CHINA-US Workshop on

Sustainable Management of Soil and Water Resources

Shenyang, China

January 5-8, 2010

Contents

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Workshop Goals and Objectives

Introduction

On July 20, 2006, in Beijing, representatives of the University of Tennessee-Oak Ridge National Laboratory's (UT-ORNL) Joint Institute for Biological Sciences (JIBS) and UT's Institute for a Secure and Sustainable Environment (ISSE) signed a framework agreement for the establishment of a **China-US Joint Research Center for Ecosystem and Environmental Change** (http://isse.utk.edu/jrceec/). The focus of this agreement is to promote research collaboration, academic exchange, student education, and technology training and transfer in areas of environmental concern. This specific agreement was reached with two Institutes of the Chinese Academy of Science (CAS)—the Institute of Geographical Science and Natural Resources Research (IGSNRR) and the Research Center for Eco-Environmental Science (RCEES)—both in Beijing. The center's primary collaborative themes include: (1) ecosystem processes and management, (2) environmental sustainability of bioenergy production, (3) ecological foundations of water resources and quality, and (4) technologies for improvement of eco-environmental systems. Since establishment, the Joint Center has prepared six joint research proposals and convened five academic conferences sponsored by the Chinese Academy of Sciences, Natural Science Foundation of China (NSFC), U.S. National Science Foundation (NSF), and U.S. Department of Energy (DOE). Student exchanges, mainly funded by the U.S. partners, have been made in the area of ecosystem fluxes of carbon, water and nitrogen. Annual reciprocal visits of the leaders and scientists of the partnering institutes have explored many exciting opportunities for future China-US collaboration. As a follow-up activity, the **China-US Workshop on Sustainable Management of Soil and Water Resources** will be organized by members of the China-US Joint Center, Institute of Applied Ecology, and Shenyang Agricultural University, to bring together soil and water researchers from China and the United States to exchange recent scientific findings and promote international collaboration in research and education.

Background and significance

The Chinese and US economies are the globally dominant contributors to greenhouse gas emissions and potential climate impacts and thus have common strategic interests in environmental and economic sustainability. In recent decades, the urbanization of China has increased from 17% in 1978 to 45% in 2008. Meanwhile, competition for land use, which can have adverse consequences for agricultural productivity and water quality, has intensified. Currently, sustainable management and effective remediation technologies are needed in almost all regions of China. Similar problems, to a lesser extent, also exist in the United States. Experiences in the two nations related to protection of soil and water resources may be complementary in some aspects. For example, an opportunity exists for China and the U.S. to collaborate on economic and technical assessment of carbon emissions management under the Clean

Development Mechanism of the Kyoto Climate Protocol. The two governments have signed a Ten-Year Energy and Environment Cooperation Framework in June 2008 to facilitate such joint efforts. It is appropriate to create a venue for leading Chinese and American scientists to communicate with each other and explore the potential for collaboration in innovative research and student education within the framework of the China-US Joint Research Center. Such interactions will accelerate the development and transfer of new technologies, train the next generation of scientists, and encourage international cooperation.

Workshop goals and objectives

Workshop participants will discuss recent advances in research on the sustainable utilization and protection of soil and water resources, and discuss future research to develop and implement relevant biological and environmental technologies. The workshop will particularly seek to develop long-term joint research/education programs among participants in sustainable management of soil and water resources, including risk assessment and remediation. Specifically, the workshop will address:

1. Optimized strategies for watershed management;
2. Transport and fate of environmental contaminants;
3. Soil carbon as affected by land use, agricultural practices, and ecosystem management;
4. Molecular techniques for identifying mechanisms of soil carbon biochemical processes;
5. Establishment of a joint laboratory for research collaboration in carbon and water.

Agenda of China-US Workshop

Sustainable Management of Soil and Water Resources

Tuesday, January 5, 2010, Huaren Hotel

Registration, reception and visit

09:00-20:00 **Domestic delegate registration and pickup of materials: Reception Hall**

12:00-14:00 **Lunch at Huaren Hotel**

18:00-20:00 **Welcome dinner at Huaren Hotel**

Authors for oral presentation are expected to submit your slides on-site when registration.

US delegation visit Liaoning Academy of Agricultural Sciences and Shenyang Agricultural University

Wednesday, January 6, 2010

07:00-08:20 **Breakfast at Huaren Hotel**

08:20-08:50 **Coach transport from Huaren Hotel to Institute of Applied Ecology**

Conference Focus on Soil and Water Resources Management

08:50-09:20 **Welcome and Introduction** (Conference Room of the Institute)

[Moderator: ***Xu-Dong Zhang*** and ***Jack Parker***, Workshop Chairs]

08:50 Welcome and opening remarks (***Xing-Guo Han***, Director of Institute)

09:00 Guest Introduction (***Xu-Dong Zhang*** and ***Jack Parker***)

09:10 Workshop Objectives (***Jie Zhuang***)

09:20-10:00 **Keynote Addresses**

[Moderator: ***Xu-Dong Zhang***]

09:20 "Models, uncertainty and cost optimization of water management decisions" by ***Jack Parker***, University of Tennessee

10:00-10:30 **Coffee Break and Workshop Group Picture**

10:30-11:45 **Plenary Addresses**

[Moderators: ***Ji-Zheng He*** and ***Ronald Turco***]

10:30 "Assessing crop water productivity in China: a hydrological modeling approach" by ***Feng Huang*** and ***Bao-Guo Li***, China Agricultural University

10:55 "Climate and land use change impacts on water resources in the U.S." by ***Keith Cherkauer***, Purdue University

11:20 "Agricultural water management in the Hebei Plain: challenges and technologies" by ***Tu-Sheng Ren***, China Agricultural University

11:45-13:00 **Buffet Lunch** (Tianrun restaurant) **and Poster Presentations** (Conference Room of the Institute)

13:00-13:40 **Keynote Address**

[Moderators: ***Jing-Guo Wang*** and ***Keith Cherkauer***]

13:00 "Nitrogen cycling and ammonia oxidation microorganisms in terrestrial ecosystems as revealed by bio-molecular techniques" by ***Ji-Zheng He***, Research Centre for Eco-environmental Sciences, CAS

13:40-15:20 **Plenary Addresses**

[Moderators: ***Jing-Guo Wang*** and ***Keith Cherkauer***]

13:40 "Almond organophosphate and pyrethroid use in the San Joaquin Valley watershed and their associated environmental risk" by ***Xing-Mei Liu*** and ***Jian-Ming Xu***, Zhejiang University

14:05 "Transport of colloid-Associated contaminants in porous media" by ***Jie Zhuang***, University of Tennessee

14:30 "Multiscale investigations of subsurface radionuclide and co-contaminants at the OR-IFRC site" by ***Fan Zhang***, Institute of Tibetan Plateau Research, CAS

14:55 "The eco-toxicology and its function in the establishment of soil quality standards" by ***Yu-Fang Song***, Institute of Applied Ecology, CAS

15:20-15:40 **Coffee Break**

15:40-16:30 **Plenary Addresses**

[Moderators: ***Jian-Ming Xu*** and ***Jack Parker***]

15:40 "Carbon and nutrient dynamics during storm events in a rapidly urbanizing watershed" by ***Qiang He***, University of Tennessee

16:05 "Transformation process of ^{15}N-labeled maize residue-N into soil microbial residues under different inorganic N addition levels" by ***Xue-Li Ding***, Institute of Applied Ecology, CAS

16:30-17:00 **Group Discussion on Soil and Water Resources Management Issues**

[Moderators: ***Jian-Ming Xu*** and ***Jack Parker***]

17:00-17:50 **Group Discussion on International Collaboration and Student/Scientist Exchange**

[Moderator: ***Xu-Dong Zhang*** and ***Timothy Filley***]

Topic: International collaboration and communication; China-US student exchange program

17:50-20:30 **Reception banquet (Haomawang Restaurant)**

20:30 **Coach return to Huaren Hotel or the Institute**

Thursday, January 7, 2010

07:00-08:30 **Breakfast at Huaren Hotel**

08:30-09:00 **Coach transport from Huaren Hotel to Institute of Applied Ecology**

Conference Focus on Soil Carbon and Biochemical Processes

09:00-09:40 **Keynote Addresses**

[Moderator: ***Donald Tyler*** and ***Jing-Kuan Wang***]

09:00 "Greenhouse gas source and sink functions of Chinese terrestrial ecosystem in recent 30 years" by ***Zu-Cong Cai***, Institute of Soil Science, CAS

09:40-10:00 **Coffee Break**

10:00-11:40 **Plenary Addresses**

[Moderators: ***Timothy Filley*** and ***Tu-Sheng Ren***]

10:00 "Carbon sequestration in terrestrial ecosystem (Csite) overview" by ***Donald Tyler***, University of Tennessee

10:25 "Functions of soil organic pools on soil structural stabilization and micro biological resilience" by ***Bin Zhang***, Institute of Agricultural Resources and Regional planning, CAAS

10:50 "Microbial transformation of fertilizer nitrogen and formation of soil nitrogen transitional pool" by ***Xu-Dong Zhang***, Institute of Applied Ecology, CAS

11:15 "Estimating regional changes in soil carbon using field methods and existing inventory data" by ***Neal Eash***, University of Tennessee, and Tristram West, Oak Ridge National Lab

11:40-13:00 **Buffet Lunch (Tianrun restaurant) and Poster Presentations**

13:00-13:40 **Keynote Address**

[Moderators: ***Neal Eash*** and ***Bin Zhang***]

13:00 "Aggregate hierarchy and the stabilization of root-derived organic matter" by ***Julie Jastrow***, Argonne National Laboratory

13:40-15:40 **Plenary Addresses**

[Moderators: ***Neal Eash*** and ***Bin Zhang***]

13:40 "Impact of long-term fertilization on the compositions of denitrifiers in paddy soil" by ***Wen-Xue Wei***, Institute of Subtropical Agriculture, CAS

14:05 "Carbon sequestration in agricultural soil as affected by nitrogen management" by ***Jing-Guo Wang***, China Agricultural University

14:30 "Feedbacks within the soil-macrofauna-litter system controlling soil organic matter dynamics" by ***Timothy Filley***, Purdue University

14:55 "Assessment of ^{15}N and ^{13}C incorporation into soil amino acids and amino sugars by chromatography-mass spectrometry techniques" by ***Hong-Bo He***, Institute of Applied Ecology, CAS

15:20-15:40 **Coffee Break**

15:40-16:30 **Plenary Addresses**

[Moderators: ***Julie Jastrow*** and ***Wen-Xue Wei***]

15:40 "Implications of manufactured nanomaterials on soil and water resources" by ***Ronald Turco***, Purdue University

16:05 "The mineralization of newly synthesized amino acids in soil manipulated by glucose and inorganic nitrogen application" by ***Wei Zhang***, Institute of Applied Ecology, CAS

16:30-17:10 **Group Discussion on Soil Carbon and Nutrient Issues and Biochemical Processes**

[Moderators: ***Julie Jastrow*** and ***Wen-Xue Wei***]

17:10-17:40 **Kickoff of China-US Collaboration Program for Soil and Water Research**

[***Xu-Dong Zhang*** and ***Jie Zhuang***]

17:40-18:00 **Concluding Remarks** [***Jack Parker***]

18:00 **Workshop Ends and Dinner** (**Tianrun restaurant)**

Friday, January 8, 2010

A day tour to Qipanshan Ice and Snow World (8:00-15:00) and departure

Administration and Services

Slides Pickup

Authors for oral presentation are expected to submit your slides on-site when registration on January 5. Other authors who arrive after January 5 are required to submit your slides at conference service room in Huaren Hotel. Please kindly pay attention to giving us your slides copy at least one day earlier before your presentation.

Poster Presentation

Location: Conference Room, Institute of Applied Ecology

All posters are displayed during the whole conference period. Poster presentation is arranged at 12:20-13:00 on January 6-7. Authors are expected to have your posters ready by 8:30 on January 6 and are required to stand beside the poster board for questions during the period. Please remove your poster after the conference.

Internet Service

Free internet service is available in the rooms of Huaren Hotel. Internet service is also provided in the conference room, but only for urgent email access.

Check-out Time

The check-out time is 14:00. After that, you will be charged additional room rate for one more day's stay.

Contact Us

For further information regarding the China-US Workshop, please contact:

Chair: Prof. Xu-Dong Zhang, E-mail: xdzhang@iae.ac.cn, Tel: +86-24-83970375,
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Presentation Abstracts

(By presentation order)

Models, uncertainty and cost optimization of water management decisions

Jack Parker

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The primary purpose of computer models for soil, water and other natural resources is to help make better decisions regarding the management of limited and valuable resources. In a free market economy, the best decision generally implies maximizing the net monetary benefit of the resource owner. In real economies today, political factors frequently override property rights and the “best” decision involves minimizing cost subject to compliance with political mandates. This is the situation when environmental regulations trump cost-benefit considerations. We thus seek to make decisions that minimize the cost of regulatory compliance. However, in complex systems, the cost outcome of a given decision is often far from clear due to uncertainty in physical variables, model accuracy, measurement error, unit cost estimates, etc. We can treat uncertainty by seeking to minimize the *expected value* of net present value (NPV) cost – i.e., the probability-weighted average of the cost for various possible outcomes. For more risk averse decision-makers, we may alternatively seek to minimize NPV cost upper confidence limit at a given probability level. An application is presented involving stochastic cost optimization of a groundwater remediation system design. The computational approach uses a computer model to predict remediation performance coupled with a module to compute net present value cost to meet defined remediation criteria given unit monitoring, operating and capital costs and discount rates, an inverse solution to estimate model parameters and their uncertainty from available data, an error analysis module to determine uncertainty in performance and cost, and a module to determine optimal decision variables to meet specified management objectives and minimize expected cost. The methodology can also be employed to assess the value of collecting additional data in terms of reducing NPV cost. Furthermore, when formulating models to solve real-world problems, one must make various assumptions about what processes to consider or disregard and what level of detail to include. Many people of the mistaken opinion that the “best” model is unquestionably the most rigorous and complex model that science offers. However, we demonstrate that more rigorous models can actually be less reliable than simpler models due to greater parametric uncertainty when the models are calibrated to the same data sets.

Biosketch: Jack Parker is a Research Scientist at the University of Tennessee’s Institute for a Secure and Sustainable Environment and the Civil and Environmental Engineering Department. Previously he was a Distinguished Research Scientist at Oak Ridge National Laboratory for 7 years, a Professor of Contaminant Hydrology at Virginia Tech and for 12 years, and President and founder of the consulting company Environmental Systems & Technologies, Inc. for 12 years. He has directed many research and consulting projects involving the modeling of multiphase subsurface contaminant transport at refineries, terminals, and other facilities. His research has focused on the development and testing of models for multiphase flow and chemical transport, remedial assessment and design optimization, risk assessment, inverse modeling, and analysis of model reliability. He has authored over 200 technical publications and served on numerous expert panels, advisory and review boards, and delegations for government agencies, professional groups, private industry and others. He has taught academic and short courses and presented workshops and invited seminars on modeling subsurface contaminant transport in some 15 countries. Computer models he developed have been employed in over 30 countries. He has served as an expert witness in numerous civil actions involving groundwater contamination with hydrocarbons and organic solvents.

Assessing crop water productivity in China: a hydrological modeling approach

Feng Huang, Bao-Guo Li

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Investigating the links between crop production and water use is crucial in addressing the intensified conflicts between water scarcity and food security. We proposed and developed an integrated analytical framework for approaching China's agricultural water use through incorporating the core concepts contained in the paradigm shift in water resource management in the recent decade, i.e. integrated river basin management, real water saving, water accounting, green water and blue water, effective irrigation efficiency, water productivity, and virtual water. The objective of the research is to investigate the region- and basin-scale crop water productivity (CWP) and associated green water (GW) and blue water (BW) depletion. An estimation method coupling hydrologic model SWAT and crop and water statistics was developed and validated. The overall performance of the method was acceptable, and it's appropriate in assessing basin-scale GW, BW and CWP in China. Within the time period of 1998 – 2007, the median CWP of grain crops in China is 0.839 kg m^{-3}. Of all the water that is potentially available for crop use, 57% comes from green rainfall water while the remaining 43% from blue irrigated water. In total water depleted in crop yield formation, around 60% derives from green water and 40% from blue water, confirming the critical role played by green water in crop production. The blue water depletion rate ranges from 0.48 to 0.87, with most of the basins exceeding 0.50; the green water depletion rate from 0.39 to 0.85, with the majority of basins being beyond 0.60. We conclude that both blue water and green water shortage will contribute to water scarcity in grain crop production. Hence, we proposed and defined a water bottom line for China's food security, and it is around 780 km^3. Both yield and CWP are already high by global standards and the scope for further enhancement is limited. The potential of improvement may be met by improving crop, soil and water management at and across all spatial scales, and breaking the barrier bottlenecking the breeding of high-water-use-efficiency varieties.

Climate and land use change impacts on water resources in the U.S.

Keith Cherkauer

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Land-use and climate change have the potential to significantly change the hydrologic cycle at local and regional scales. The Midwestern United States has experienced significant land use change with deforestation during European settlement, intense row crop agriculture in the 20^{th} century and continued urbanization. Additionally, the region is likely to get warmer and wetter under projections of future climate change, with a shift in precipitation to wetter winters and springs and summers either the same or drier. Analysis of observed climatic and hydrologic variables can provide insight into the changes that have occurred over the last century, but by calibrating and evaluating physically based hydrologic models using existing observations, those models can be used to extend observational records both spatially and temporally. The Variable Infiltration Capacity (VIC) large-scale model has been used to study land use and climate change impacts on the regional hydrologic cycle. In particular, it has been used to study changes in cold season processes (snow cover and soil frost), daily streamflow metrics and flood frequencies, soil moisture availability, drought frequency and large-scale erosion potential. This presentation will provide an overview of how historic climate data and future projections from global climate models (GCMs) have been used to study changes in water and energy fluxes using the VIC model in the Midwestern United States.

Biosketch: Dr. Cherkauer is an Assistant Professor of Agricultural and Biological Engineering at Purdue University. He received a B.A. in Physics from Augustana College, Rock Island, Illinois; an M.S. in Aerospace Engineering (Environmental Remote Sensing) from the University of Colorado, Boulder, Colorado; and a Ph.D. in Civil and Environmental Engineering from the University of Washington, Seattle, Washington. Before joining the ABE department in 2004, he worked for two years as a Research Scientist in Civil and Environmental Engineering at the University of Washington. Dr. Cherkauer works to integrate field based observations, remote sensing products and hydrology models to address questions and concerns related to environmental change and to further our understanding of land-atmosphere interactions and the hydrologic cycle. His recent research has included the impact of snow and soil frost on spring soil conditions, flooding and soil erosion; land use (deforestation and urbanization) and climate change impacts on the surface water and energy balance including streamflow variability and the occurrence and severity of drought; and using remote sensing to monitor water quality in river systems including water temperature, sediment transport and chlorophyll. Much of his work is focused on the upper Mississippi and Ohio Rivers basins and the Great Lakes drainage basin and their tributaries including the Wabash River watershed, however, his techniques are applicable to watersheds throughout the world.

Agricultural water management in the Hebei Plain: challenges and technologies

Tu-Sheng Ren[1], Chu-Sheng Hu[2]

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[2] *Center for Agricultural Resources Research, Institute of Genetic and Developmental Biology, Chinese Academy of Science, Shijiazhuang China*

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Water shortage has become the most limiting factor affecting social and economic stability of Hebei Plain, one of the most important agricultural regions in China. As the largest water consumer, agriculture has been recognized as the major cause for groundwater table decline and water shortage in the Hebei Plain. The objectives of the current study were to examine the major challenges in agricultural water management, and to explore viable options and technologies that will lead to the long-term water sustainability in this region. Our analysis indicated that to save water from agriculture, it is essential to reduce winter wheat the frequency in crop rotation, and to limit winter wheat planting area in Hebei. In addition, an integrated management strategy including proper cropping system, conservation tillage, and better irrigation technologies is required to improve water use efficiency.

Nitrogen cycling and ammonia oxidation microorganisms in terrestrial ecosystems as revealed by bio-molecular techniques

Ji-Zheng He

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Metagenomic and cultivation studies have revealed the existence of ammonia-oxidizing archaeon (AOA) containing all three ammonia monooxygenase subunits (*amoA, amoB* and *amoC*). AOA were found dominating in *amoA* gene copy numbers over AOB in 12 European soils. We recently investigated the abundance and community structure of AOA in acidic and alkaline upland agricultural soils, nitrogen (N)-rich grassland soils and paddy soils, and found their different characteristics in different soils. There were higher copy numbers of AOA *amoA* gene than bacterial *amoA* gene in the acidic red soils with pH ranging from 3.7 to 6.0. There was a significant positive relationship between the AOA *amoA* gene copy numbers and the potential nitrification rates (PNR) in these acidic soils. The alkaline soils (pH 8.3 - 8.7) under different fertilization treatments showed no significant changes in archaeal *amoA* gene copy numbers and the AOA compositions, although the archaeal *amoA* gene copy numbers were significantly higher than those of AOB. There were significant positive correlation between the bacterial *amoA* gene copy numbers and PNR, but no correlation between the archaeal *amoA* gene copy numbers and PNR. In the N-rich grassland soils, although AOA are present in large numbers in these soils, neither their abundance nor their activity increased with the application of an ammonia substrate, suggesting that their abundance was not related to the rate of nitrification. These results suggest that AOA are the numerically dominant ammonia oxidizers over AOB in most soils. They may actively involve in the nitrification of acidic soils, but not in the alkaline soils and N-rich neutral soils.

Almond organophosphate and pyrethroid use in the San Joaquin Valley watershed and their associated environmental risk

Xing-Mei Liu[1], Yu Zhan[2], Yu-Zhou Luo[2], Ming-Hua Zhang[2], Jian-Ming Xu[1]

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With the increased scrutiny of organophosphate (OP) due to surface water contamination concerns, there is an emerging reliance on pyrethroid pesticides. Pyrethroids are more economical to farmers, however, probably bring about new environmental issues. California Pesticide Use Report (PUR) database was used to determine the OP and pyrethroid use trends in the San Joaquin Valley (SJV) for almonds from 1992 to 2005. With high pesticide-use growers addressed, environmental potential risk indicator for pesticides (EPRIP) model was employed to evaluate associated environmental relative risks in soil and in surface water. Emission potential (EP) of pesticide product was used to estimate the air relative risk. GIS was used to delineate the spatial distribution patterns of environmental risk evaluation in almonds. Results showed that OP use decreased and pyrethroid use increased. Though the environmental behavior of pyrethroid is not well understood at present, the model results in this study showed evidence that pyrethroid posed less environmental risks to soil, air and water resources than OP.

Transport of colloid-associated contaminants in porous media

Jie Zhuang

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Colloid transport in the subsurface is of concern to drinking water quality due to introduction of viruses, pathogenic bacteria, protozoans, and colloid-/nano-sized industry materials, as well as the potential for co-transport of toxic chemicals sorbed to mobile mineral colloids. More than 2,000 articles have been published to address colloid transport, but the vast majority of the studies focused on water-saturated (groundwater) environments, even though most pathogens and toxicants enter groundwater via transport through the vadose zone, i.e., the shallow zone only partially saturated with water. Further, almost all studies of unsaturated systems are limited to steady state flow, while in nature flow in the vadose zone is dominated by alternate transient wetting and drying events (e.g., storms, or flushing toilets). Under steady-state flow conditions, air-water and air-water-solid interfaces are relatively stable and uniformly distributed in soil, resulting in persisting attachment of colloids at those interfaces. However, under transient unsaturated flow conditions, the transport is subject to temporal changes in water content and pore water velocity and thus in the thickness of water films and connectivity of flow paths. Movement of the air-water interface and the extent of air-water-solid interfaces have been found to promote colloid detachment and transport. Field studies demonstrate that soil colloids can be released in large concentrations during rainfall events, presumably due to hydrodynamic and chemical perturbations associated with the advancing wetting front. Water content/pressure and capillary forces have been reported to play a critical role during transient flow in controlling interfacial retention and transport of colloids. This presentation provides an overview on the influential factors and corresponding mechanisms controlling the deposition and transport of colloidal contaminants, including the interactions of complicated chemical and physical processes.

Biosketch: Dr. Zhuang is research director for the Institute for a Secure and Sustainable Environment (ISSE) and research associate professor in the Department of Biosystems Engineering and Soil Science at the University of Tennessee. He is also the coordinator of the China-U.S. Joint Research Center for Ecosystem and Environmental Change. Over the past two decades, Dr. Zhuang has worked on many challenging scientific research projects in the United States, Japan, and China. His research is focused on the fate and transport of contaminants (viruses, radionuclides, colloids, and munitions constituents) in the environment; soil carbon management; soil hydrology; and carbon-water-nitrogen fluxes of terrestrial ecosystems. He has published more than 40 research papers on high-profile international journals. Dr. Zhuang was a research fellow of Japan Society for Promotion of Science from 1998 to 2000. Currently, he is an editorial board member for three international journals, *Ecotoxicology*, *Environmental Management*, and *Pedosphere*. Dr. Zhuang also contributes a significant amount of his time to the China-U.S. Initiative launched by the University of Tennessee/Oak Ridge National Laboratory's Joint Institute of Biological Science and ISSE, with the aim of promoting U.S.-China collaborations in the areas of global environmental change, bioenergy sustainability, and international education.

Multiscale investigations of subsurface radionuclide and co-contaminants at the OR-IFRC site

Fan Zhang

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Multi-process and multi-scale modeling of the former S-3 Ponds waste disposal site on the Oak Ridge Reservation have been performed to develop a practical model to simulate the biogeochemical processes that control contaminant uranium mobility and ultimately to predict remediation of the geochemically complex site. The computer code HydroGeoChem v5.0 is a comprehensive model for fluid flow, thermal and reactive transport. HydroGeoChem was coupled with the nonlinear inversion code PEST and used as our primary modeling tool. Biogeochemical reaction models have been successfully built to analyze lab and field experiments. Parallel computers have been used to reduce the computational time and to address observation variability in calibrating the site-wide contaminant transport model. Reaction models developed through simulation of batch, column, and field experiments will be incorporated into the local-scale models to help interpret future on site investigation.

The eco-toxicology, and its function in the establishment of soil quality standards

Yu-Fang Song

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Based on the brief review on ecotoxicology, the eco-toxicity response of Earthworm and Followed by PAHs of sub-lethal PAHs (polycyclic aromatic hydrocarbons) was assessed. Phenanthrene (Phe), pyrene (Pyr), fluoranthene (Flu) and benzo(a)pyrene (Bap) represented of PAHs with different molecular weigh and rings were tested. Series experiments performed included as follows: the acute and chronic and reproduction test; cytchrome P450 (Cyt P450) assays and gene expression test with annetocin (a reproduction regulating gene), and TCTP (translationally controlled tumor protein), a tumorigenic response gene as the target genes. Adult earthworms *(E. fetida)*, 300 to 600 mg fresh weight were used and randomly assigned to brown meadow soil with PAHs added. All the experiments were performed and modified with in accordance with ISO protocol.

Results indicated that all of tested PAHs (Phe, Pyr, Flu and BaP) in soil have caused the changes of Cyt P450 activity dynamically during the period of test. And the response model for each PAH was varies from one to another indicating probability chronic metabolism toxicity on earthworm by Phe, Pyr and Flu., a stronger eco-risk by BaP.

The Annetocin and TCTP gene expression in earthworm on exposure to PAH contaminated soil indicated that Annetocin was up-regulated by 0.1 and 1.0 mg/kg benzo(a)pyrene significantly, and extent range of up-regulation was 58 and 83 times higher than control. Phe, Pyr and Flu have caused the up regulation on Annetocin in the concentration range from 1.0-10.0mg/kg. TCTP was up regulated by BaP, and the extent was 14 times in 0.1 mg/kg and 106 times in 1.0 mg/kg, TCTP was up -regulated by 0.1 and 1 mg/kg of Phe, and 1.0 mg/kg of Pyr, and1.0 and 10 mg/kg of Flu, but was down-regulated by 10.0 mg/kg of Phe significantly.

Our study indicated that the sub-lethal PAHs in soil have caused the changes of earthworm by Cyt P450 and Annetocin and TCTP gene expression. However, BaP showed the instant, longer and significant response, indicating its stronger toxicity of metabolism, reproduction and carcinogenesis, it showed significant eco-risk potential than other PAHs tested.

Carbon and nitrogen dynamics during storm events in a rapidly urbanizing watershed

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Dissolved organic carbon and nitrogen were monitored during storm events in the Beaver Creek Watershed, located in a rapidly urbanizing watershed in Northeast Tennessee, USA. A strong positive correlation between DOC flux and storm flow was observed during the most intense storms only. In contrast, the correlations between carbon flux and storm flow were increasingly weaker with decreasing storm flow rate. The increase in DOC flux during high storm flows could be attributed to the greater input of allochthonous organic carbon from land facilitated by the formation of preferential flow path of precipitation through the upper soil horizon during intense storm events, which reduced the potential of organic carbon loss due to sorption to soil at deep layers. The importance of terrestrial organic transport to stream water during high flows is also corroborated by the presence of high AHS fractions in DOC collected at high flow conditions, which is characteristic of humic substances derived from terrestrial organic materials. The nitrate level had strong negative correlations with storm flow, which was shown to primarily originate from groundwater flow. In comparison, the flux of phosphorus followed the trend of storm flow rate, which demonstrated that sources of phosphorous were primarily surface soil layers near stream and mobilization could be attributed to flushing by rainwater as expected.

Biosktech: Dr. Qiang He received his PhD in environmental engineering from the University of Illinois at Urbana-Champaign. He was a post-doctoral researcher at ORNL-ESD for two years before he joined UT as an assistant professor in 2007. His research is focused on developing sustainable management strategies for water quality in the changing environment and renewable energy production. He also has research experiences in bioremediation and wastewater treatment using molecular and functional genomics tools.

Transformation dynamics of ^{15}N-labeled maize residue-N into soil microbial residues under different inorganic N addition levels

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Identifying the effect of inorganic N addition on microbial transformation of plant residue-N into microbial biomass residues is crucial for understanding of microbial process during the plant residue decomposition and the factors controlling these processes in soils. Amino sugars as microbial biomarkers are usually used to elucidate C and N incorporation into microbial residues because they are also involved in microorganism-mediated soil organic matter cycling. Therefore, we conducted a 38-week incubation experiment where maize (*Zea mays* L.) residues labeled with ^{15}N (23.25 atom% ^{15}N) were added to a silt loam soil (Mollisol), along with a gradient of unlabelled $(NH_4)_2SO_4$. A new isotope based GC/MS technique was used to differentiate the maize residue derived amino sugars from those existed in soil. We found that greater amounts of maize residue-N, on average, were incorporated into amino sugars in lower (N_{low}) or no additional N treatments (N_0), while higher inorganic N addition rates (N_{med} and N_{high}) slowed down this transformation process during the early stages of the plant residue degradation. However, the trend was reversed at the later stages. The results indicate that sufficient inorganic N supply would prolong the time of nutrient release from the high C/N plant residues and enhance the potential of the microbial community to sequester plant N into their cell wall residues over the long term. Moreover, the declined percentages of newly-formed amino sugars were larger than soil inherent amino sugar portions, suggesting that the new amino sugar was preferentially decomposed by microorganisms when available N was depleted gradually in soils, and play an important role in mediating soil N cycling. Further, the dynamics of maize residue-N transformation into individual amino sugars were compound-specific. Newly-formed muramic acid played a more active role in mediating soil C and/or N cycles under nutrient or energy limitation, while newly-formed glucosamine as well as galactosamine were stabilized gradually with time and contributed to the long-term maintenance of soil organic matter. In conclusion, regulating inorganic N supply is necessary for enhancing the ability of the microbial community to sequester exogenous substrates into their biomass and residues and favors microbial-derived SOM formation.

Greenhouse gas source and sink functions of Chinese terrestrial ecosystem in recent 30 years

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Terrestrial ecosystems act as a source or sink for the atmospheric greenhouse gases carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), depending on land use and management. The paper presents a review of the literature on carbon, CH4 and N2O fluxes from the terrestrial ecosystems in China and analyzes its greenhouse gas budget. Carbon storage in biomass and soils in Chinese terrestrial ecosystems reached a minimum in the late 1970s, and then increased in the last three decades with an estimated rate ranging from 0.19 Pg C y-1 to 0.26 Pg C y-1 mainly due to reforestation and afforestation. During the same period, CH4 emission from natural wetlands was estimated to be 7.21 Tg CH4 y-1 and that from flooded rice fields was 7.41 Tg CH4 y-1. At the same time aerobic soils took up atmospheric CH4 at a rate of 2.45 Tg CH4 y-1. Nitrous oxide emission from forestlands, grasslands and farmlands was positively correlated with precipitation at the national scale, and the emission rate was positively correlated with CH4 uptake rate in forestlands and grasslands (P<0.01). The natural N2O source was estimated to be 456 Gg N y-1 and the anthropogenic source (from farmlands) to be 292-476.3 Gg N y-1 with a mean of 372.6 Gg N y-1. The integrated budget of greenhouse gas indicated that Chinese terrestrial ecosystems acted as a small net sink of global warming potential (GWP), ranging from 0.01 Pg CO2-eq y-1 to 0.26 Pg CO2-eq y-1, presenting a striking contrast to global terrestrial ecosystems, which were a source of 2.75-6.78 Pg CO2-eq y-1. However, the ratios of anthropogenic sources of CH4 and N2O to the natural sources were much larger in Chinese terrestrial ecosystems than the global averages, reflecting greater human disturbance on terrestrial ecosystems in China. > > Key words: Terrestrial ecosystems, Carbon dioxide, Methane, Nitrous oxide

Carbon sequestration in terrestrial ecosystem (Csite) overview

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The CSiTE project is a multi-lab, Oak Ridge National Lab (ORNL), Argonne National Lab (ANL), and Pacific Northwest National Lab (PNNL) that has been in progress for 10 years. A new science focus area has been developed that builds on the research done previously. The last 5 years of research were in collaboration with the University of Tennessee (UT) using switchgrass (Panicum virgatum) Research plots at the UT Milan Research and Education Center, Milan TN. These were begun in 2004 to investigate switchgrass as a potential bioenergy crop and develop specific production recommendations. The plots used involved cultivar comparisons, and seeding rate-nitrogen rate interaction studies. Above and below-ground biomass, soil carbon, soil microbial community structure, and soil aggregation were some of the variables being investigated. The new plan involves an expansion of this work to include switchgrass and big bluestem (Andropogon gerardii) on newly established sites at Fermi Lab, near ANL and at the Milan Center. These experiments will also involve in-depth measurements to determine processes of carbon storage and sequestration. Twenty four scientists from the three national labs and three universities will be involved. The overarching goal is to provide an improved and quantitative understanding of basic processes that control carbon sequestration in managed ecosystems.

Biosketch: Don Tyler was raised on a dark-fired tobacco and beef cattle farm in the far western portion of KY in Graves, Co. near Mayfield, KY and graduated from Lowes high School in 1968. He graduated for Murray State University, Murray, KY in 1972 with a B.S. degree in agriculture and chemistry. He received his M.S. degree in 1975 and his Ph.D. degree in soil chemistry from the University of Kentucky in 1978. Since then, he has been employed by the University of Tennessee at Knoxville in the Biosystems Engineering and Soil Science Department. He is stationed off the main campus at the West Tennessee Research and Education Center in Jackson, TN. He was promoted to the rank of Professor in 1991. His research has emphasized no-tillage cropping systems, cover crops and soil erosion control. He is presently involved with a large team investigating biomass cropping systems, mainly switchgrass, for bioenergy production. He has authored or co-authored over 65 refereed publications and numerous other proceedings and abstracts. He has traveled, representing the University of Tennessee, to Thailand, Mexico, Germany, South Africa and Lesotho, Africa to speak on no-tillage cropping and bioenergy production. He has also made two trips to China, in 2006, and 2008, to give seminars on no-tillage and cooperate on research between UT and the Chinese Academy of Sciences.

Functions of soil organic pools on soil structural stabilization and micro biological resilience

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Soil organic carbon (SOC) can be physically fractionated into different pools (mineral associated organic carbon (mSOC), particulate organic carbon (POC) and dissolved organic carbon (DOC)). They may have played different the functions on soil physical and microbial stability due to difference in decomposability, mobility and hydrophobicity as well as different locations within soil structure. Series of incubation and simulation experiment were conducted to isolate the functions of the active soil organic carbon pools of DOC and POC.

After 18 years of revegetation on a severely eroded bareland, SOC, mSOC, POC and DOC increased dramatically, resulting in largest proportion in mSOC, followed by POC and lowest in DOC. Soil wet stability was mostly correlated to SOC and mineral associated organic carbon (mSOC). However, POC was significantly correlated to total porosity, suggesting the significant effect of SOC and POC on soil aggregation. Dissolved organic carbon (DOC) was enriched on the surface of aggregate with repeated wetting and drying cycles, resulting in enhanced soil water repellency (SWR) if DOC originates from hydrophobic substances. SWR was more closely correlated to SOC and to hydrophobic DOC (H-DOC) concentration than to total DOC and hydrophobic acid (HA-DOC) in the top soil. The humification and aromaticity indices of DOC indicated that greater SWR can be attributed to greater amount of litter fall and more active microbial decomposition. SWR was significantly correlated to tensile strength (TS), wet stability (WS), suggesting that the combined influences of soil organic compounds binding and coating soil particles, retarding water wettability and modifying soil porosity are probably extremely important mechanisms of mechanical stabilization in soil. Although POC was less correlated to soil wet stability, POC encapsulated within soil aggregates with wetting and drying cycles resulted in higher cohesion and mechanical resilience. In addition, destroying the soil aggregate structure increased the microbial resilience only for the revegetated soil with higher POC content through altered its bacterial community structure, suggesting that soil aggregation may contribute to the generation of bacterial community structure and mediation of microbiological stability through the protection of soil organic carbon.

Microbial transformation of fertilizer nitrogen and formation of soil nitrogen transitional pool

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Nitrogen fertilizer consumption was increased rapidly in China since 1980s. However, low N utilization efficiency led to not only high cost for agricultural production but also environmental issues due to N losses from soil. Therefore, the improvement of soil ability to optimize the process of fertilizer N transformation and storage in organic forms is essential to reduce the N loss. Amino acids and amino sugars are highly involved in the microbe-driven N cycling. The differentiation between fertilizer-derived N-containing compounds and the originally existed portion in soil was obtained by using a ^{15}N-labeling and GC/LC-MS technique. It was found that the conversion of fertilizer N into microbial metabolite and structural compounds of microbial cell wall indicated by amino acids and amino sugars in soil was governed largely by C substrate supply. When C substrate supply was sufficient, large amounts of fertilizer N could be transformed into amino acids and amino sugars. In addition, the newly-synthesized compounds could be mineralized to compensate microbial or crop requirement for N upon available N deficiency. Interestingly, the mineralization rate was regulated by inorganic N levels in soil. The findings indicate that there is transitional pool of soil N, which contributes our new understanding of N cycling in soil.

Estimating regional changes in soil carbon using field methods and existing inventory data

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Many countries in sub-Saharan Africa continue to be food importers despite a substantial monetary influx in the form of food relief, subsidies, or development projects. Currently there is interest in 1) improving food production through sustainable conservation agricultural practices that will 2) include more diverse rotations with a goal of year round residue- or plant-cover, and 3) increase soil carbon levels. One criterium for determining agricultural sustainability is to document increased soil carbon levels. Full carbon accounting of terrestrial ecosystems is intended to account for changes in soil management practices and changes in resulting carbon dioxide emissions. Work is ongoing in the Midwest U.S. to develop a full carbon accounting framework that can be used for estimates of on-site net carbon flux or for full greenhouse gas inventory at a high spatial resolution. Because terrestrial carbon databases are limited for much of Africa, out approach will be to collect baseline soil carbon data from research sites with contrasting soil management practices in Malawi, Mozambique, and Lesotho as part of a funded five-year USAID. Soil carbon dioxide flux, total soil carbon values, and high resolution remote sensing will be used to begin to build databases in Africa similar to those in the U.S. capable of predicting regional or national changes in soil carbon based upon changes in soil management practices.

Biosketch: Neal Eash is an Associate Professor in Biosystems Engineering & Soil Science at the University of Tennessee (55% teaching, 45% research). His research area is in soil fertility and carbon cycling in organic production systems. He has ongoing no-till research in Lesotho and Thailand. He also continues to farm his home 160-acre farm in Ohio using only no-till methods. Eash grew up on a farm in north central Ohio and farmed on his own for several years prior to going to Africa. In the early 1980's he worked in Botswana, Africa as an agricultural extensionist for over three years with Mennonite Central Committee. While in Botswana, Neal assisted local subsistence farmers to increase food production. In 1987 he received his B.S. degree in agronomy from Iowa State University. In July, 1986, Neal collected soil samples for his M.S. thesis which evaluated the effects of 1500 years of near-continuous agriculture in the Colca Valley, Peru, that was funded through the Lindbergh Foundation and the National Science Foundation. His Ph.D. research focused on the effects of the soil fungi on soil aggregation and quality. After completing his Ph.D. in 1993 he accepted an Agricultural Extension Specialist position with the University of Tennessee. While working in Tennessee he presented information on biosolids marketing and utilization, municipal solid waste composting, and food waste composting in venues ranging from wastewater treatment plants in Memphis to several prisons throughout the state of Tennessee. Eash was successful in securing extramural research support to evaluate nitrate loading rates in constructed wetlands and utilization of co-composted biosolids on agronomic crops. In 1997, Eash accepted a teaching/research position with the University of Minnesota where he and a co-worker established a unique collaborative agronomy teaching program at Southwest State University (SSU). Students enrolled in this program could take all of their classes at SSU and graduate with a degree from the University of Minnesota. This program quickly grew from five students in the Fall of 1997 to more than eighty two years later requiring the hiring of additional faculty. While at the University of Minnesota Neal conducted extramurally funded research on soil carbon dioxide flux, using strip tillage to maintain erosion control while maximizing yields, and deep banded fertilization in medium- and high testing soils. In 2001, Eash and two co-workers received a USDA Challenge grant that provided students the opportunity to compare environmental and agricultural issues in the Florida Everglades, Brazil, and Costa Rica.

Aggregate hierarchy and the stabilization of root-derived organic matter

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Nearly ideal conditions for soil aggregate formation and stabilization exist in the rhizosphere. In soils with a legacy of exploration by roots, a hierarchical aggregate structure often develops across multiple spatial scales. As fibrous roots grow, they exert pressures and locally dry the soil causing soil particles to be pushed and drawn together at the same time that exudates and rhizodeposits support a diverse microbial and faunal community. Roots and the hyphae of associated mycorrhizal fungi serve as a flexible latticework that enmeshes and stabilizes larger aggregates. Because root turnover often occurs within the inner space of soil aggregates, the decomposition process leads to the formation and stabilization of microaggregates within macroaggregates and development of an aggregate hierarchy. The resulting physical structure feeds back to impact decomposer access to substrates, air, water, and nutrients, thereby affecting decomposition and soil carbon cycling and sequestration. These processes will be examined by synthesizing results from studies of the gradients provided by a chronosequence of tallgrass prairie restorations, where frequent burning limits the inputs of surface litter to soil organic matter. Early chronosequence studies investigated the direct and indirect causal effects of roots and mycorrhizal hyphae on macroaggregate stabilization and demonstrated the spatial scale at which these effects operate. More recent research has confirmed this rhizosphere-dominated system has steadily accrued soil carbon for 30 years and explored the nature and spatial location of accumulated carbon. Most of the carbon accrual occurred in the silt-sized component of microaggregates stabilized within macroaggregates. However, rates of carbon accrual differed among various physically isolated fractions, suggesting that some pools reach steady state faster than others or that the storage capacity of some pools may be limited while other pools continue to accumulate carbon. A key mechanism limiting storage capacity appears to be fine-scale pore architecture and pore filling, which may occur via organomineral agglomeration or mineral encapsulation of colloidal organic matter. Continued carbon accrual then depends on how well organic matter can be stabilized in larger scale pores. In conclusion, the stabilization of root-derived organic matter is facilitated by turnover of roots in intimate association with the self-organizing structure of soil solids and pores.

Biosketch: Julie Jastrow is a terrestrial ecologist in the Biosciences Division at Argonne National Laboratory. She holds a B.S. and M.S. from the University of Illinois at Urbana-Champaign and earned a Ph.D. in biological sciences from the University of Illinois at Chicago. Dr. Jastrow has contributed to research on restoration ecology, mycorrhizae, plant-soil interactions, and soil structure. Her current research activities are focused on the mechanisms and processes controlling soil carbon cycling and sequestration. She is one of three chief scientists for the U.S. Department of Energy's Consortium for Enhancing Carbon Sequestration in Terrestrial Ecosystems (CSiTE), is a past President of the Soil Ecology Society, served as a Consulting Editor for the journal *Plant and Soil*, and was a member of the National Academy of Sciences Frontiers in Soil Science Research Workshop Steering Committee.

Impact of long-term fertilization on the compositions of denitrifiers in Paddy Soil

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The objective of this study was to explore the impacts of 17-year application of inorganic and organic fertilizer on the activity, abundance and composition of the denitrifying community. Soil samples were collected from CK plots (no fertilizer), N (nitrogen fertilizer), NPK (nitrogen, phosphorus and potassium fertilizers) and NPK+OM (NPK plus organic matter). The activity was measured in the term of potential denitrification rate. The *nirK*, *nirS*, *nosZ* gene community compositions were analyzed using terminal restriction fragment length polymorphism (T-RFLP) and the abundance was determined by quantitive PCR. Denitrifying enzyme activity (DEA) was significantly correlated with the abundance of denitrifiers. Both the largest abundance of the denitrifiers and the highest DEA occurred in the NPK+OM treatment, and the lowest was in CK treatment. Of the measured abiotic factors, soil carbon content was highly correlated with observed differences in community composition and DEA. This study shows that the addition of different fertilizers affects the activity, abundance and the composition of the denitrifying communities in paddy soil.

Carbon sequestration in agricultural soil as affected by nitrogen management

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Increase in soil organic carbon pool in the Chinese agricultural soil during 1980's to 2000 could be, to a great extent, attributed to increasing application of fertilizer nitrogen, resulting in increase in net crop primary production. This has been confirmed with the long-term fertilization experiments.

However, further increase in N use in agricultural soil to increase carbon sequestration is questionable, as the N overuse became common in China. In fact, the optimal application of N led to the highest carbon input through rhizodeposition.

Among all of the factors influencing soil carbon sequestration, nitrogen use is easily manageable. Nitrogen not only affects net plant primary production and plant chemistry, consequently on soil organic carbon input and decomposability, but also bring about significant influence on organic carbon transformation in soil. The best N management objective is to maximize carbon input and minimize the carbon output.

Feedbacks within the Soil-Macrofauna-Litter System controlling soil organic matter dynamics

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Important insights into the dynamics of biogeochemical cycling of soil and litter have been made through the structural and isotopic characterization of their constituent plant-derived biopolymeric components. These investigations span spatiotemporally from micron to continental basin scale and from annual cropping cycles to the paleoclimate records. Recent work exploiting the natural isotope shifts in plant communities or applying enrichment labeling techniques has demonstrated how organic matter derived from biopolymers such as lignin, cutin, and suberin are decomposed, partitioned, stabilized or destabilized in nature. By far, most studies that combine compound-specific isotope analysis (CSIA) and molecular quantitation in terrestrial systems have focused upon lignin as it provides a relatively higher level of discrimination among botanical sources and is well suited to track input from natural and agroecosytems to soil and rivers. Indeed, the CSIA of lignin phenols in litter and soil particle fractions has helped to change the perception of lignin as a “refractory” biomolecule in mineral soil and focus attention on aliphatic and microbial macromolecules for long term soil organic matter stabilization. Building from this, greater research attention is being paid to aliphatic polyesters like suberin and cutin which, because of differences in chemical structure, have the capacity to help discriminate among foliar/shoot and root inputs to soils and their relative importance in soil organic matter accrual. This talk will highlight some of these important applications and developments. New research on the stabilization/destabilization of soil organic matter, as a result of changes to above and below ground productivity from an enhanced atmospheric CO_2 forest experiment, will also be discussed. Additionally, CSIA of lignin, cutin and suberin from invertebrate fecal pellets in forest soils will illustrate the potential role that these organisms play in the selective packaging and delivery of root and foliar tissue to soil particles and how they can contribute to accumulation patterns of plant organic matter observed in soil.

Biosketch: Dr. Timothy Filley is an Associate Professor of isotope geochemistry in the Department of Earth and Atmospheric Sciences (EAS), Purdue University. He also serves as the Associate Department Head for the EAS Graduate Program. He received his B.S. in Chemistry from Loyola University of Chicago, his Ph.D. in Geochemistry from the Department of Geosciences, The Pennsylvania State University, and he was a Carnegie Institution of Washington Postdoctoral Fellow from 1998-2000. Dr. Filley was elected national program chair for the Geochemistry Division of the American Chemical Society from 2006-2007. His expertise is in the area of ecosystem and environmental biogeochemistry. A central theme of his group’s research is the response of terrestrial ecosystems to environmental change, such as land use and land cover change (agriculture and rangeland activity), hydrologic pulses (storm events), climate change (increased atmospheric CO_2), and invasive species (e.g. invasive invertebrate activity). He and his group track these impacts by observing the chemical (elemental and molecular) and stable isotopic transformations of plant and microbial biomolecules stored within litter, soil organic matter, and stream and river aquatic fractions. These studies comprise both field- and laboratory-scales, using a variety of spectroscopic and analytical techniques to investigate the fundamental controls on SOM stabilization, the fate of emerging pollutants, such as manufactured nanocarbon, in soils, the chemical mechanisms of plant tissue biodegradation in nature as well as in biofuels applications, and the multiple physical and chemical fates of terrestrial organic carbon as it is exported to rivers and lakes.

Assessment of ^{15}N and ^{13}C incorporation into soil amino acids and amino sugars by chromatography-mass spectrometry techniques

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Identifying the transformation process of amino acids and amino sugars was essential to probe into the fate and turnover of soil carbon and nitrogen due to their important roles in the biogeochemical cycling of vital elements. However, because both amino acids and amino sugars are stably accumulated in soil, their transformation dynamics can only be achieved by differentiating between the newly bio-synthesized and the inherent compounds, which was relied on the isotope tracer method, i.e., the labeled portion was derived from the immobilization of the extraneous substrates. We, therefore, developed a novel method combining ^{15}N or ^{13}C–containing substrate labeling and gas (liquid) chromatograph/mass spectrometry technique to trace ^{15}N and ^{13}C isotope incorporation into amino sugars and amino acids. The MS determination was conducted by a full scan mode and the intensity of the compound-specific base peak (F) as well as the adjacent minor peaks was monitored. The enrichment of ^{15}N in the target compound was evaluated according to the intensity ratio of mass $F+n_N$ to F (n_N is the nitrogen atom number in the underivatized fragment structure in amino acids and amino sugars). And accordingly, the intensity ratio increment of m/z $F+n_C$ to F (n_C is the original skeleton carbon number in each fragment) indicated the direct ^{13}C-glucose conversion to soil amino acids and amino sugar. The enrichment of ^{15}N or ^{13}C in amino acids and amino sugars during incubations was estimated by calculating the atom percentage excess (APE). In principle, the calculated APE represented the carbon or nitrogen turnover velocity of individual amino acids induced by the available substrates. And furthermore, based on both the content and APE of each amino acid and amino sugar, the labeled and unlabeled portion can be differentiated definitely, allowing us to detect incorporation of new C or N atoms into microbial metabolites and residues during bio-chemical process in soils, thus laid solid foundation to investigate the dynamics of soil amino acid and amino sugar pool.

Implications of manufactured nanomaterials on soil and water resources

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The potential for release of manufactured nanomaterials, such as fullerenes, fullerols, carbon nanotubes, and nanometals to the environment, either as spills, emissions from manufacturing as or loses from finished products, is foreseeable. Moreover, the potential use of nanomaterials in environmental systems is also inevitable and desirable. As history suggests, key ecological aspects of the introduced materials should be assessed before widespread use of the technology is undertaken. While studies to evaluate the effects of manufactured nanomaterials in aqueous environments and pure culture systems are becoming more common, limited work has been undertaken to scrutinize the effects of manufactured nanomaterials on soil and soil processes. Clearly, the impact on soil systems should be considered as other studies have indicated a toxic effect of some nanomaterials on both prokaryotic and eukaryotic organisms. In this presentation, the impacts of fullerene (C60), an aqueous dispersion of C60 (nC60) and other nanomaterials (nanometals) on soil microbial functions underpinning soil processes will be reviewed and discussed.

Biosketch: Dr. Ronald F. Turco is a Professor in the Department of Agronomy and Director of the Indiana Water Resources Research Center. He has BS degrees from the University of Idaho in Bacteriology and Soil Science and a Ph.D. from Washington State University in Soil Microbiology. His research has concentrated on understanding how the behavior of microorganism and the processes they control in environmental systems, is influenced by human activity. His current projects are divided in three areas: 1) understanding the dynamic interactions controlling the fate of pathogenic bacteria introduced into soil and water, 2) developing a system to provide a better predictive capacity to the environmental fate of manufactured nano materials (fullerenes, single wall carbon nanotubes and nanometals) introduced in soil and water, and 3) defining the unintended consequences of biofuel production on the long-term functioning of soil resources. He has authored many articles and reports and has delivered numerous invited and volunteered presentations. Dr. Turco teaches two graduate level courses: Soil Microbiology and Biotransformation of Anthropogenic Molecules and he teaches an undergraduate course entitled Soil Ecology.

The mineralization of newly synthesized amino acids in soil manipulated by glucose and inorganic nitrogen application

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The microbial immobilization of inorganic N to organic compounds in soil such as amino acids after nitrogen fertilizer application was essential to decrease the fertilizer-N leaching. Organic nitrogen was not the major form directly for plant uptake, so it was necessary to put focus on the mineralization of this newly synthesized amino acids polymer. However, the decomposition of this newly synthesized amino acids polymer could not be investigated clearly until they were differentiated from the inherent portions in soil by using the ^{15}N isotope tracing technique. Therefore, the goal of our study was to investigate the mineralization process of the newly synthesized amino acids polymers by evaluating the dynamic of ^{15}N enrichment and the enzyme activities of protease and arylamidase. A laboratory mineralization experiment was carried out with glucose as carbon source and $(NH_4)_2SO_4$ as N source. The ^{15}N enrichment in each amino acid was determined by LC/MS. Our results showed that the mineralization rate of the newly synthesized amino acids was faster than the inherent portions in soil and the mineralization process of amino acids was compound-specific. Glucose could significantly improve both the protease and arylamidase activities, whereas the mineralization of the newly synthesized amino acids was not enhanced in this case. Nitrogen addition could inhibit the two enzyme activities; however, the influence of nitrogen addition on the mineralization process of the newly synthesized amino acids was dependent on the nitrogen addition levels. We supposed that the inhibition effect of nitrogen addition may be the key to regulate the mineralization process of the newly synthesized organic compounds.

Effect of long-term fertilization and plastic mulching on organic fractions and microbial diversity in brown earth

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Soil organic carbon plays a crucial role in the cycles of almost all the major plant nutrients. Soi1 microbia1 community is an important measure of sustainable 1and use and is sensitive to changes in the soi1 as the alarm signal and sensitive index. So organic fractions and microbiological characters and diversity have been focused. Based on 20-years-old (1987-2007) located brown earth experiment site at Shenyang Agricultural University, Liaoning Province, the methods of organic fractions and PLFA and PCR-DGGE were used to determine the change of organic fractions and microbial diversity in the long-term fertilization and plastic mulching soil in order to explore the effects on their inter-relation between soil organic fractions and microbial diversity. The main results were as follows:

1.Organic fractions in treatments were affected by the 20-years-old fertilizations. The contents of total organic carbon in treatments of M4 and M4N2P1 were 25.1% and 35.4% higher than that of CK, respectively, while those of treatment of N4 was 1.7% lower than that of CK. The proportion of labile organic carbon in the total organic carbon in M4 was 62.5% higher than that of CK, while those in treatments of M4N2P1 and N4 were 12.5 % and 59.1 % lower than that of CK, respectively. The proportion of DOC in the total organic carbon in treatments of N4, M4 and M4N2P1 were 28.4%, 27.6% and 37.9% lower than that of CK, respectively. The proportions of microbial biomass carbon in the total organic carbon in treatments of M4 and M4N2P1 were 118.1 % and 5.6 % higher than treatment of CK, respectively. The proportion of particulated organic carbon in the total organic carbon in treatments of M4 and M4N2P1 were 65.3%and 4.8% higher than that in CK, while that of N4 was 21.8%lower than that of CK.

2. The contents of total organic carbon and organic fractions were decreased after 20-year-old plastic mulching. Total organic carbon in covered treatment of N4 was higher than that of uncovered soil significantly. The content of labile organic carbon in covered treatment of CK was higher than that of uncovered soil, but the DOC was lower than that in uncovered soil. The microbial biomass carbon in covered treatments of CK, N4 and M4 was lower than that of corresponding uncovered treatment respectively. While there was no significant difference in particulated organic carbon between covered and uncovered treatments.

3.Total contents of PLFA were changed after 20-year-old long-term cultivation in the order, M4N2P1 > M4 > N4 > CK. The trend of soil microbial community changed obviously because of different fertilization. Application of manure could increase bacterial diversity, while single application of inorganic N fertilizer could decrease it. There was no significant effect of long–term plastic mulching on the total content of PLFA. The microbial community structure in covered treatments trended to identical development despite of different fertilization treatments. The bacteria diversity in treatments of N4 and M4 was decreased by plastic mulching.

4. There are some intimate relations between Shannon-wiener, total organic carbon and labile organic carbon, microbial biomass carbon and particulated organic carbon. The organic fractions could be indicative index to soil health. The microbial diversity of soil was also the indication of change on active organic fractions of soil and soil fertility.

Poster Abstracts

P1. Seasonal variability of CH_4 fluxes from three landuse types soils in Three Gorges area, Central China

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CH_4 fluxes of agricultural soils in subtropical ecosystem are required. To fulfill this, a four-year campaign was started to determine the temporal CH_4 fluxes from three land use types (vegetable field, uplands, orchards) at Zigui county, located in Three Gorges Reservoir Area, subtropical China (from 23 April-2004 to 20 December-2008). Impacts of key environmental drivers (soil temperature and soil moisture, NO_3^-–N and NH_4^+–N contents), and land use on CH_4 fluxes were presented. Our results suggested that soil were sinks of atmospheric CH_4. Annual mean CH_4 fluxes were –0.09 ~ –1.30 kg CH_4 ha^{-1} yr^{-1}. Vegetable field had significantly lower CH_4 uptake than other two agriculture land uses. Every year, the climate was warm and wet from April through September (the hot-humid season) and became cool and dry from October through March (the cool-dry season). The CH_4 fluxes and environmental variables (soil temperature, water filled pore space (WFPS), soil NO_3^-–N and NH_4^+–N contents) had a significant seasonal variability. CH_4 uptake was significantly higher in cool-dry season than in hot-humid season. Soil CH_4 fluxes were associated with all the environmental derivers with combined R^2 of rang from 0.30 to 0.47, respectively, and CH_4 flux was strongly related with WFPS and soil NH_4^+–N contents. As a result, CH_4 fluxes from different land uses strongly depended on different climatic predictors along with soil nutrient status, which interacted in conjunction with each other to supply the readily available substrates for the gas fluxes from the subtropical soils.

P2. Effect of long-term fertilizer application on the balance and transformation of soil inorganic carbon in North-China Plain

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Soils play a significant role in the global carbon cycle. Soil inorganic carbon (SIC) is most abundant in arid and semi-arid regions, where the soil may contain 2 to 5 times more SIC than SOC. High CO_2 concentration in soil resulting from microbial and root respiration is the main factor controlling the dissolution of pedogenic carbonates, their re-crystallization and formation of pedogenic carbonates under these conditions. This is one important feature in the transformation of SOC to SIC. However, the role of the SIC pool on the greenhouse effect is less well understood. Four Long-Term fertilizer application stations in North-China Plain were studied to understand the effect of long-term fertilizer application on the amount and rate of organic and inorganic C accumulations and soil total carbon (STC) pool losses and gains. Our results suggest that changes of STC and SOC poll after the long-term fertilizer application were different, especially application of N fertilizer and manure or chemical fertilization with straw incorporation. The effects of different fertilizer application more than 20 years on the relative content of pedogenic carbonate (PC) and SIC were different, with the increase of SIC content, the ratio of PC were decrease, especially NP application or NP with manure incorporation. But, N application was opposite. These results indicate that it is important to include SIC pool in the accurate evaluation of the impact of fertilizer on the balance of soil total carbon pool in arid and semi-arid region.

P3. The transformation of amino sugars in Mollisol manipulated by glucose and inorganic nitrogen application

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Microorganisms are highly involved in soil organic matter cycling. Different substrate application influenced soil microcosm environment and thus the microbial metabolism process was changed. However, as microbial residues the dynamics of amino sugars is still kept unclear. The turnover of the amino sugars and the shift of microbial community can be indicated by tracing the isotope enrichment in amino sugars after incubation with glucose and ^{15}N-containing inorganic nitrogen added in different forms and time intervals. The transformation pattern of amino sugars was compound-specific with the turnover of muramic acid the fastest while that of galactosamine the lowest. The isotope enrichment difference between muramic acid and glucosamine suggested that bacteria were more favor of available substrates in short period but the shift to fungi-dominant community occurred in long term incubation even if the substrates was applied continuously. The dynamics of amino sugar pool was depended on both individual compound and substrate application. All three kinds of amino sugars were decomposed in the case of carbon deficiency, while after glucose addition, the accumulation of glucosamine was evident in the amendments but muramic acid was decomposed significantly when nitrate was applied once a week or ammonium applied every two weeks. Furthermore, expect glucosamine in the ammonium addition once a week, the synthesis of amino sugars was accompanied with the decomposition, especially of muramic acid in NO_3^- amendment. Considering the heterogeneity of amino sugars, we deduced that fungal cell wall residues tended to be accumulated in soil matrics and mainly contributed to the stabilization of the soil organic matter, while the turnover of bacterial cell walls was rapid and the accumulation was transient, playing active roles in compensating the carbon and nitrogen demand. Our investigation was essential to probe into the turnover mechanism of amino sugars and improve their microbial significance in soil organic matter cycling as well.

P4. Effect of long-term phosphorus fertilization on microbial community structure and its seasonal dynamics in arable Mollisol

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Phosphorus fertilization is one of the most important P resources to crops in Mollisol. Soil samples of 4 long-term fertilization treatments, i.e. CK (control), P (mineral phosphorus fertilizer), M (pig manure) and MP (pig manure plus mineral phosphorus fertilizer), were collected to investigate the effects of phosphorus application and its combination with pig manure on microbial communities in Mollisol and their seasonal dynamics at corn seedling stage, large bell stage, grain filling stage and harvest time , respectively. Phospholipid fatty acids (PLFAs), soil microbial biomass Carbon (C_{mic}) and alkaline phosphatase were determined for this aim. The results showed that although the phosphorus contents in P treatments were obviously higher than those without P, the crop yields in P treatments were both lower than those corresponding no-P treatments. Furthermore, alkaline phosphatase activities, specific PLFA contents of fungi in P treatments were significantly lower than those without P. As for bacterial PLFAs contents, no significant difference was observed between CK and P treatments, but the obvious decline was observed in MP treatment in contrast with MCK. C_{mic} contents in P treatment was obviously higher than CK at early crop growth stages, however, C_{mic} in MP was significantly lower than M during late crop growth stages especially for grain filling stage. The great variations of soil microbial community during the crop growth stages across different treatments were also investigated. In CK and P treatments, the contents of C_{mic}, and bacterial or fungal PLFAs were relatively lower in early crop stages than late ones, and reverse trend was observed for alkaline phosphatase activity; and generally, the single application of mineral phosphorus resulted in more significant difference between grain filling stage and harvest time. On the other hand, in pig manure treatments with or without mineral phosphorus, the highest microbial community populations or activities was observed at early crop growth stages such as seedling and bell stages. The factor analysis of PLFAs showed that the application of farmyard manure and crop growth strongly affected the soil microbial community structure.

P5. Neutral sugar accumulation and distribution in particle-size fractions of a Chinese Mollisol as affected by long-term fertilizations

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The pool of carbohydrate constitutes a significant portion of soil organic matter. The complex biological, chemical, and physical processes involved in SOM turnover can partly be deduced from the dynamics of soil carbohydrates. Both the concentration and composition of the neutral sugars (NS) can be used to assess plant–microbe relationships in SOM dynamics. The NS in particle-size fractions were therefore measured to assess the influences of organic manure and chemical fertilizer application on the characteristics of the size pools. A long-term experiment of fertilizations was set up in the Mollisol area (Gongzhuling, China) in 1979 and the composite soil surface samples (0-20cm) were collected in 2005 from 12 treatment plots, including 3 series of treatments, organic manure, chemical fertilizers and the combination of both. Afterwards, the samples were fractionated into fine clay (<0.2μm), coarse clay (0.2-2μm), silt (2-50μm), fine sand (50-250μm) and coarse sand (250-2000μm) and then the NS contents were measured by a GC-FID method.

Our results showed that although the clay and silt fractions comprised the major NS pools, there was a large variation among the size separates due to fertilization effects. The application of organic manure alone resulted in a significantly increase in the accumulation of NS in each particle-size fraction, but preferential enrichment was especially found in the coarse sand, indicating that organic manure plays a key role in promoting SOM quality in the Chinese Mollisol. The application of chemical fertilizers had no clear effect on either NS accumulation or distribution in size fractions. The combined application of chemical fertilizers and organic manure, however, did not only enhance the accumulation of NS in all size fractions, but also leaded to a shift of NS from fine to coarse particles. The significant decrease of the (Gal+Man):(Ara+Xyl) ratio in all the particle-size fractions, especially the coarse fractions indicated a higher contribution of plant sugars to the polysaccharide pool in the plots amended with organic manure, suggesting that soil microorganisms do not necessarily utilize all of the plant derived organic components, the extra part of which will be stored in large fractions as carbon and energy sources for future use. The findings therefore reveal that enough organic input is very necessary for maintain the quantity and quality of organic matter in the soil.

P6. Impact of long-term inorganic and organic fertilizer applications on lignin dynamics in Mollisol

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Fertilization is one of the essential managements to maintain and increase soil organic matter level in agricultural soil. It has been realized that fertilizer applications influence different organic carbon (including labile and refractory) pools in arable soil diversely, however, the dynamic of relative refractory lignin response to different fertilization patterns is still kept unclear. Therefore, the impact of different long-term (30 years) fertilizations (i.e. inorganic and organic fertilizers alone) on both content and degradation degree of lignin in the Mollisol in northeast China was investigated. Lignin monomers were released by alkaline CuO oxidation method and quantified by gas chromatography (GC)/flame ionization detection (FID). At the time scale of decades, long-term inorganic fertilization exhibited no significant effect on both the content of lignin in soil and the relative accumulation of lignin in SOC in 0-20 cm, but could increase those of lignin in 20-40 cm. In addition, higher acid to aldehyde ratios of vanillyl and syringyl units suggested that lignin phenols were in a more oxidized state in both two soil layers in comparison with those sampled in 1989. By contrast, lignin was clearly accumulated in both two soil depths after long-term organic fertilizer application and the relative accumulation of lignin in SOC was evident in two horizons. Furthermore, the application of organic fertilizer brought a great amount input of carbon which could improve microbial activity significantly, thus the oxidation degree of lignin was also increased in two soil layers compared with the unfertilized treatment. Our investigation was essential to delineate a better fertilizer management practice under a maize cropping system of Mollisol in northeast of China.

P7. The impaction of nitrogen fertilization on nitrogen concentrations in stream explored with subwatershed and contributing zone approaches

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The impact of agricultural activities, especially fertilizer application on stream water quality in agricultural watershed is a crucial issue. In this paper, subwatershed and contributing zone approaches were used to explore the correlations between nitrogen application and nitrogen concentrations in stream for a small watershed in Three Gorges Reservoir Area, China. The results indicated that, (1) Average nitrogen application rate was 273 kg N ha^{-1} and chemical fertilizers accounted for about 90%. Total nitrogen (TN) concentrations in stream were more than 2.50 mg L^{-1}, and nitrate (NO_3^--N) was the dominant species. TN was obviously higher in the wet season than in the dry season; (2) Average nitrogen application rate per hectare in subwatersheds significantly correlated with nitrogen concentrations in stream water. However, the contributing zone approach showed a significant correlation between total nitrogen application amount and nitrogen concentrations, especially in the area of 200 m of upstream contributing zones. These results indicated that both subwatershed and contributing zone approaches are feasible methods to study the characteristics and influencing factors of nutrients in stream, but the analytical objects are different. Furthermore, the present study provides a basic theory and method to study the influence of agricultural pollutants on stream in some small agricultural watersheds.

P8. Nitrogen output via runoff for a small watershed in the three gorges reservoir area

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For understanding the dynamic change of nitrogen output with runoff from a small rural watershed in the Three Gorges Reservoir area, a monitoring point was setup in the outlet of Zhangjiachong watershed to observe runoff volumes, nitrogen concentrations and nitrogen input loads from April of 2007 to March of 2008. These results indicated that: (1) nitrogen concentrations dramatically increased during rainfall process, but these values decreased with the runoff dropped; (2) the distribution of various species nitrogen output presented significant seasonal variation; N output was distinctly higher in the rainy months (from June to September), accounted for more than 75% of total output, the total nitrogen in runoff was dominated by NO_3^--N, more than 80%. Thus, summer was the key period of N input, and it is a priority for nutrients loss management to avoid NO_3^--N loss. (3) Significant linear relations between nitrogen discharge and precipitation. Moreover, fertilizer application was the main source in this watershed. These above conclusions suggested that rainfall and fertilizer application are the main reasons for nitrogen loss in Zhangjiachong watershed.

P9. Phosphorus leaching from an aquatic brown paddy soil after chemical fertilizer application

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This study investigated the effects of different rates of phosphorus (P) fertilizer application on P loss by leaching and on vertical transportation of P. An aquatic brown paddy soil in organic glass columns was used for the experiments. There were no significant differences ($p=0.23$) in the concentrations of dissolved reactive P (DRP), unreactive P (UP), and water total P (WTP) in drainage water between samples subjected to different rates of P application. The concentrations of DRP, UP, and WTP were <0.1 mg P l^{-1}because of the strong P adsorption capacity of the test soil. There were no significant differences in the amounts of P lost through leaching at 60 cm soil depth between soils with different P application rates. However, a significant vertical movement of 0.5 M $NaHCO_3$-extractable P (Olsen-P) and 0.01 M $CaCl_2$-extractable P ($CaCl_2$-P) occurred in the soil when the P application rate was >800 kg P ha^{-1}. The relationship between Olsen-P and $CaCl_2$-P in the soil suggested that the threshold value of Olsen-P was 53.7 mg kg^{-1}, and that levels above that could trigger a rapid increase in soil $CaCl_2$-P. Therefore, high rates of P application to soils (above 384 kg P ha^{-1}) should be avoided to reduce the risk of nonpoint source P pollution caused by field drainage and runoff, especially in high P status soils.

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