIL ORGANIC CARBON

TÓTH, GERGELY; BAMPA, FRANCESCA (FRANCESCA.BAMPA@JRC.EC.EUROPA.EU); DE BROGNIEZ, DELPHINE; JONES, ARWYN; MONTANARELLA, LUCA

Joint Research Centre, European Commission

The general LUCAS (Land Use/Land Cover Area Frame Survey) aims to monitor changes in management and coverage of the European territory. The general LUCAS sampling is based on a regular grid across Europe defined as the intersection points of a 2 x 2 km grid covering the territory of the EU. The topsoil survey component of it, conducted in 2009, aimed to produce the first coherent sampling and harmonized physicochemical analysis of soils from 25 EU Member States (EU-27 except Bulgaria and Romania). For topsoil (0-30cm) sampling a subset of around 21,000 points from the participating countries was extracted as representative points in the general LUCAS. Stratification was based on topography and land use. Soil samples were analysed for basic soil properties, including particle size distribution, pH, organic carbon, carbonates, NPK, CEC and multispectral properties. The LUCAS topsoil dataset represent the most comprehensive topsoil information base at EU level. Data on land management practices are available from the general LUCAS, allowing the analysis of the effect of land management on various soil properties, including soil organic carbon (SOC). Preliminary studies have been performed on the dataset, taking climatic zones, regions and management practices into consideration. Results highlight important linkages among these factors and help understanding and quantifying the potential of European croplands with regards to carbon sequestration and other major soil functions.

CLIMATE VARIABILITY INFLUENCES SOIL MANAGEMENT AT HOUSEHOLD AND COMMUNITY SCALES

KINYANGI, JAMES (J.KINYANGI@CGIAR.ORG); MUNGAI, CATHERINE; CHESTERMAN, SABRINA; CRAMMER, LAURA

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Denmark

Keywords: East Africa, soil fertility, water management, food security, household

In East Africa, the achievement of suitable harvests to realize a basic measure of food security has been significantly affected by unpredictable weather and climatic patterns. In response, many communities have made adjustments to their farmlands including tillage area changes, the introduction of basic irrigation and construction of a variety of soil and water management structures. Concentrating on soil and water management practices, this study profiles the linkages between climate change, agriculture and food security in four countries in East Africa, focused at changes in the household level. Factors leading to reduced soil moisture particularly increasingly erratic rainfall, reduced annual precipitation, frequent droughts and a shift in the rain system due to corresponding ploughing periods and resultant yields were found to be the main drivers of change in the study areas.

During the survey key behavioral changes observed included the construction of irrigation ditches and ridges /bunds, mulching, terraces, stone lines, contour ploughing, crop rotations and inter cropping, use of more mineral/chemical fertilizer where affordable and manure application. Knowledge and evidence of water resource management techniques at the household level is very poor. There is need for a systemic planning approach to water storage structures at the watershed level, especially where high runoff is occurring as well as a need for irrigation technology, tanks for water harvesting, dams or water ponds, boreholes and inlet/ water gates. Results from 699 households across the 35 villages show that less than a third of farmers have adopted any form of improved soil and water management practices. This is a serious problem as such measures are instrumental in adaptation to climate change as well as their link to soil mitigation efforts.

SOIL CARBON SEQUESTRATION POTENTIAL FOR AFFORESTED PASTURES IN THE MEDITERRANEAN CLIMATIC ZONE, A META-ANALYSIS

HOOGMOED, MARIANNE (MARIANNE.HOOGMOED@MONASH.EDU); CUNNINGHAM, SHAUN;THOMSON, JIM; BAKER, PATRICK; BERGINGER, JASON; CAVAGNARO, TIMOTHY

Monash University, Australia

Afforestation of agricultural land is increasing in many parts of the world. An important driver of this change is the greater ability of developing forests than pastures and annual crops, to sequester large amounts of carbon from the atmosphere and potentially mitigate climate change. The higher carbon storing potential of forests is intuitively apparent (i.e. more biomass and woody tissue) and has been confirmed by several studies. However, whether there will be an associated increase in soil carbon remains unclear. Determining this impact of afforestation is important as soil carbon provides a more stable and longer-term sink of carbon than plant biomass. Knowing which factors affect the rate and magnitude of soil carbon sequestration will improve management of "carbon plantings" in the future.

In a changing climate, pastures in Mediterranean areas are likely to become less productive, and afforestation more profitable and widespread with carbon payment schemes. This significant land-use change towards perennial, woody species will have important impacts on carbon cycling in these landscapes. Therefore, we used a meta-analysis approach to quantify the effects of afforestation of pastures on soil carbon sequestration in Mediterranean climates.

A change in soil carbon was not found after three decades of afforestation. However, there was an increase in the C:N ratio of the soils over this period. Although there was no evidence of an increase in soil carbon after three decades, the increase of the C:N ratio over this short period suggests that soil C will increase in the longer term due to continued litter inputs and a reduced decomposition rate compared with the original pastures.

Author index

Author index

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

Y

Z

ISBN 978-946173-168-5